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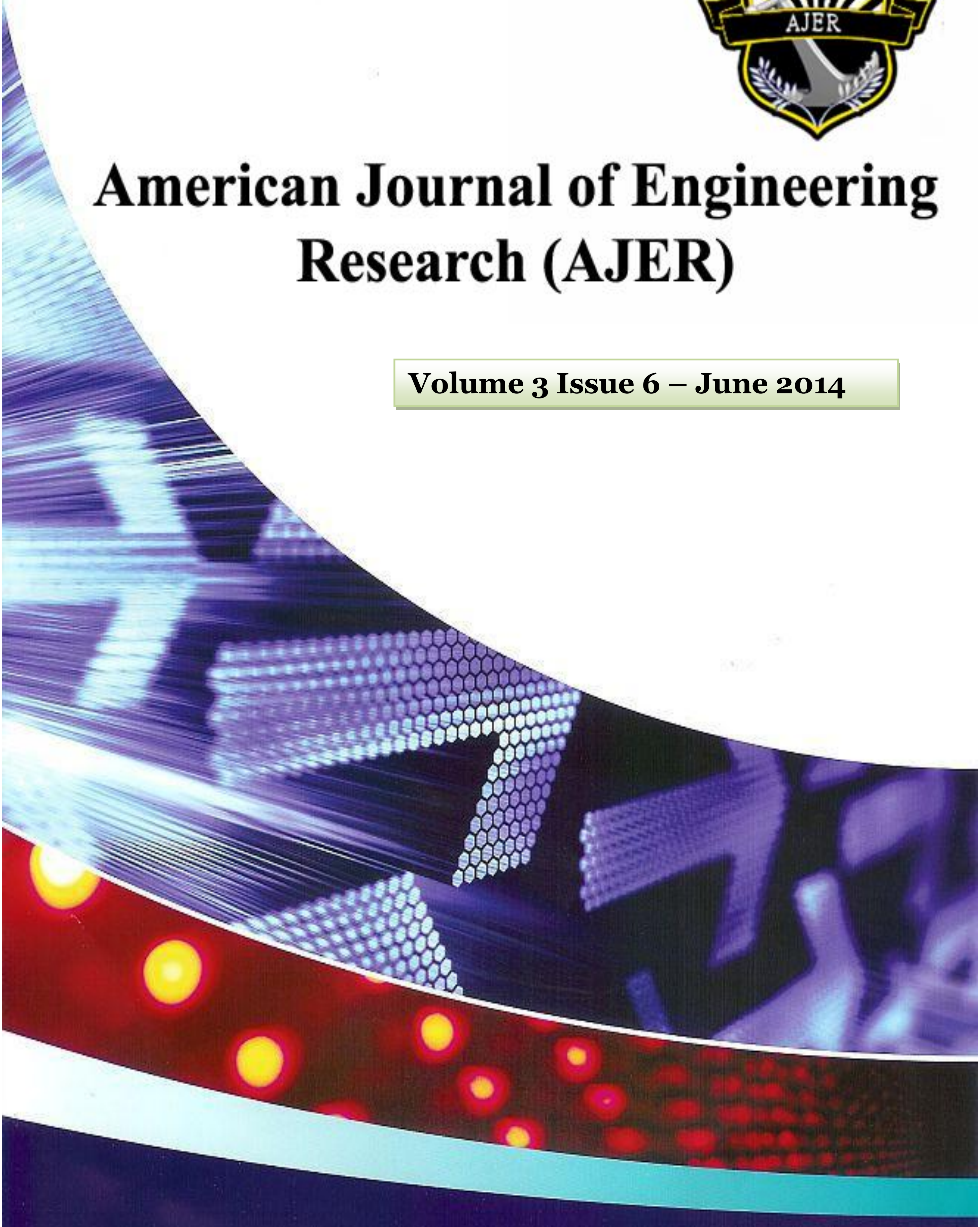

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Synthesis of $CoAl_2O_4$ spinel from cobalt-loaded zeolite-A

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Abstract: - One of the methods for synthesis of $CoAl_2O_4$ is calcination of cobalt loaded zeolite which is yielded via ion-exchange treatment on zeolites. In the present work for the first time the phase evolution of cobalt loaded zeolite-A studied by simultaneous thermal analysis. To get better understanding of microstructure of products x-ray diffraction and scanning electron microscopy were taken. Results showed that zeolite collapse and spinel nucleation happen around 845°C, in which nanocrystalline spinel are being dispersed within the amorphous siliceous matrix.

Keywords: *- cobalt aluminate, spinel, zeolite A, ion-exchange, pigment*

I. INTRODUCTION

Cobalt aluminate normal spinel ($CoAl_2O_4$) is known as an idiochromatic ceramic blue pigment whose blue color is attributed to tetrahedrally coordinated Co^{2+} ions [1,2]. As cobalt aluminate spinel possesses basicity and redox capbility and is stable at high temperatures, potential application of the composition has been studied for heterogeneous catalyst in reforming of methane, capture and decomposition of nitrous oxide and capture of carbon dioxide [3]. Then to take full advantage of the mixture for those applications, so far four synthesis approaches have been reported. Among the methods, solid state reaction between the corresponding metal salts like oxides and carbonates powders through conventional heating is considered as a reliable and common method for synthesis of the spinel. But this method has some drawbacks: a) seeks heating at high temperatures, above 1200°C, b) is time consuming, at least 10 hours, c) inevitable inhomogeneity of the mixed powders, thereby, existing some unwanted compounds after calcination like: Al_2O_3 , Co_3O_4 , CoO and spinel with Co/Al≥0.5 ($Co^{2+}Co^{3+}_xAl_{2-x}O_4$) at which the extra cobalt ions as Co^{3+} would be placed in octahedral positions and bring green to black tint into the pigment [1,2,4,5]. Some alternative methods such as sol-gel [5-8], co-precipitation [9] and cobalt-loaded zeolite [4,10,11] have been suggested in recent years in order to get rid of different problems in solid state reaction.

Cobalt-loaded zeolite method consists of two steps, ion-exchange and calcination. In ion exchange treatment, the extra framework cations of zeolite (here Na^+ for zeolite A) are replaced by Co^{2+} and the product is called "cobalt-loaded zeolite" or "cobalt-exchanged zeolite". Heating the cobalt-loaded zeolite collapses zeolite framework and cobalt aluminate spinel nucleates simultaneously in an amorphous matrix. This amorphous matrix brings some advantages, including: a) a better and sooner matching of pigment particles with glaze and also delaying the dissolution of pigments in glaze, b) to limit the escape of harmful cobalt ion into the environment, c) to prevent spinel crystals from being agglomerate during calcination. Leaching away the matrix gives well separated fine spinel crystals that are appropriate for catalyst application. Moreover, some general advantages of the rout are summarized in the following: a) ion-exchange treatment gives a uniform elemental distribution of Co^{2+} ions in the atomic scale beside Al^{+3} ions in zeolite framework. Then atomic diffusion, which is as a main barrier in solid reaction process, would be largely promoted [4,5,10], b) in maximum rate of ion-exchange each of the two Al^{3+} ions are balanced by one Co^{2+}. Then, the molar ratio of Co/Al would be equal or less than 0.5. Therefore, there would be no need to be concerned about the formation of cobalt aluminate spinels with Co/Al≥0.5 ($Co^{2+}Co_x^{3+}Al_{2-x}O_4$). This method also has some advantages in comparison with co-precipitation and sol-gel. Co-precipitation often gives non-uniform product in large batches. Moreover, the alumina which is often formed from inhomogeneous precursors cannot be dissolved as easy as silica. Alkoxide precursors for sol-gel method are expensive and strict safety precautions have to be observed during the calcination step.

Chemically, zeolites are represented by the empirical formula {$M_{2/n}O$. Al_2O_3. $ySiO_2$. wH_2O} where M is extra-framework cation belongs to groups IA or group IIA elements, such as sodium, potassium, magnesium and calcium. Each AlO_4 tetrahedron in the framework bears a net negative charge which is balanced by extra-framework cation. The cations are mobile and ordinarily undergo ion exchange [12]. Cation exchange capacity (CEC) of zeolites is depended on some factors like: 1) size of channel's window of zeolite's structure, 2) Si/Al molar ratio in zeolite formula. Low silica zeolites (1≤ Si/Al ≤1.5) like zeolite-A which is chosen for fallowing experiments have higher CEC in comparison with high silica zeolites [13]. 3) charge density (charge/size) of ion that is supposed to enter into the zeolite as a guest ion, 4) size of guest ion and hydrated guest ion [13,14], 5) hydration energy of guest ion [14-16], 6) pH [14,17-19], 7) electrostatic bonding energy of the competing ions to the inner cavity surface of zeolite, [14]. 8) temperature [15-18,20,21].
Although several works has been conducted to determine cobal-loaded zeolite-A properties [4,10,11], still there is no exact insight about thermal behavior of ones. The motivation of the existing research is to investigate and implement thermal behavior of the pigment and subsequently phase evolution. For this means, STA and XRD equipments was utilized to explain the changes during heating process.

II. MATERIALS AND METHODS

Ion exchange was done at 85°C for 30 minutes in agitating aqueous solution of cobalt chloride with concentration of 0.1 M and solid/solution weight ratio of 30 g/lit. The purity of zeolite-A powder and hydrated cobalt chloride ($CoCl_2.6H_2O$) was 90% and 98%, respectively. The pH of suspension without adding additive was 6 and didn't change. Fig. 1 shows the steps followed in this investigation for synthesis of cobalt aluminate normal spinel via "cobalt-loaded zeolite" method. Cobalt-loaded zeolite-A that yielded from ion exchange treatment was filtered, washed with deionized water, dried and then calcined.

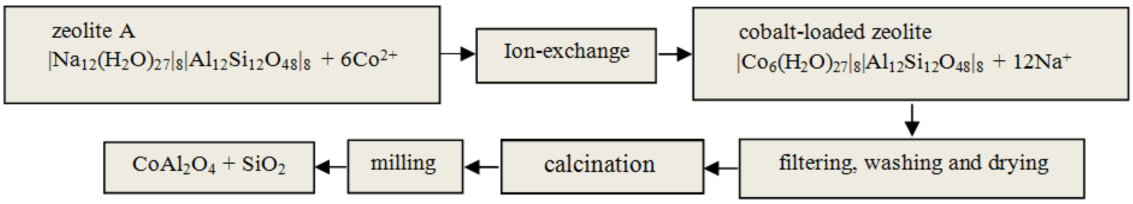

Figure 1: Steps involved in synthesis of $CoAl_2O_4$ from zeolite-A via "cobalt-loaded zeolite" method.

Calcination was done in two separate groups for different aims.

First group of calcinations

In order to find out what phase evolutions happen at peak temperatures detected by differential thermal analysis (DTA). First of all prepared samples heated up to the given temperatures taken by that thermal analysis tool with same heating rate as the DTA analysis (10°C/min). just after hitting the determined temperatures samples quenched in front of blowing cold air (5°C).

Second group of calcinations

Samples held at determined temperatures (ranging from 600 to 1200°C) for 5 hours for the sake of accomplishment of the spinel crystal growth and then cooled down within the furnace to room temperature. The characterizing tools used in this research: X-ray diffraction (XRD) in a Philips Expert diffractometer with Ni filtered CuKα radiation. Energy dispersive X-ray (EDX) with VEGA\\TESCAN microscope operated in voltage 30 kV. High resolution transmission electron microscopy (HRTEM), model: Tecnai TF20 FEGTEM, operating at 200kV. Simultaneous thermal analysis (STA) was done with a NETZSCH STA 409 PC/PG instrument with heating rate of (10°C/min).

III. RESULTS AND DISCUSSION

As shown in Fig.1 first step is ion-exchange treatment in which two Na^+ ions in zeolite-A structure are replaced by one Co^{2+} ion. Fig. 2 shows the map of Co^{2+} ion in cobalt-loaded zeolite-A (Fig. 2.c), and map of Na^+ ion for both zeolite-A and cobalt-loaded zeolite-A, (Fig. 2.b and d, respectively). Fig.2 further reveals a uniform distribution of Co^{2+} was formed in zeolite powder after the ion-exchange treatment, thereby reducing the population of Na^+ ions. Size of channel's window of zeolite-A is (4.1 * 4.1 A˚) [22] meanwhile the size of cobalt ion (Co^{2+}) is estimated around 1.3A˚ and for completely hydrated cobalt $[Co(H_2O)_6]^{2+}$ is approximately 8.46A˚ in diameter [13]. In this situation some of the H_2O molecules around the hydrated cobalt ion are stripped of to allow successful passage of the narrow windows [14].

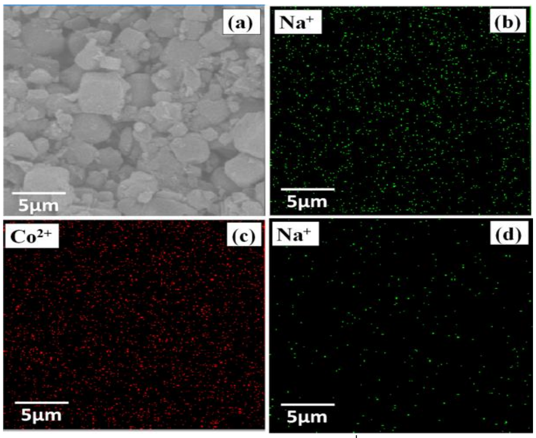

Figure 2: SEM micrograph of zeolite-A powder (a), map of Na^+ ion in zeolite-A (b), map of Co^{2+} and Na^+ ions in cobalt-loaded zeolite-A (c and d, respectively).

STA analysis of cobalt-loaded zeolite-A is given in Fig. 3. According to the TGA graph, 27% weight loss happens by 600°C. The reduction in weight is attributed to crystalline water and superficial water and also would be much legal when the weight loss number is being compared with weight loss one (24%) that is indicated in case of zeolite-A formula. In order for distinguishing slight weight changes as much as, derivation TG graph (DTG) in terms of time was taken (see Fig.4). The two distinct peaks shown in DTG which are assigned at 120 and 175°C (Fig. 4) are matched with an obvious endothermic peak at 120°C and a slight slope change about 175°C in DTA graph (Fig.3) respectively. Generally, there are two types of H_2O molecules in channels of zeolites structural: (a) H_2O molecules coordinating the extra-framework cations and (b) "spacefilling H_2O molecules" bonded by hydrogen bonds to the cavity surface. While hydrated zeolite is being heated, the released H_2O first is bonded to extra-framework Na, and followed deal mainly by "spacefilling" hydrogen-bonded molecules [14]. Accordingly, the endothermic peak and weight loss at 120°C might mostly be related to exiting the H_2O coordinating extraframework Na and the "spacefilling" H_2O molecules release is expedited around 175°C.

Oxidation of Co(II) to Co(III) happens about 300°C [2] then the weak exothermic broad peak around 310°C in DTA graph (Fig. 3) can be related to this oxidation although there is not a clear sign of oxygen absorption and consequent weight increase in the TG and DTG graphs (Fig. 3 and Fig. 4). Dropping the DTA graph after 1050°C (Fig. 3) can be the result of melting the glass matrix.

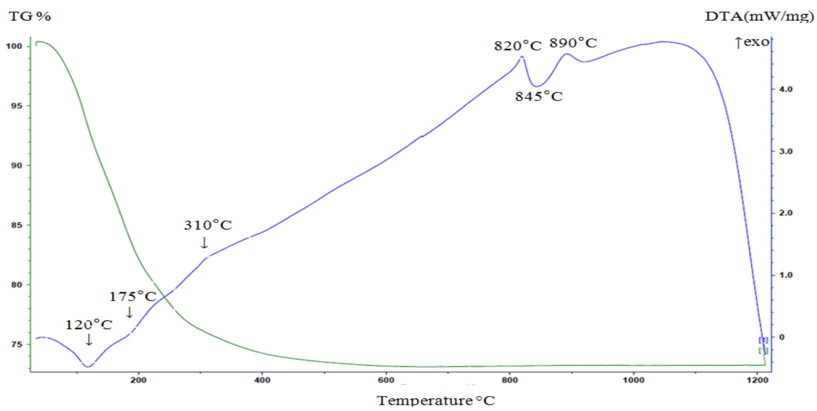

Figure 3: STA analysis of cobalt-loaded zeolite-A.

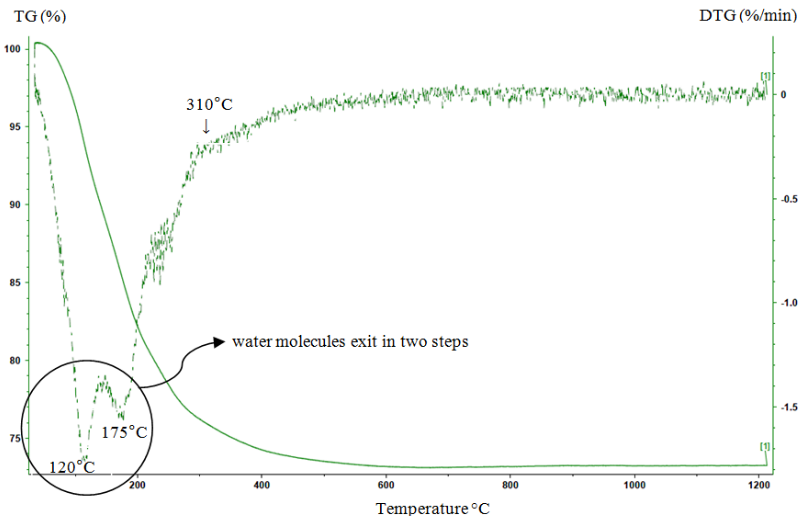

Figure 4: TG and DTG graphs which are obtained from STA analysis of cobalt-loaded zeolite-A.

Three more peaks can be distinguished in the DTA graph: two exothermic at 820 and 890°C and one endothermic at 845°C. In order to find out what phase evolutions happen at these temperatures the *first group of calcinations* was performed. The XRD phase analysis of products are shown in Fig. 5. As this figure shows all the peaks in XRD pattern of samples-820°C belong to zeolite-A which means that zeolite structure is remained stable until this temperature. Conclusively, the supposed weak exothermic peak at 820°C in DTA graph (Fig. 3) should not be taken a signified peak because no phase evolution happens at this temperature. The XRD pattern of sample-845°C shows that at this temperature zeolite framework collapses which results in appearing an endothermic peak at this temperature in DTA graph (Fig. 3). Moreover, a broad peak at 2θ=65.5° can be distinguished in this pattern which belongs to cobalt aluminate spinel and is the sign of spinel nucleation in parallel with zeolite collapse. Perhaps the exothermic effect of crystal nucleation about 845°C is dominated by the endothermic effect zeolite collapse.

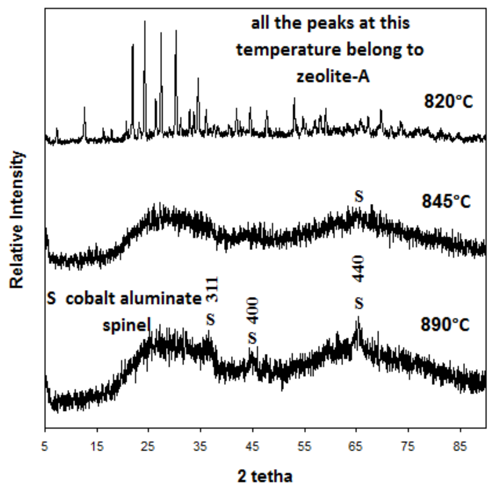

Figure 5: XRD phase analysis of *first group of calcinations* products. Samples are heated until 820°C, 845°C and 890°C and quenched in front of blowing cold air.

In the XRD pattern of sample-890°C three peaks belong to cobalt aluminate spinel appears. The exothermic peak at 890°C in DTA graph (Fig. 3) can be related to the vast nucleation and growth of cobalt aluminate spinel. The collapse of zeolite framework is necessary for the nucleation of spinel. In fact, these two occur simultaneously. The temperature of this transition depends on type of zeolite and guest transition element [10]. This temperature is reported between 750˚C-770˚C by M.T.J. Lodge et al [4], who used zeolite-X as precursor and 840°C by W. Schmidt et al [10] who used ambient pressure for calcination of cobalt-loaded zeolite-A.

In order to complete the spinel crystal growth *second group of calcinations* was performed. Fig. 6. shows the XRD phase analysis of products. The XRD results show that the zeolite structure is until 600°C. At 800°C zeolite framework collapses and distinct peaks belonging to cobalt aluminate spinel structure appear.

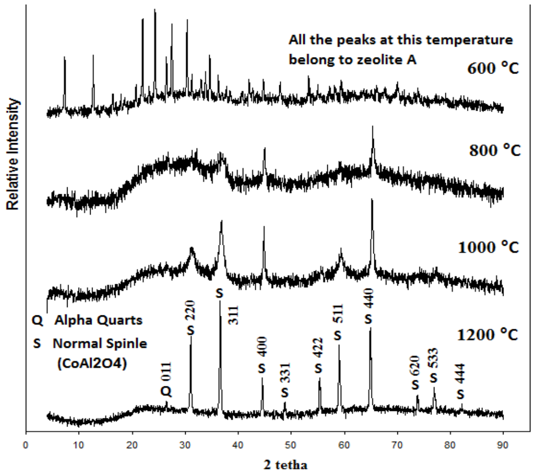

Figure 6: XRD phase analysis of *second group of calcinations* products. Samples are heated at 600, 800, 1000 and 1200°C for five hours and cooled down within the furnace.

Comparing the XRD patterns of sample-800°C in Fig. 6. and sample-890°C in Fig. 5. it can be concluded that holding the sample at calcination temperature for 5 hours has helped zeolite structure collapsing and spinel nucleation and decreases the temperature of this transition more than 100°C. Fig. 6. further reveals that with increasing the heating temperature to 1000 and 1200°C the spinel structure peaks become narrower and more intensified. The weak peak at 2θ°=26.4° which can be distinguished in XRD pattern of sample-1200°C is for alpha quartz structure and all the other peaks belong to normal spinel ($CoAl_2O_4$). The peak at 2θ=48.1° confirms that the yielded spinel is "normal" spinel [2]. Moreover, the broad hill in the range 20°<2θ°<30° is related to the amorphous phase consist of Si remained from collapsing the zeolite-A plus oxygen, sodium and probably some unreacted aluminum.

HRTEM image of sample1200°C is given in Fig. 7.a. The image reveals cubic crystals and polycrystals of $CoAl_2O_4$ embedded in an amorphous matrix. Fig. 7.b shows the TEM diffraction pattern of one of these crystalline areas. In Fig. 7.b the distance between diffraction points and center is equal to 1/d = R/(λ.L) which d is lattice space, R is vector distance , λ is wavelength and L is camera length. Other than two diffraction points, (310) and (330), which belong to alpha quartz, Other ones are assigned for spinel structure. Some of the diffraction points which belong to one zone-axis are indexed.

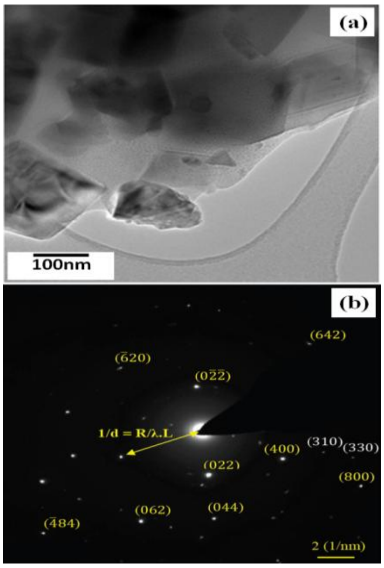

Fig. 7. HRTEM images of sample 1200˚C which shows spinel's cubs embedded in amorphous matrix (a), TEM diffraction pattern of one of these crystalline areas (b).

The average crystallite size of $CoAl_2O_4$ was calculated using Sherrer formula, below, [23] for samples synthesized at 1000 and 1200°C (Table 1).

$$t = \frac{0.9\lambda}{B\ Cos\theta_B}$$

Where t is particle diameter, λ is the wavelength of the incident X-ray radiation, θ_B is the Bragg angle that exactly satisfies the Bragg law and B is the width at half maximum height of the analyzed reflection. The results in Table 1 show that increasing the temperature from 1000 to 1200°C causes a substantial crystal growth from 12 to 43.3 nm in average. The average size of crystals in TEM images (Fig. 7) seems bigger than what was calculated via Sherrer formula through XRD patterns (Table 1). A part of this disagreement could be because of the fact that the crystals observed in TEM image can be polycrystalline and the Deby Sherrer formula only gives the average crystallite size.

Table 1. The average crystallite size of $CoAl_2O_4$ calculated from Deby Sherrer formula for samples calcined at 1000 and 1200˚C

Temp	Average crystallite size
1000˚C	12 nm
1200˚C	43.3 nm

IV. CONCLUSION

Using ion-exchange treatment, Co^{2+} ions uniformly disperse into the zeolite-A structure. By heating the "cobalt-loaded zeolite-A" the two special types of H_2O molecules, spacefilling and H_2O coordinating the extra-framework cations, go out mostly at 175 and 120°C respectively. Collapse of zeolite structure and nucleation of spinel happen simultaneously around 845°C. Blue cobalt aluminate normal spinel crystals dispersed in a silicious matrix is the final product of calcination process. The average crystallite size for sample calcined at highest temperature (1200°C) for 5 hours was 43.3 nm.

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Nigerian Power Sector: Comparative Analysis of Productivity

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Abstract: -Undoubtedly, power instability in the Nigerian Power Sector despite several mitigative measures by the government has created some chocks in the national socio-economic wheel of development. Unfortunately, the conceptual objective of the power reforms to remedy inadequate power generation capacity, inefficient usage of capacity, ineffective regulation and high technical losses is tardily being achieved. This research comparatively analyzed the rate of productivity change in Nigeria's power sector from 2005 – 2013. The analysis reveals that privatization improved the productivity index by 89%. It is expected that this work may assist the power policy makers and regulators to come up with abetter framework for the full realization of the noble goals envisaged in this reform act.

Keywords:- *Ineffective regulation, Productivity change, Productivity index, Power reform, Technical losses.*

I. INTRODUCTION

Electric power poverty is the lack of or limited access to electricity. Put differently, it occurs when supply of electric power falls below demand or expectations. Electric power poverty is a perennial social problem affecting most developing countries not just Nigeria alone. Statistics shows that 1.6 billion people (one quarter of the world population) have no access to electricity, 80% of them in South Asia and Sub-Saharan Africa (IEA, 2002). Four out of five people without electricity live in rural areas of the developing countries. Electric power poverty or crisis is a major barrier to growth and development in several areas of the world. This implies that many countries wishing to develop and become industrialized, must address their electric power challenges and ensure that adequate electricity is provided at affordable cost.

Electricity plays a very important role in the socio-economic and technological development of every nation. The electricity demand in Nigeria far outstrips the supply and the supply is epileptic in nature. The country is faced with acute electricity problems, which is hindering its development notwithstanding the availability of vast natural resources in the country. It is widely accepted that there is a strong correlation between socio-economic development and the availability of electricity. No doubt the epileptic performance of the power sector, in terms of matching supply with demand expectations, has led to a decline in the living standard of the population and hampered sustainable development in the country. Given the low levels of electricity generation and access in Sub-Saharan Africa, it is not surprising that per capita consumption of electricity averages just 457 kWh annually, with the average falling to 124 kWh if South Africa is excluded (World Bank, 2005). The wide energy gap and poverty in comparative regional terms is apparent in per capita electricity consumption in Nigeria being 140 KWh in 2004 compared to 1337 KWh in Egypt and 4560 KWh in South Africa as at 2003 (IwayemiA., 2008[a]). Nigeria's projected per capita consumption of 5000kWh in 2030 will be about 20% above the level that obtained in South Africa in 2003.

For the past three decades, inadequate quantity, quality and access to electricity services have been a routine feature in Nigeria. Although Nigeria is blessed with large amount of renewable energy resources like hydropower, solar, wind and biomass, extensive substitution of poor public electricity supply with high polluting self-generated power prevails. In fact, Nigeria's economy has been described as a *"diesel generator economy"* where businesses incur extremely high overhead cost in maintaining their power generators which cause unsafe health environment due to their carbon footprints. Conceptually, the power reforms are aimed at solving a myriad of problems, including limited access to infrastructure, low connection rates, inadequate power generation capacity, poor utilization capacity, and lack of capital for investment, ineffective regulation, high technical losses and vandalism as well as insufficient transmission and distribution facilities (Adenikinju, 1998).

II. OVERVIEW

To discuss the power sector in Nigeria in a realistic and practical context, some brief review is necessary to give an insight into the sector since independence. The history of electricity in Nigeria dates back to 1896 when electricity was first produced in Lagos, fifteen years after its introduction in Britain from which Nigeria obtained independence in 1960. The total capacity of generators used then was 60kW (Makoju J.O, 2007). The first attempt to nationally coordinate the supply and development of electricity occurred in 1950 with the establishment of a central body known as Electricity Corporation of Nigeria, ECN.

On1st April 1972, the operation of ECN and NDA were merged to form National Electric Power Authority (NEPA) a company with exclusive monopoly over electricity generation, transmission, distribution and sales throughout the country. Sincethe inception of NEPA which was renamed Power Holding Company of Nigeria (PHCN), the authority expanded annually in order to meet the ever-increasing demand. Unfortunately, majority of Nigerians still do not have access to electricity and supply to those connected is not regular. Nigeria also joined the trend, having deregulated its electricity industry through the enactment of the Electric Power Reform Act of 2005 (Isola W.A., 2011). The law paved the way for restructuring the power sector by the unbundling of PHCN into 18 companies: six generating companies, one transmission company, and 11 distribution companies and Independent Power Producers (IPPs). The incorporation of these enterprises under the National Integrated Power Project (NIPP) has been concluded. Ironically, though the electricity crisis has intensified,the present government has suspended the NIPP citing constitutional reasons associated with its financing from excess crude funds (Iwayemi A., 2008[a]).

Despite its long history, PHCN's developmentwas very slow and electricity generation in Nigeria deteriorated over the years. This was hardly expected given the country's enormous endowment in natural resources that facilitate and enhance electricity production. While the generation, transmission and distribution (GTD) deteriorated, the demand for electricity exponentially increases continuously. PHCN has been incapable of providing minimum acceptable international standards of electricity service reliability, accessibility and availability for the past three decades (Iwayemi A., 2008[b]). One method PHCN has used to beef up its actual power output from time to time has been the commissioning of new stations. Experience has shown that new power plants merely solve the problem in the short run. The technical problems that put out the older units no sooner than latter affect the new ones and they also go down (Adeola A., 2008). One of the objectives of this study is to compare the performance of the country's power generation stations over a period of time and make recommendations on how to improve their performance.

III. METHODOLOGY

Electric energy production in Nigeria over the last 40 years varied from gas–fired, oil–fired, hydroelectric power systems to coal-fired with hydroelectric power system and gas–fired system taking precedence (Garba B.& Sambo A.S. et al, 2009). Substantial expansion in quantity, quality and access to electricity is fundamental to rapid and sustained economic growth and poverty reduction.

The analysis of a network utility, such as an electricity industry, requires a fundamental rethinking on the way in which the sector is operated and regulated. The basic idea is to compare the productivity of Nigeria's power plants and to assess the impact of reform on Nigeria's power sector.

The policy implications of surveyed papers focus on the differences in efficiency and drivers of efficiency, the role of alternative regulatory frameworks in efficiency, and the comparative analysis of public and private companies. Kleit and Terrell observed that deregulating electricity generation increases efficiency while Barros and Peypoch state that regulation without competition decreases efficiency (Barros & Peypoch, 2008; Kleit & Terrell, 2000). Efficiency analysis in relation to electricity has been concentrated on distribution networks. Jamasb and Pollitt reviewed the frequency with which different input and output variables are used to model electricity distribution (Jamasb T.& Pollitt M., 2001).

Research on Nigeria power sector includes those on policies and issues, electricity generation, transmission and distribution, cost of infrastructure failure, energy poverty and investments in the power sector and analysis of power sector productivity(Iwayemi A., 2008; Garba B. et al, 2009; Adenikinju A., 2005; Agba M., 2011; Iwuamadi O.C. et al, 2012). None of these papers compared the annual productivity of Nigerian power plants and assessed the impact of the reformon the power sector using MATLAB®.

IV. MODEL DESCRIPTION AND ANALYSIS

The comparative analysis of productivity of a network utility, such as the Nigerian electricity industry requires a fundamental consideration of all factors of electricity production. This research analysis is with specific interest in electricity generation in Nigeria. Not restricting the survey to a sample of recent papers on energy production, it is observed that they adopt one of two complementary efficiency methodologies: Data Envelopment Analysis and the Stochastic Frontier Model. It is recognized in literature that both methods give similar ranking and that there is no universally agreed set of input and output variables for modeling of electricity units. This work employed the Cobb-Douglas Stochastic Frontier Model and Malmquist Index.

Cobb-Douglas Stochastic Frontier Model

If the electricity generation function is denoted by $G(L,K)$, then the partial derivative $\partial G/_{\partial L}$, is the rate at which electricity generation changes with respect to the amount of labor. Economists call it the marginal production with respect to labor or the marginal productivity of labor. Likewise, the partial derivative $\partial G/_{\partial K}$ is the rate of change of electricity generation with respect to capital and is called the marginal productivity of capital (Bao Hong, Tan, 2008).

In these terms, the assumptions made by Cobb and Douglas can be stated as follows:

1. If either labor or capital vanishes, then so will production.
2. The marginal productivity of labor is proportional to the amount of production per unit of labor.
3. The marginal productivity of capital is proportional to the amount of production per unit of capital.

Because the production per unit of labor is $G/_{L}$, assumption 2 says that $\partial G/_{\partial L} = \alpha[G/_{L}]$, for some constant α. If we keep K constant $(K = K_0)$ then this partial differential equation becomes an ordinary differential equation:

$$dG/_{dL} = \alpha[G/_{L}] \quad (1.0)$$

This separable differential equation can be solved by re-arranging the terms and integrating both sides:

$$\int 1/_{G}\, dG = \alpha \int 1/_{L}\, dL \quad (1.1)$$

$$\ln(G) = \alpha \ln(cL) = \ln(cL)^{\alpha} \quad (1.2)$$

And finally,

$$P(L,K_0) = C_1(K_0)L^{\alpha} \quad (1.3)$$

Where $C_1(K_0)$ is the constant of integration and we write it as a function of K_0 since it could depend on the value of K_0.

Similarly, assumption 3 says that:

$$dG/_{dK} = \beta[G/_{K}] \quad (1.4)$$

Keeping L constant$(L = L_0)$, this differential equation can be solved to get:

$$G(L_0,K) = C_2(L_0)K^{\beta} \quad (1.5)$$

Finally, combining equations (1.3) and (1.5) gives:

$$G(L,K) = bL^{\alpha}K^{\beta} \quad (1.6)$$

Where b is a constant that is independent of both L and K.

Assumption 1 shows that α > 0 and β > 0.

Notice from *equation (1.6)* that if labor and capital is both increased by a factor m, then

$$G(mL,mK) = b(mL)^{\alpha}(mK)^{\beta} = m^{\alpha+\beta}(bL^{\alpha}K^{\beta}) = m^{\alpha+\beta}G(L,K) \quad (1.7)$$

If $\alpha + \beta = 1$, then $G(mL,mK) = mG(L,K)$, which means that production is also increased by a factor of *m* (Boa Hong, Tan; 2008).

Here the Cobb-Douglas stochastic production frontier function is as written in equation (1.6)

$G(L,K) = bL^{\alpha}K^{\beta}$

Where:

• $G = the\ total\ electricity\ generated\ in\ a\ period$
• $L = labor\ input\ (the\ total\ number\ of\ person\ hours\ worked\ in\ a\ period)$
• $K = capacity\ input\ (the\ installed\ capacity\ of\ equipments)$
• $b = total\ factor\ of\ productivity$

$\alpha\ and\ \beta$ are the output elasticities of labor and capital, respectively. These values are constants determined by available technology in a given period.

Output elasticity measures the responsiveness of output to a change in level of either labor or capital used in production (Iwuamadi et al, 2012).

V. MALMQUIST INDEX

This is a bilateral index that enables a productivity comparison between two different entities of similar category or between two different periods for the same entity. These entities could be economy, firms, processes, performances and so on. It is based on the concept of production function, that is, a function of maximum possible production, with respect to a set of inputs pertaining to capital and labor (Malmquist S., 1953).

Here, we are comparing the productivity function between periods to assess the impact of power reform. Assume that the aggregate electricity generation function of a utility firm is given as$G(L, K)$. Then for firm A in period*t*, we have the aggregate production function as $G_t(L_{A_t}, K_{A_t})$ and for period *t+1*, we have $G_{t+1}(L_{A_{t+1}}, K_{A_{t+1}})$. L and Kdescribe the labor inputand the installed capacity respectively.

Substituting the inputs of period *t+1* into the generation function of *t* results to$G_t(L_{A_{t+1}}, K_{A_{t+1}})$and the inputs of *t* into *t+1* to get$G_{t+1}(L_{A_t}, K_{A_t})$. The Malmquist index of period *t* with respect to period *t+1* is the geometric mean of $M_{A_t} = G_t(L_{A_t}, K_{A_t}) \big/ G_t(L_{A_{t+1}}, K_{A_{t+1}})$ (1.8a)

and

$$M'_{A_t} = G_{t+1}(L_{A_t}, K_{A_t}) \big/ G_{t+1}(L_{A_{t+1}}, K_{A_{t+1}}) \tag{1.8b}$$

Mathematically Malquist Index, *MI*for firm *A* between periods*t and t+1* is stated as:

$$MI_{A_{(t,t+1)}} = \sqrt[2]{(M_{A_t} \times M'_{A_t})} = \sqrt[2]{\left(\frac{G_t(L_{A_t}, K_{A_t})}{G_t(L_{A_{t+1}}, K_{A_{t+1}})}\right)\left(\frac{G_{t+1}(L_{A_t}, K_{A_t})}{G_{t+1}(L_{A_{t+1}}, K_{A_{t+1}})}\right)} \tag{1.8c}$$

VI. DATA SOURCE

This analysis made use of dataset on all the existing Nigerian electricity plants from 2005 to 2013 from several sources. The sources of the data are the Power Holding Company of Nigeria generation report, National Control Center PHCN Oshogbo, publications of Nigerian Ministry of Power and Steel. However data gaps are filled with other sources such as National Power Training Institute of Nigeria (NAPTIN) and publication of Iwuamadi et al, 2012.

VII. ESTIMATION OF MODELS

Let the power generation technology of Nigerian power stations in time *t*, be denoted as$\mathcal{G}_t$, which represents the transformation inputs$\{X^t \in R^m\}$ into the outputs$\{Y^t \in R^n\}$.

$$\mathcal{G}_t = \{(X^t, Y^t): X^t\, can\ produce\ Y^t\}$$

$$\{(K_t, L_t) \in X^t\}\ where\ K\ and\ L\ are\ installed\ capacityand\ labor\ respectively$$

$$\{(E_p, L_{av}, L_{max}) \in Y^t\}\ whereE_p, L_{av}\ and\ L_{max}\ are\ electric\ energy\ produced, average\ load\ and\ maximumload\ respectively$$

$$R^m\ and\ R^n\ are\ all\ the\ inputs\ and\ outputs\ respectively$$

Assuming constant return to scale of the input variables in consideration (Iwuamadi et al, 2012), an algorithm for human labor is given as:

$$L_t = \left|\left(\frac{K_t - K_{t-1}}{K_{t-1}}\right) L_{t-1} + L_{t-1}\right|_{t=2,3,4\ldots\ldots} \tag{1.9}$$

The output Cobb-Douglas stochastic production frontier function at time period *t* isdefined as:

$$G_t(L_{A_t}, K_{A_t}) = P_t * K_{A_t}^{\alpha_t} * L_{A_t}^{\beta_t} \tag{1.10}$$

where $P_t = \beta_t / \alpha_t = Total\ factor\ productivity\ at\ period\ t$

$\beta_t = utilization\ factor$

$\alpha_t = capacity\ factor\ at\ t$

$(Iwuamadi\ et\ al, 2012)$

$$\{(K_t, L_t): K_t \geq 0, L_t \geq 0\} \tag{1.11}$$

To compare productivity over a period of time*t and t+1*, mixed period Cobb-Douglas stochastic production frontier functions is defined as:

$$G_t(L_{A_{t+1}}, K_{A_{t+1}}) = P_{t+1} * K_{A_{t+1}}^{\alpha_t} * L_{A_{t+1}}^{\beta_t} \tag{1.12a}$$

$$G_{t+1}(L_{A_t}, K_{A_t}) = P_t * K_{A_t}^{\alpha_{t+1}} * L_{A_t}^{\beta_{t+1}} \tag{1.12b}$$

Productivity change in firm *A*, between periods *t* and *t+1* can be measured relative to time period *t* as M_{A_t} or relative to time period *t+1* as M'_{A_t} ,where

$$M_{A_t} = \frac{P_t * K_{A_t}^{\alpha_t} * L_{A_t}^{\beta_t}}{P_{t+1} * K_{A_{t+1}}^{\alpha_t} * L_{A_{t+1}}^{\beta_t}} \quad (1.13a)$$

$$M'_{A_t} = \frac{P_t * K_{A_t}^{\alpha_{t+1}} * L_{A_t}^{\beta_{t+1}}}{P_{t+1} * K_{A_{t+1}}^{\alpha_{t+1}} * L_{A_{t+1}}^{\beta_{t+1}}} \quad (1.13b)$$

The Malmquist productivity change index between *t* and *t+1* is defined as the geometric mean of M_{A_t} and M'_{A_t}. This is given as:

$$MI_{A_{(t,t+1)}} = \sqrt[2]{\left(\frac{P_t * K_{A_t}^{\alpha_t} * L_{A_t}^{\beta_t}}{P_{t+1} * K_{A_{t+1}}^{\alpha_t} * L_{A_{t+1}}^{\beta_t}}\right) \times \left(\frac{P_t * K_{A_t}^{\alpha_{t+1}} * L_{A_t}^{\beta_{t+1}}}{P_{t+1} * K_{A_{t+1}}^{\alpha_{t+1}} * L_{A_{t+1}}^{\beta_{t+1}}}\right)} \quad (1.14)$$

If this index exceeds unity, it indicates that there has been improvement in productivity between period *t* and *t+1*. Values less than unity suggest regression.
Equation (1.14) can be simplified further as:

$$MI_{A_{(t,t+1)}} = \left[\frac{P_t * K_{A_t}^{\alpha_t} * L_{A_t}^{\beta_t}}{P_{t+1} * K_{A_{t+1}}^{\alpha_{t+1}} * L_{A_{t+1}}^{\beta_{t+1}}}\right] \times \sqrt[2]{\left[\frac{P_t * K_{A_t}^{\alpha_{t+1}} * L_{A_t}^{\beta_{t+1}}}{P_t * K_{A_t}^{\alpha_t} * L_{A_t}^{\beta_t}}\right] \times \left[\frac{P_{t+1} * K_{A_{t+1}}^{\alpha_{t+1}} * L_{A_{t+1}}^{\beta_{t+1}}}{P_{t+1} * K_{A_{t+1}}^{\alpha_t} * L_{A_{t+1}}^{\beta_t}}\right]} \quad (1.15)$$

Where,

$$Technical\ Efficiency, TEFFC = \frac{P_t * K_{A_t}^{\alpha_t} * L_{A_t}^{\beta_t}}{P_{t+1} * K_{A_{t+1}}^{\alpha_{t+1}} * L_{A_{t+1}}^{\beta_{t+1}}}$$

Technological progress,

$$TECHC = \sqrt[2]{\left[\frac{P_t * K_{A_t}^{\alpha_{t+1}} * L_{A_t}^{\beta_{t+1}}}{P_t * K_{A_t}^{\alpha_t} * L_{A_t}^{\beta_t}}\right] \times \left[\frac{P_{t+1} * K_{A_{t+1}}^{\alpha_{t+1}} * L_{A_{t+1}}^{\beta_{t+1}}}{P_{t+1} * K_{A_{t+1}}^{\alpha_t} * L_{A_{t+1}}^{\beta_t}}\right]}$$

Equation (1.15) can be summarized as:

$$MALM = TEFFC \times TECHC \quad (1.16)$$

The Malmquist Index also referred to as Productivity Change Index is decomposed into two separate indexes measuring technical efficiency change (TEFFC) and technological change (TECHC). *TEFFC* measures the "catching up" to the frontier isoquant i.e. change in technical efficiency over the two periods. TEFFC is defined as the diffusion of best-practice technology in the management of activity (Ade I. et al, 2011). This is attributed to investment planning, technical experience and management and organization in power stations.
TECHC measures the shift in the frontier isoquant from one period to another i.e. change in technology over the two periods. As a consequence of innovation, technological changes occur, that is adoption of new technologies by best-practice power plant (Ade I. et al, 2011). This also reveals the effect of routine maintenance on the plants. If the value of either of these components is greater than the previous respective value, it suggests improvement but if otherwise it suggests the opposite.

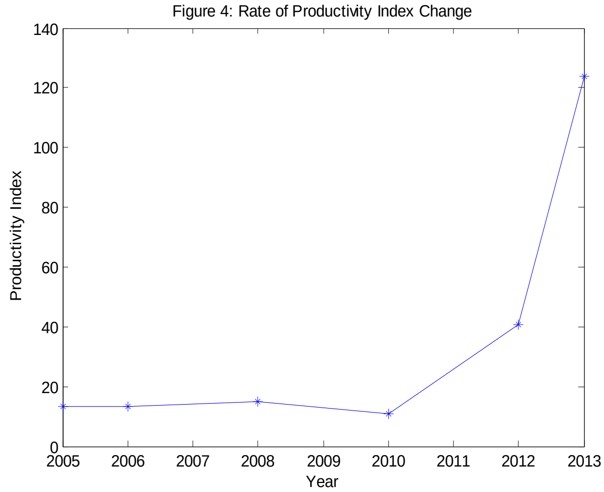
VIII. EFFICIENCY RESULT

Table 1: Table of the Productivity Change Index

YEAR	TEFFC	TECHC	Productivity Index
2005	1.0000	13.386	13.386
2006	1.1801	11.235	13.257
2008	1.9542	7.6215	14.894
2010	0.0983	108.45	10.658
2012	0.1712	285.25	40.787
2013	0.8329	148.75	123.89

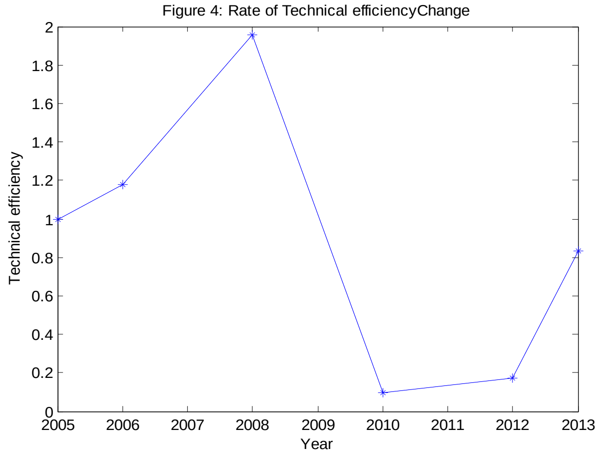
The Productivity Change Index result in Table 1 shows the annual productivity change of the period under review. The comparative analysis is sequential and orderly as are the years under review. The Productivity Change Index shown in Table 1 had 0.97% fall from 2005 to 2006 and 39.75% fall from 2008 to 2010. The unavailability of power plants due to insufficient gas supply in 2009 cost the power sector about 2000MW (Omachonu J. & Chiejine A., 2009).

Figure 4: Rate of Productivity Index Change



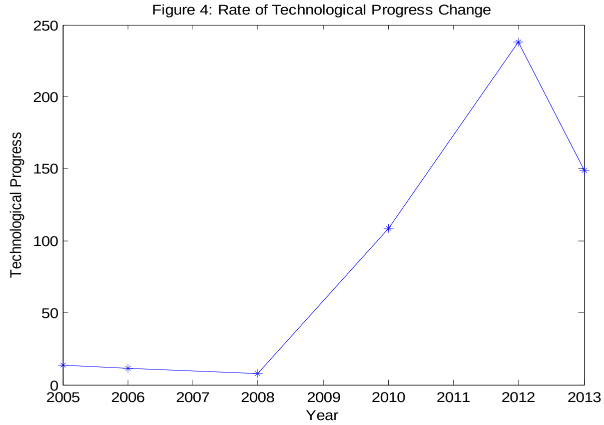
The sector experienced an average index increase in productivity of 11% from 2006 to 2008 and a rapid rise of 73.9% and 67.1% from 2010 to 2012 and 2012 to 2013 respectively.

Figure 4: Rate of Technical efficiencyChange



The trend of TEFFC shows a rapid fall of over 100% from 2008 to 2010. This reveals how inefficiently and ineffectively managed the power stations are in terms of downtime. It was observed that some plants were under utilized for their normal hours of operation all year round. At different times some of the plants were inevitably idle for such reasons as undergoing routine maintenance/inspection and fault development. However, the transmission network is likely to have more downtime than the plants and is likely to be called upon to generate for less time than it is actually available just as in 2009. In 2009, the power sector lost 450MW due to vandalisation of Okoloma Gas Station which supplies gas to Afam Power Station (Omachonu J. & Chiejine A., 2009). TEFFC has since then risen by 88.2% which is attributed to the rehabilitation of existing generating units, expansion of transmission capacity and the procurement of power from independent operators.

Figure 4: Rate of Technological Progress Change



The trend of TECHC graph is epileptic as it shows about 19.14% and 47.42% fall from 2005 to 2006 and 2006 to 2008 respectively. This reveals the constant deteriorating trend of power plants either as a result of insufficient routine maintenance/inspection and fault development. Due to the commissioning and installation of new generating plants at Ajaokuta 1, Agip 1(Okpai), Afam VI, Omoku and Egbin AES the sector experienced an appreciable rise in TECHC of 93% and 63% from 2008 to 2010 and 2010 to 2012 respectively. TECHC fell in 2013 owing to the rift between the Federal Government and the Labor Union during the final privatization process.

IX. CONCLUSION

The conceptual objective of the power reforms to remedy inadequate power generation capacity, inefficient usage of capacity, ineffective regulation and high technical losses is gradually being achieved.

The analysis reveals the eroding technical efficiency and technological setback in the power system. A number of reasons could be adduced to be responsible for this shortfall in power sector performance. These include: low plant availability due to breakdown, overdue overhaul of units, obsolete technology relative to advancement in the field, instability of the national grid system, ageing of plant components, disruption in gas supply, among others.

Measures to improve the performance indices of the sector is not just by privatization but includes: training of Operational and Maintenance (O&M) personnel regularly, improvement in O&M practices, proper Performance Evaluation of all power stations, organizing regular management meetings and improvement in the general housekeeping of the power plants. Another measure is the elimination or minimization of concerns about security of gas supply associated with resource control agitation in the Niger-Delta region. Credible and decisive effort to eliminate tension is more urgent than ever before. There should be an immense drive to harness other sources of electric energy not just limiting to and expanding on the same energy source. The country is blessed with a large amount of renewable energy resources like hydropower, solar, wind and biomass which will not only boost quantity and quality of electricity but also its reliability.

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An Implicit Method for Solving Fuzzy Partial Differential Equation with Nonlocal Boundary Conditions

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Abstract: - In this paper we introduce a numerical solution for the fuzzy heat equation with nonlocal boundary conditions. The main purpose is finding a difference scheme for the one dimensional heat equation with nonlocal boundary conditions. In these types of problems, an integral equation is appeared in the boundary conditions. We first express the necessary materials and definitions, and then consider our difference scheme and next the integrals in the boundary equations are approximated by the composite trapezoid rule. In the final part, we present an example for checking the numerical results. In this example we obtain the Hausdorff distance between exact solution and approximate solution.

Keywords: *- Fuzzy numbers, Fuzzy heat equation, Finite difference scheme, stability*.

I. INTRODUCTION

This paper is concerned with the numerical solution of the heat equation

$$(D_t - a^2 D_x^2)\tilde{U} = \tilde{O} \qquad x \in (0,1), \;\; t \in (0,1] \tag{1}$$

Subject to the nonlocal boundary conditions

$$\begin{cases} \tilde{U}(0,t) = \int_0^1 k_0(x)\tilde{U}(x,t)dx + \widetilde{g_0}(t) \\ \tilde{U}(1,t) = \int_0^1 k_1(x)\tilde{U}(x,t)dx + \widetilde{g_1}(t) \end{cases} \tag{2}$$

And the initial condition

$$\tilde{U}(x,0) = \tilde{g}(x) \qquad x \in (0,1) \tag{3}$$

Where $\tilde{f}, \tilde{k}_0, \tilde{k}_1, \tilde{g}_0, \tilde{g}_1$ *and* $\tilde{g}$ are known fuzzy functions. Over the last few years, many other physical phenomena were formulated into nonlocal mathematical models [1]. Hence, the numerical solution of parabolic partial differential equations with nonlocal boundary specifications is currently an active area of research. The topics of numerical methods for solving fuzzy differential equations have been rapidly growing in recent years. The concept of fuzzy derivative was first introduced by Chang and Zadeh in [10]. It was following up by Dubois and Prade in [1], who defined and used the extension principle. Other methods have been discussed by Puri and Relescu in [4] and Goestschel and Voxman in [9]. The initial value problem for first order fuzzy differential equations has been studied by several authors [5, 6, 7, 8, and 11]. On the metric space (E^n, D) of normal fuzzy convex sets with the distance D gave by the maximum of the Hausdorff distances between the corresponding levels sets.

II. MATERIALS AND DEFINITIONS

We begin this section with defining the notation we will use in the paper. Let X be a location of objects denoted generically by x, and then a fuzzy set $\tilde{A}$ in X is a set of ordered pairs $\tilde{A} = \{(x, \mu_{\tilde{A}}(x)|x \in X\}$. $\mu_{\tilde{A}}$ is called the membership function or grade of membership of x in $\tilde{A}$. The range of the membership function is a subset of the nonnegative real numbers whose supremum is finite.

Definition 2.1. The set of elements that belong to the fuzzy set $\tilde{A}$ at least to the degree α is called α-cut set:

$$A_a = \{x \in X|\mu_{\tilde{A}}(x) \geq \alpha\}$$

$A'_a = \{x \in X|\mu_{\tilde{A}}(x) \geq \alpha\}$ is called strong α-cut.

Definition 2.2. The triangular fuzzy number $\tilde{N}$ is defined by three numbers $\alpha < m < \beta$ as $\tilde{A} = (\alpha, m, \beta)$. This representation is interpreted as membership function:

$$\mu_{\tilde{A}}(x) = \begin{cases} \dfrac{x-\alpha}{m-\alpha} & \alpha \leq x \leq m \\ 1 & x = m \\ \dfrac{x-\beta}{m-\beta} & m < x \leq \beta \\ 0 & o.\omega \end{cases}$$

If $\alpha > 0(\alpha \geq 0)$ then $\tilde{A} > 0(\tilde{A} \geq 0)$,
If $\beta < 0(\beta \leq 0)$ then $\tilde{A} < 0(\tilde{A} \leq 0)$.

Definition 2.3. An arbitrary number is showed by an ordered pair of functions $\left(\underline{a}(r), \overline{a}(r)\right), 0 \leq r \leq 1$, which satisfies the following requirements:

1. $\underline{a}(r)$ is a bounded left semi continuous non-decreasing function over [0,1],
2. $\overline{a}(r)$ is a bounded left semi continuous non-decreasing function over [0,1],
3. $\underline{a}(r) \leq \overline{a}(r)$ $, 0 \leq r \leq 1$.

In particular, if $\underline{a}, \overline{a}$ are linear functions we have a triangular fuzzy number.
A crisp number a is simply represented by $\underline{a}(r) = \overline{a}(r) = \mathrm{a}$ $, 0 \leq r \leq 1$.

Definition 2.4. For arbitrary fuzzy numbers $(\underline{u}(r), \overline{u}(r))$ $, v = (\underline{u}(r), \overline{u}(r))$ we have algebraic operations bellow:

1. $ku = \begin{cases} (k\underline{u}, k\,\overline{u}) & k \geq 0 \\ (k\overline{u}, k\underline{u}) & k < 0 \end{cases}$
2. $u + v = (\underline{u}(r) + \underline{v}(r), \overline{u}(r) + \overline{v}(r))$
3. $u - v = (\underline{u}(r) - \underline{v}(r), \overline{u}(r) - \overline{v}(r))$
4. $u.v = (mins, maxs)$, which $s = \{\underline{uv}, \underline{u}\overline{v}, \overline{u}\underline{v}, \overline{uv}\}$.

Remark. Since the α-cut of fuzzy numbers is always a closed and bounded interval, so we can write $\widetilde{A_\alpha} = [\underline{a}(\alpha), \overline{a}(\alpha)]$, for all α.

Definition 2.5. Assume $u = \left(\underline{u}(r), \overline{u}(r)\right)$, $v = (\underline{v}(r), \overline{v}(r))$ are two fuzzy numbers. The Hausdorff metric D_H is defined by:

$$D_H(u, v) = \sup_{r \in [0,1]} \max\{|\underline{u}(r) - \underline{v}(r)|, |\overline{u}(r) - \overline{v}(r)|\} \qquad (4)$$

This metric is a bound for error. By it we obtain the difference between exact solution and approximate solution.

III. FINITE DIFFERENCE METHOD

In this section we solve the fuzzy heat equation by an implicit method. Assume $\widetilde{U}$ is a fuzzy function of the independent crisp variable x and t. We define:

$$I = \{(x, t)|0 \leq x \leq 1, 0 \leq t \leq T\}$$

α-cut of $\widetilde{U}(x, t)$ and it's the parametric form, will be:

$$\widetilde{U}(x, t)[\alpha] = \left[\underline{U}(x, t; \alpha), \overline{U}(x, t; \alpha)\right].$$

We let that the $\underline{U}(x, t; \alpha), \overline{U}(x, t; \alpha)$ have continuous partial differential, therefore $(D_t - a^2 D_x^2)\overline{U}(x, t; \alpha)$, and $(D_t - a^2 D_x^2)\underline{U}(x, t; \alpha)$ are continuous for all $(x, t) \in I$, all $\alpha \in [0,1]$. we divide the domain $[0,1] \times [0, T]$ in to $M \times N$ mesh with spatial step size $h = \frac{1}{N}$ in x −direction and in x −direction and $k = \frac{T}{M}$ in t −direction. The gride points are given by:

$$x_i = ih \qquad i = 0,1, \ldots, N$$
$$t_j = jk \qquad j = 0,1, \ldots, M$$

Denote the value of $\widetilde{U}$ at the representative mesh point $p(x_i, t_j)$ by:

$\widetilde{U}_p = \widetilde{U}(x_i, t_j) = \widetilde{U}_{i,j}$

And also parameter form of fuzzy number $\widetilde{U}_{i,j}$ is:

$$\widetilde{U}_{i,j} = (\underline{U}_{i,j}, \overline{U}_{i,j})$$

We have:

$$\begin{cases} (D_t)\widetilde{U}_{i,j} = (D_t\underline{U}_{i,j}, D_t\overline{U}_{i,j}) \\ (D_x^2)\widetilde{U}_{i,j} = (D_x^2\underline{U}_{i,j}, D_x^2\overline{U}_{i,j}) \end{cases}$$

Then by Taylor's expansion we obtain:

$$\begin{cases} D_x^2\underline{U}_{i,j} \simeq \dfrac{\underline{u}_{i-1,j+1} - 2\overline{u}_{i,j+1} + \underline{u}_{i+1,j+1}}{h^2} \\ D_x^2\overline{U}_{i,j} \simeq \dfrac{\overline{u}_{i-1,j+1} - 2\underline{u}_{i,j+1} + \overline{u}_{i+1,j+1}}{h^2} \end{cases}$$

And also for $(D_t)\widetilde{U}$ at p, we have:

$$\begin{cases} D_t\underline{U}_{i,j} \simeq \frac{\underline{u}_{i,j+1} - \overline{u}_{i,j}}{k} \\ D_t\overline{U}_{i,j} \simeq \frac{\overline{u}_{i,j+1} - \underline{u}_{i,j}}{k} \end{cases} \tag{6}$$

Parametric form of heat equation will be:

$$\begin{cases} D_t\underline{U}_{i,j} - a^2 D_x^2\overline{U}_{i,j} = \tilde{0} \\ D_t\overline{U}_{i,j} - a^2 D_x^2\underline{U}_{i,j} = \tilde{0} \end{cases} \tag{7}$$

By (4) and (5) the difference scheme for heat equation is:

$$\begin{cases} \frac{\underline{u}_{i,j+1} - \overline{u}_{i,j}}{k} - a^2 \frac{\overline{u}_{i-1,j+1} - 2\underline{u}_{i,j+1} + \overline{u}_{i+1,j+1}}{h^2} = 0 \\ \frac{\overline{u}_{i,j+1} - \underline{u}_{i,j}}{k} - a^2 \frac{\underline{u}_{i-1,j+1} - 2\overline{u}_{i,j+1} + \underline{u}_{i+1,j+1}}{h^2} = 0 \end{cases} \tag{8}$$

By above equations we obtain:

$$\begin{cases} -r\overline{u}_{i-1,j+1} + (1+2r)\underline{u}_{i,j+1} - r\overline{u}_{i+1,j+1} = \underline{u}_{i,j} \\ -r\underline{u}_{i-1,j+1} + (1+2r)\overline{u}_{i,j+1} - r\underline{u}_{i+1,j+1} = \overline{u}_{i,j} \end{cases} \tag{9}$$

Where:

$$r = \frac{ka^2}{h^2}$$

$\widetilde{U} = (\underline{u}, \overline{u})$ is the exact solution of the approximating difference equations, and $x_i, (i = 1, \dots, N-1)$ and $t_j, (j = 0,1, \dots, M)$.

We have $2(N-1)$ equations with $2(N+1)$ unknowns. Therefore we need other four equations. We obtain these equations by boundary conditions (2) are described by the trapezoid rule. So

$$a_0\widetilde{U}_{0,j+1} + \sum_{i=1}^{N-1} a_i\widetilde{U}_{i,j+1} + a_N\widetilde{U}_{i,j+1} \approx -\tilde{g}_{0,i+1}$$

$$b_0\widetilde{U}_{0,j+1} + \sum_{i=1}^{N-1} b_i\widetilde{U}_{i,j+1} + b_N\widetilde{U}_{i,j+1} \approx -\tilde{g}_{1,i+1}$$

Where

$$a_0 = \frac{h}{2}k_0(x_0) - 1 \qquad a_N = \frac{h}{2}k_0(x_N)$$

$$b_N = \frac{h}{2}k_1(x_N) - 1 \qquad b_0 = \frac{h}{2}k_1(x_0)$$

And

$$a_i = hk_0(x_i) \quad , \quad b_i = hk_1(x_i) \qquad i = 1, \dots, N-1$$

Also parametric form of fuzzy numbers $\tilde{g}_0$ and $\tilde{g}_1$ are:

$$\tilde{g}_0 = \left(\underline{g}_0, \overline{g}_0\right) \qquad \tilde{g}_1 = \left(\underline{g}_1, \overline{g}_1\right)$$

By equations (9) we obtain:

$$-r\widetilde{U}_{i-1,j+1} + (1+2r)\widetilde{U}_{i,j+1} - r\widetilde{U}_{i+1,j+1} = \widetilde{U}_{i,j} \qquad \begin{matrix} i = 1, \dots, N-1 \\ j = 0,1, \dots, M \end{matrix}$$

Therefore equations can be written in matrix form as:

$$\begin{pmatrix} a_0 & a_1 & a_2 & \cdots & a_N \\ -r & 1+2r & -r & & \\ & \ddots & \ddots & \ddots & \\ & -r & 1+2r & -r & \\ b_0 & \dots & b_{N-2} & b_{N-1} & b_N \end{pmatrix}$$

Then we will have:

$$A\tilde{U}_{j+1} = \tilde{U}_j$$

The coefficients matrix of this system i.e. $A = (a_{ij})$ is a crisp matrix $(N+1) \times (N+1)$, and $\tilde{U}_{j+1} = (\tilde{u}_{1,j+1}, \dots, \tilde{u}_{N,j+1})^T$, $\tilde{U}_j = (\tilde{u}_{1j}, \dots, \tilde{u}_{Nj})^T$ are fuzzy vectors in the parametric form. Where $\tilde{u}_{1,j+1} = (\underline{u}_{i,j+1}, \overline{u}_{i,j+1})$ and $\tilde{u}_{ij} = (\underline{u}_{ij}, \overline{u}_{ij})$. So we have to solve a system of order $2(N+1) \times 2(N+1)$. We re-arrangement this linear system of equations as follows:

$$SX = Y \qquad (10)$$

where

$$X = (\underline{u}_{0,j+1}, \dots, \underline{u}_{N,j+1}, -\overline{u}_{0,j+1}, \dots, -\overline{u}_{N,j+1})^T$$
$$Y = (\underline{u}_{0,j}, \dots, \underline{u}_{N,j}, -\overline{u}_{0,j}, \dots, -\overline{u}_{N,j})^T$$

And the matrix S is defined as follows:

$$a_{ij} \geq 0 \;\Rightarrow\; s_{ij} = s_{i+N+1,j+N+1} = a_{ij}$$
$$a_{ij} < 0 \;\Rightarrow\; s_{i,j+N+1} = s_{i+N+1,j} = -a_{ij}$$

the rest of matrix elementary s_{ij} which do not get these relations are zero.

IV. NUMERICAL EXAMPLE

In this section we present a numerical example to illustrate our method, whose exact solution is known to us. Consider the fuzzy heat equation

$$\frac{\partial \tilde{U}}{\partial t}(x,t) - \frac{1}{\pi^2}\frac{\partial^2 \tilde{U}}{\partial x^2}(x,t) = \tilde{0} \qquad 0 < x < 1\,, \qquad t > 0$$

Subject to the nonlocal boundary conditions

$$\tilde{U}(0,t) = \int_0^1 x\tilde{U}(x,t)dx + \left(1 + \frac{2}{\pi^2}\right)\exp(-t)$$
$$\tilde{U}(1,t) = \int_0^1 x\tilde{U}(x,t)dx - \left(1 - \frac{2}{\pi^2}\right)\exp(-t)$$

and the initial condition

$$\tilde{U}(x,0) = \tilde{K}\cos \pi x$$

and $\tilde{K}[\alpha] = [\underline{k}(\alpha), \overline{k}(\alpha)] = [\alpha - 1, 1 - \alpha]$. which is easily seen to have exact solution for

$$\frac{\partial \underline{U}}{\partial t}(x,t;\alpha) - \frac{1}{\pi^2}\frac{\partial^2 \overline{U}}{\partial x^2}(x,t;\alpha) = 0 - \alpha$$
$$\frac{\partial \overline{U}}{\partial t}(x,t;\alpha) - \frac{1}{\pi^2}\frac{\partial^2 \underline{U}}{\partial x^2}(x,t;\alpha) = 0 + \alpha$$

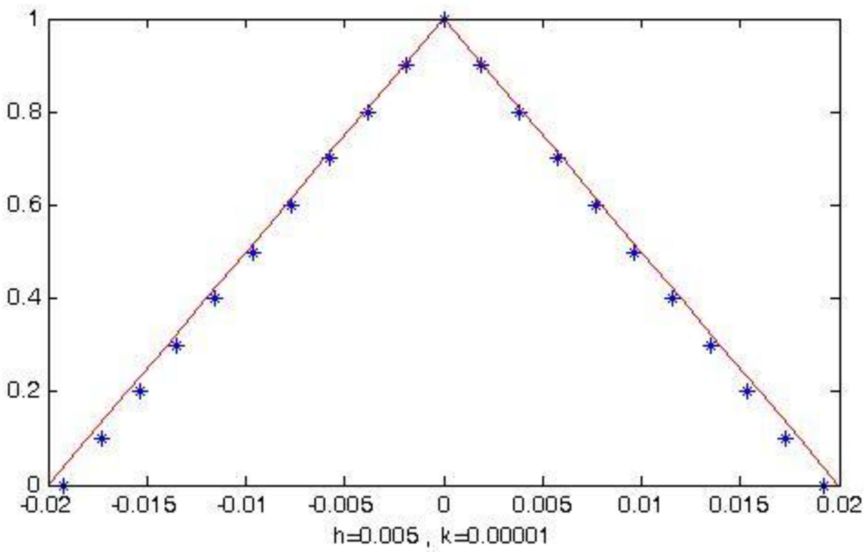
are

$$\underline{U}(x,t;\alpha) = \begin{cases} \underline{k}(\alpha)\exp(-t)\cos \pi x & 0 < x < \frac{1}{2} \\ \overline{k}(\alpha)\exp(-t)\cos \pi x & \frac{1}{2} < x < 1 \end{cases}$$

and

$$\underline{U}(x,t;\alpha) = \begin{cases} \overline{k}(\alpha)\exp(-t)\cos \pi x & 0 < x < \frac{1}{2} \\ \underline{k}(\alpha)\exp(-t)\cos \pi x & \frac{1}{2} < x < 1 \end{cases}$$

The exact and approximate solutions are shown in next figure at the point (0.2,0.001) with $h = 0.005, k = 0.00001$. The housdroff distance between solutions in this case is $7.58e - 004$.



V. CONCLUSION

Our purpose in this article is solving fuzzy partial differential equation (FPDE). We presented an implicit method for solving this equation, and we considered necessary conditions for stability of this method. In last section we given an example for consider numerical results. Also we compared the approximate solution and exact solution. Then we obtained the Hausdorf distance between them in two cases.

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A Design of Mobile Health for Android Applications

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Abstract: - For healthiness and wellness, exercising is one of the key factors. In this paper, a mobile health application is developed to recommend healthcare support referring to exercises on the Android Smart Phone. This application has been designed to provide exercise advice depending on Body Mass Index (BMI), Basal Metabolic Rate (BMR) and the energy used in each activity or sport (e.g. aerobic dancing, cycling, jogging working and swimming). Also, this application has been designed to present special exercise advice for patients with health issues. Moreover, it has been designed to store information in a database and to have the ability to produce reports to users.

Keywords: *- E-Health, mobile Health, BMI, Android, mobile application.*

I. INTRODUCTION

Mobile phones have significant impact on consumers and their life style because the phones can works as small computers. Therefore, lots of applications and services have been developed and provided on mobile phones. One area of those applications is healthcare applications. Gartner reported that 'mobile health monitoring' would be ranked as no. 5 of 'the top 10 consumer mobile applications for 2012' [1]. It is consistent with 'the top 10 strategic technology trends for 2013' that includes 'mobile device battles' and 'mobile applications and HTML5' [2]. The rate of mobile phone usage in today's world has increased exponentially at a fast and unimaginable rate. Based on the company "The Mobile World" in 2014 [MW2007] the global mobile phone usage had exceeded 4.25 billion at the end of 2014 which is equivalent to around half of the world's population [3]. Moreover, it has been predicted that the market value of mobile health will increase to be more than 11 billion USD by 2018 [3]. For medical applications, the industry of medical applications is predicted to grow about 23 percent annually over the next four years, whereas, it has been estimated at 150 million USD currently. Nevertheless, by 2015, more than one third of about 1.4 billion smart phone users will have at least one mobile health application [4].

In the past decade or so, mobile phones were merely seen and classified as portable communication tools, with the sole capability of making calls, without any physical connection to a landline. Today, certain advancements have been achieved in mobile computing industry through the inclusion of GPS systems, accelerometers, and even touch screens. Different kinds of mobile operating systems have been introduced in response to the goal of designing increasingly powerful software to take advantage of the number of processors packaged in computing hardware. Some of these operating systems are the Symbian OS, the Apple Ios Windows Mobile and Android. Due to the advanced nature of computer architectures for embedded systems computing, mobile computing has become well integrated into the very fabric of our modern way of living. It is a very useful tool for personal health monitoring and many devices such as iPhone, iPad, Google Nexus and other mobile computing devices have applications developed for health monitoring and targets specific needs of individuals. Our developed application which runs on the android platform is customizable and user friendly.

Besides, consumers have more concerns about their health. Thus, healthcare is increasingly considered for better quality of life, with the active approach focusing on prevention of their health, instead of passive approach focusing on treatment [4]. Exercise is the major option to prevent disease and illness, to gain better heath and to maintain. However, to do exercise, there are many kinds of sports, for example, aerobic dancing, jogging, walking, swimming, tennis and yoga. It is questionable, how long should one who has different body characteristics take for each kind of sport. Therefore, this mobile health application has been designed to provide appropriate time expense with each activity or sport, for not only normal users / consumers but also patients with health issues. This application is based-on the Android, which occupies more than 70% of the smart phone market in the worldwide [5].

A. Evolution of Mobile Devices

The convergence of technologies provides many advantages to consumers. Due to the combination between advanced mobile phone technology and computer technology at present, mobile phones are not just telephones, they have become smart phones, see their history as in Fig. 1[3]. Particularly, after the 3rd Generation International Mobile Telecommunications or 3G mobile networks were officially launched in Thailand in May 2013, smart phones and other mobile devices can be used efficiently because the transmission speed of data increases significantly.

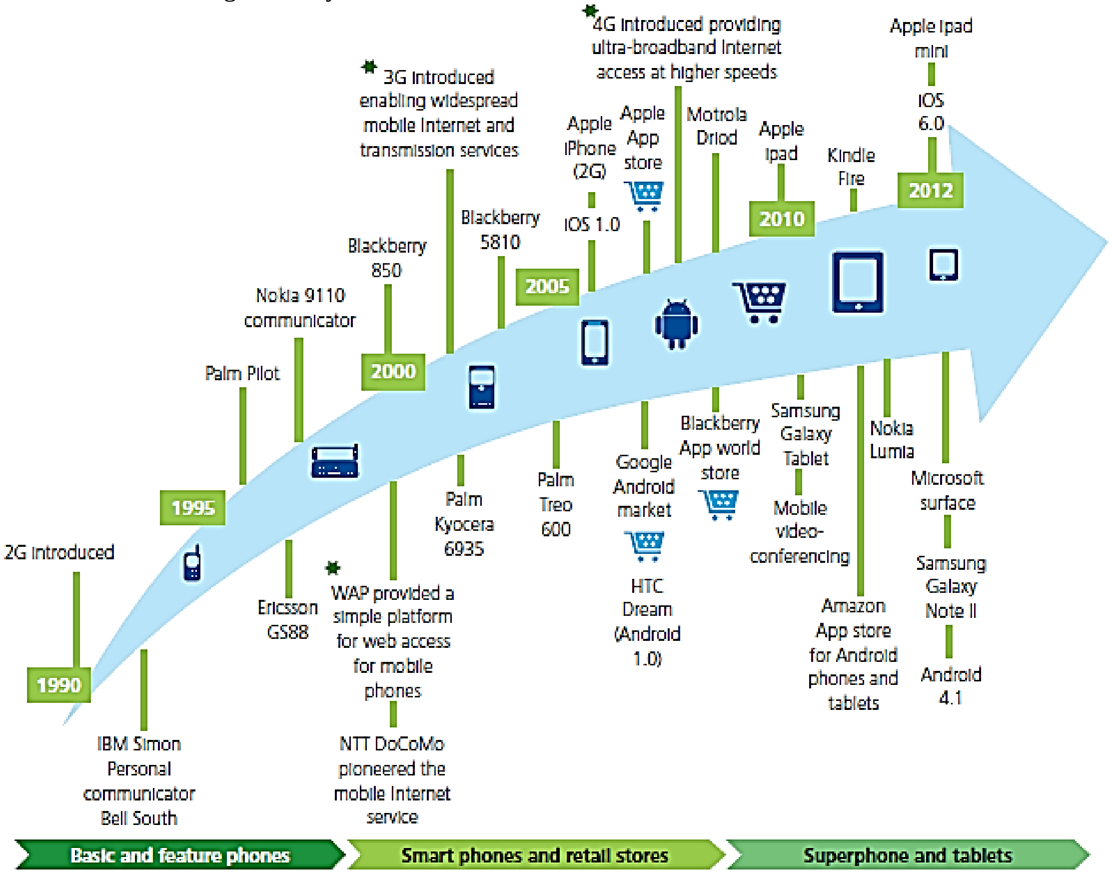


Fig. 1. The history of smart phones and mobile devices.

B. mobile Health

'Mobile Health' can combine health and mobile device technology, especially smart phones. It can be defined as 'medical and public health practice supported by mobile devices (e.g. mobile phones, patient monitoring device and wireless devices)' [1], whereas, 10 years ago, it has been defined as wireless telemedicine involving the use of mobile telecommunications and multimedia technologies and their integration with mobile healthcare delivery systems [6].

To understand clearly about 'mobile Health', understanding the mobile Health ecosystem is required. As shown in Fig. 2 [7], the mobile Health ecosystem overlaps several dynamic spheres, consisting of health, technology and finance, whereas, government is the influencer that has power to set regulations, policies, and strategies that can affect all spheres throughout the development and use of mobile Health inventions. The stakeholders in mobile Health influence the drivers, as shown in Fig. 3[7], so that mobile health can help consumers to have better health.

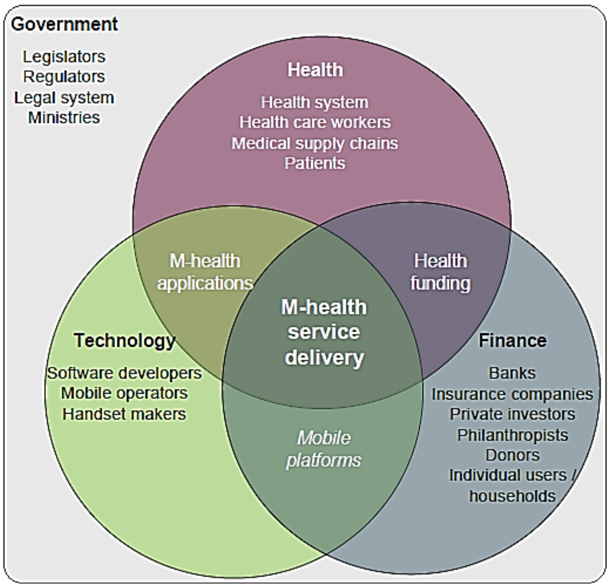


Fig. 2.The ecosystem for mobile Health.

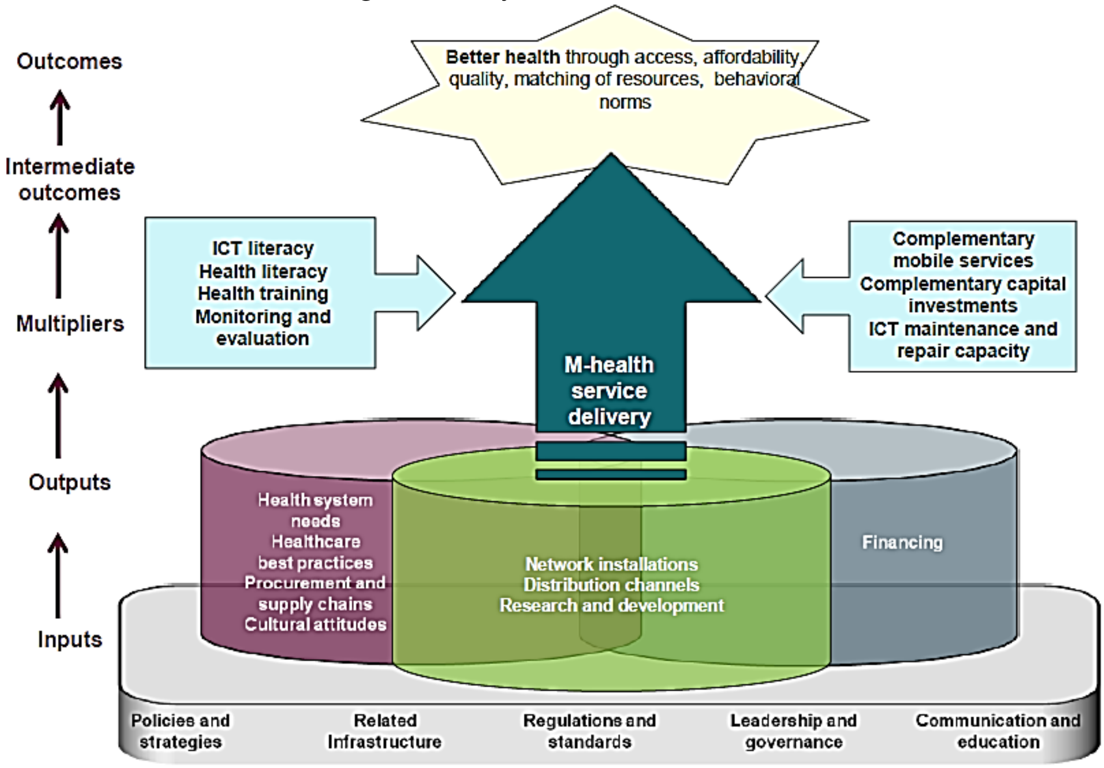


Fig. 3. Framework for mobile Health outcomes

II. PROPOSED SYSTEM DESIGN AND METHODOLOGY

A. System Architecture

The following architectural diagram shows the different modules that make up the Mobile Health android application.

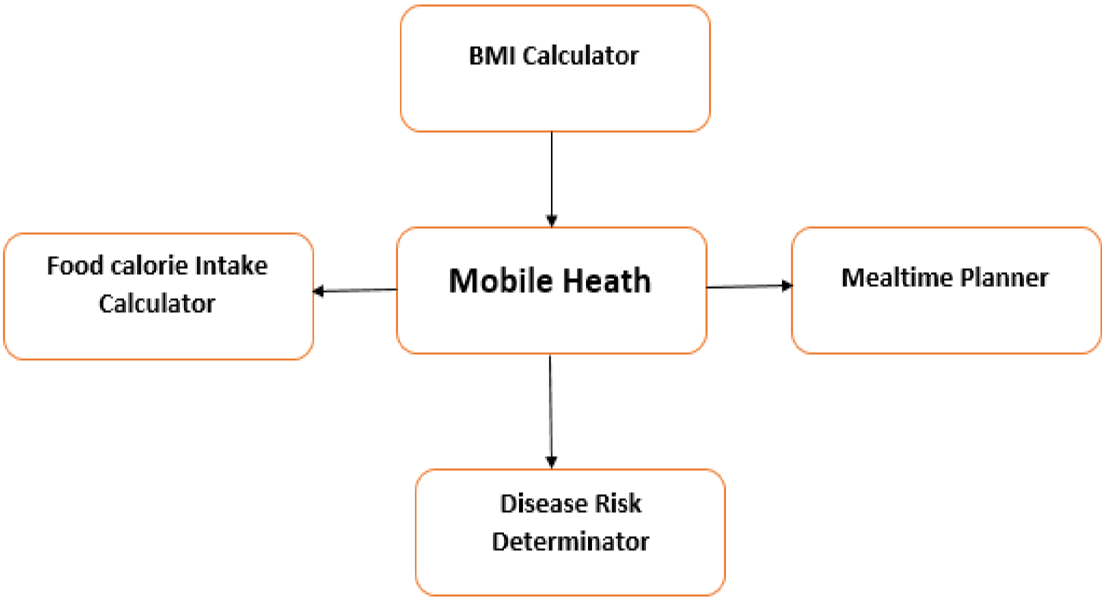


Fig. 4. Android Architectural Framework and Module development.

The proposed android architectural framework and module development as presented above encompasses four (4) modules namely: (1) Food calorie Intake Calculator (2) Mealtime Planner (3) BMI Calculator and (4) Disease Risk Determinator.

***(1) Food calorie intake Calculator Modu*le**

This module computes the calorific content values for the user interactive menu choice for breakfast, lunch and dinner. This module computes the customized menu choice and offers suggestions for other menu options to achieve your goal of either losing weight or eating healthy foods.

(2) BMI Calculator module

This module calculates the Body Mass Index (BMI) for a person based on the height and weight of the person using the formula: BMI = Weight (kg)/ (Height (m))^2 . The essence of this module is to generate useful information regarding the BMI parameter used for ascertaining a person's risk of heart disease, diabetes etc. The BMI is a heuristic proxy for estimating human body fat based on an individual's weight and height.

(3) Disease Risk Determinator Module

Based on the computation of the BMI and the user specification of the nature of work, exercise routine and other factors, the Disease Risk Determinator module then determines your risk profile and tracks it while offering excellent Meal time Planner to get back into shape and avoid unnecessary hospital visits due to poor healthy lifestyle.

(4) Mealtime Planner Module

This module presents to the user the various meal plans for breakfast, lunch, and dinner based on the amount of calories needed by the person taking into consideration, age, type and nature of work, several favorite dishes for breakfast, lunch and dinner.

A. Exercise and Related Indexes:

Exercise is any body activity that enhances physical fitness and / or maintains overall health and wellness. There are several reasons for exercise, for example, strengthening the cardiovascular system and muscles, weight loss, honing athletic skills and enjoyment. However, to evaluate and indicate the change of body after performing exercise, there are few indexes to be considered, as follows:

1) Body Mass Index (BMI): is a measurement of body fat based on height and weight, as shown in formulas [8]. It is calculated as weight (kg) divided by height squared (m2). This index is classified into four groups, based on WHO Asian BMI classifications, as shown in Table 1 [9, 10]. However, this index is mainly for men and women who are 18 – 65 years old.

2) Basal Metabolic Rate (BMR): is calculated from the variables of height, weight, age and gender [11]. This index is more accurate than calculating calorie needs based on body weight alone. However, each gender uses different formula to calculate, as shown in (2) and (3) [12].

Category	Weight	Meaning
1	<18.5	underweight
2	18.2 to < 23	Normal Weight
3	23 to < 27.5	Pre-obese
4	>=27.5	obese

Table 1. WHO Asian BMI classifications.

3) Metabolic Equivalent of Task: is a unit used to estimate the amount of oxygen used by the body during physical activity. One metabolic equivalent (MET) is defined as the amount of oxygen consumed while sitting at rest and is equal to 3.5 ml O_2 per kg body weight x min. [13,14]. The formula to calculate for caloric expenditure can be shown in (3), while the estimated METs for some kinds of exercises are shown in Table 2 [15, 16].

Where BMI = Weight (kg)/ (Height (m))^2
Where BMR = C1+(C2*M)+(C3*H)-(C4*A)
Where: BMR = Basal Metabolic Rate (Kcal. /day)
C1 = 665 for women or 66 for men
C2 = 4.35 for women or 6.23 for men
C3 = 4.7 for women or 12.7 for men
C4 = 4.7 for women or 6.8 for men
M = Body Weight in Kilograms
H = Height in Meters
A = Age in years
Kcal = 0.0175•MET•M•T
Where: Kcal = Caloric expenditure in Kilocalories.
MET = Metabolic Equivalent of Task or Activity in METs.
M = Body Weight in Kilograms.
T = Time of the activity in minutes.

Activity	MET Value
Cycling 16-19.2 km/h	6.0
Cycling 19.2-22.4 km/h	8.0
Cycling 22.4-25.6 km/h	10.0
Jogging 8 Km/h	8.0
Jogging 9.7 Km/h	10.0
Jogging 11.3 Km/h	11.5
Jogging 12.9 Km/h	13.5
Walking 4 Km/h	3.0
Walking 4.8 Km/h	3.5
Walking 5.6 Km/h	4.0
Walking 7.2 Km/h	4.5

Table 2. Examples of MET values for cycling, jogging and walking.

A. *Safe Exercise for Patients:*

There is a misunderstanding that patients with diseases should do nothing, he or she cannot do exercise. In fact, each patient can do regular exercise at least 150 minutes per week (50 minutes per day at least 3 days a week), except patients with heart diseases who need consultation from the doctor. The benefits of safe exercise for patients include [17]:

- Strengthening heart and cardiovascular system.
- Improve circulation
- Helping body use oxygen better.
- Improving heart failure symptoms.
- Lowering blood pressure.
- Improving cholesterol.

Nevertheless, each patient must check or consult the doctor first, before starting an exercise program because the doctor can help to find an appropriate exercise program for each level of fitness and physical condition. In addition, he or she must stop the exercise immediately and contact the doctor if any bad signs or symptoms occur [17].

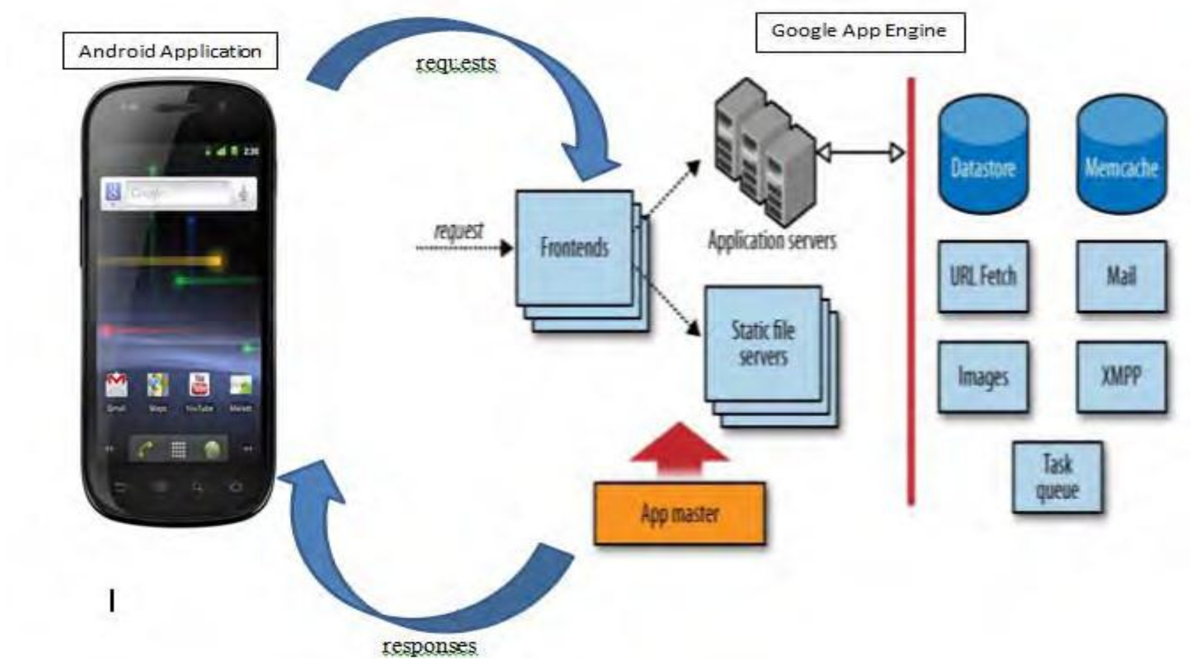


Fig. 5. Overall System Architecture source.

C. System Components

1 Web Application.

The system enables information access via the web. The web application resides and runs on The Google App engine infrastructure.

2 Database Server

This component hosts the database which would store information related to the various dishes that are made available to the developers. The data is hosted in a MySQL database and accessed by the Android application.

3 Web Service

The web service is made available to enhance faster the android application and the database.

4 Android Application

The Android application which makes it possible for a user to plan meals, track daily food requirements and generate useful help tips for the user.

As shown in Fig. 6, the mobile application is an important part that functions on a smart phone. This system was designed based on the Android Operating System and used Adobe Flex to create the user interfaces. It consists of several functions, including BMI calculation, BMR calculation, exercise caloric calculation, recommended exercise, diary and profile. There is also an important part called the provider service. Its main function is data processing. However, both parts require HTTP protocol for interfacing.

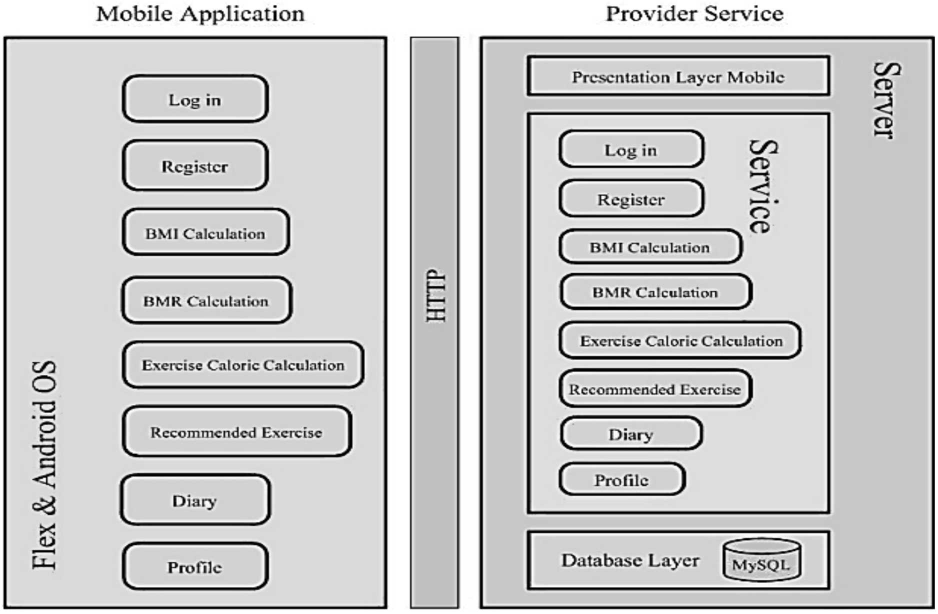


Fig. 6.The conceptual framework of the recommended exercise system

.

After planning and analysis activities, the system design was conducted. In this design phase, the system process diagram was presented in Fig. 7**.**

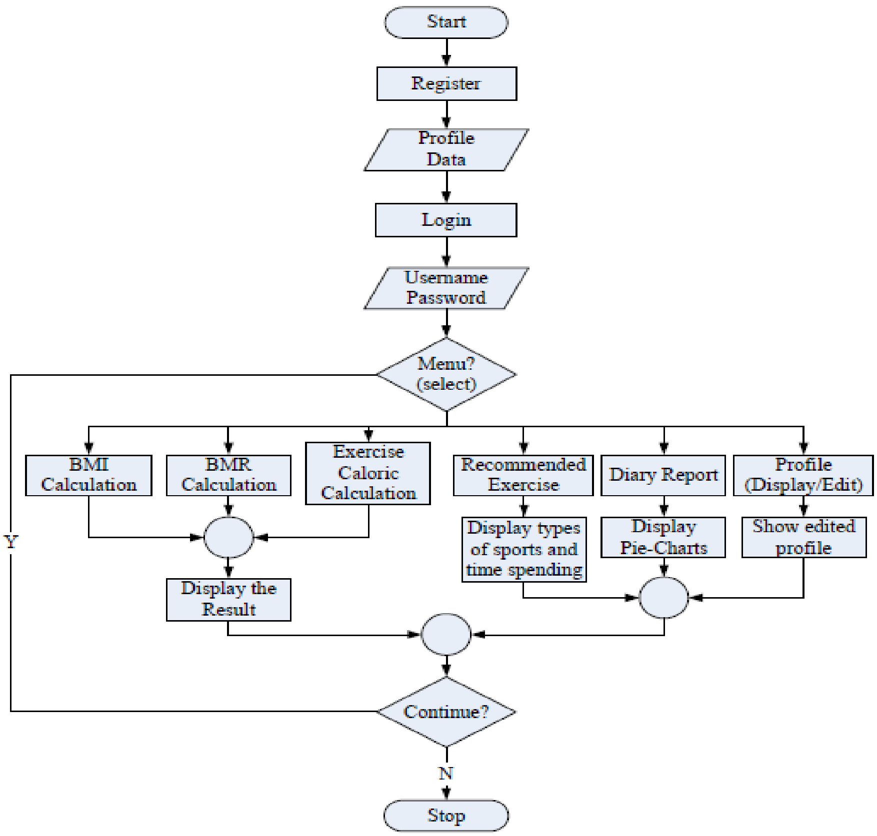


Fig. 7**.** The system process diagram.

III. RESULTS

Particularly, this section mainly presents User interfaces for BMI calculation, BMR calculation, exercise caloric calculation, recommended exercise and dairy, as shown in Fig. 8 – Fig. 9.

Therefore, it is easy for a developer or a programmer to communicate with stakeholders about each display that should be shown to users by the system.

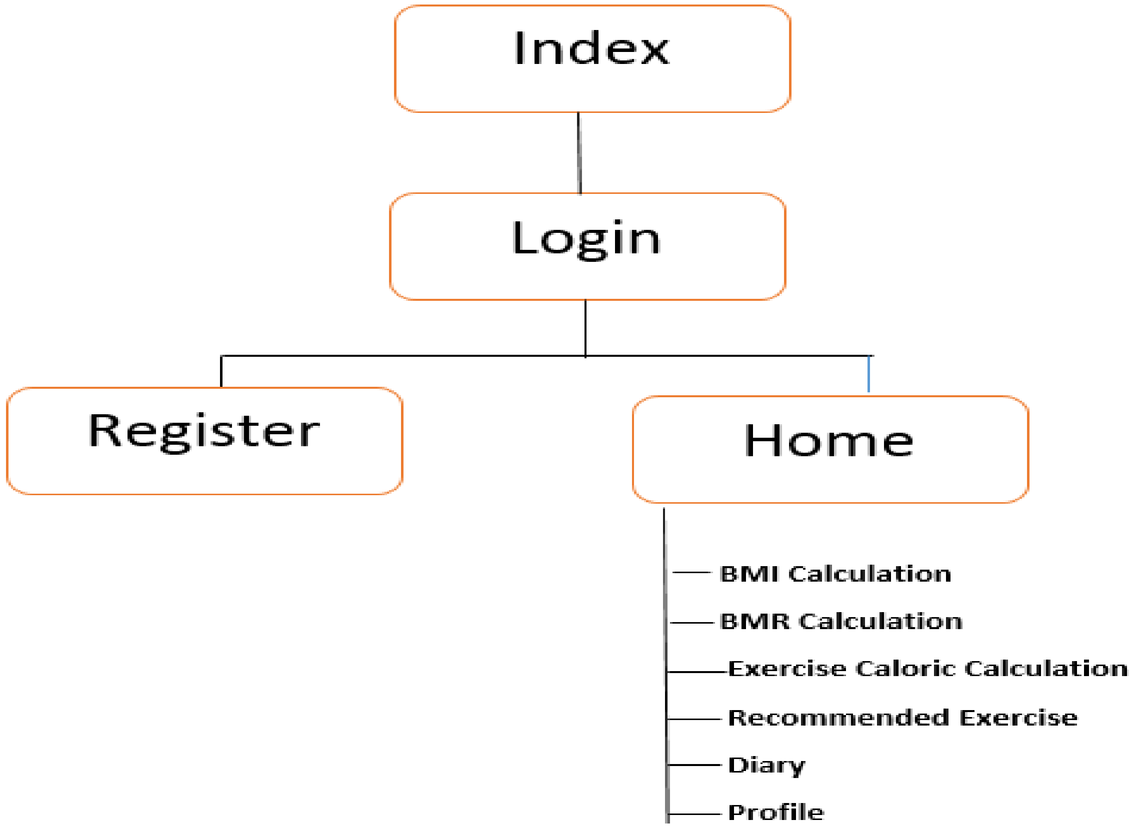
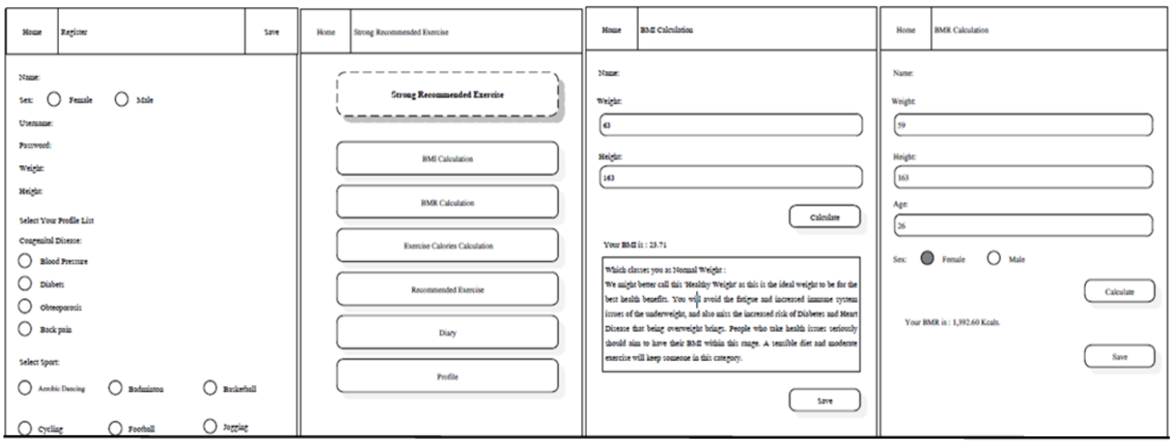
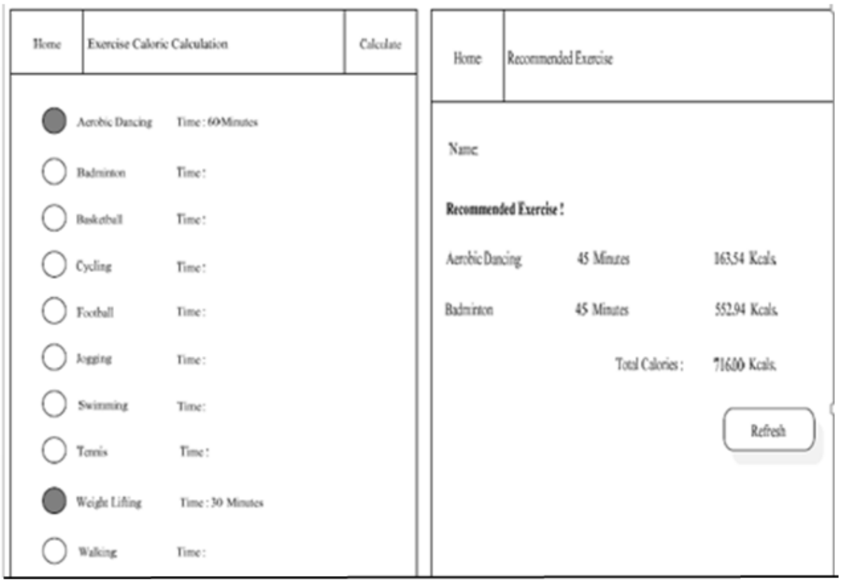


Fig. 8. Overview of the recommended exercise system.



(a) (b) (c) (d)



(e) (f)

Fig. 9. User interfaces (a) Register (b) Main menu (c) BMI Calculation (d) BMR Calculation (e) Recommended sport and time duration (f) Recommended exercise and caloric expedition.

IV. CONCLUSION

This paper presented necessary guidance and health recommendations for mobile users who have installed the android applications. The proposed system model generates food tips and recommendations for different categories of people who are underweight, overweight or obese due to a computation of their body mass indices. It specifies certain exercise regimen types that are appropriate for these different kinds of people. Further expansion to allow for versatility and ubiquity is to implement the Personal Health Monitor app on other mobile platforms apart from android.

This design of a new mobile health application called 'Recommended Exercise System on the Android Operating System' has been conducted. It has been designed to recommend exercise for each individual who has different age and physical characteristics (e.g. sex, weight and height). Therefore, he or she can exercise appropriately, not too less or too much, with different kinds of sports that he or she selects. Also, several functions have been included (e.g. calculation of BMI, BMR, caloric expedition and report). Furthermore, this mobile Health application has been also designed to be able to support different kinds of patients and exercises (e.g. back pain).

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Distribution System's Loss Reduction by Optimal Allocation and Sizing of Distributed Generation via Artificial Bee Colony Algorithm

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Abstract: - Distributed generation (DG) refers to generation applied at the distribution level. It offers a valuable alternative to traditional sources of electric power for industrial, residential and commercial applications, particularly where transmission and distribution costs are high. Great attention should be rendered to the problem of allocation and sizing of DG. The installation of DG units at non optimal places can result in an increase in system losses, implying in an increase in costs and therefore, having an effect opposite to the desired. An Algorithm proposed in this paper is Artificial Bee Colony (ABC). This method helps in optimal allocation and sizing of DG's in order to minimize the total system real power loss.

Keywords: - *ABC Algorithm,Distribution System, DG sizing, DG allocation,Distributed Generation,Loss reduction.*

I. INTRODUCTION

If a utility needs generation anywhere it can get it, the utility or end users can quickly install distributed generation. Applying generation closer to the load benefits the transmission and distribution infrastructure. Local generation can relieve overburdened transmission and distribution facilities as well as reduce losses and voltage drop. DG offers a valuable alternative to traditional sources of electric power for industrial, residential and commercial applications. The impact of DG in system operating characteristics, such as electric losses, voltage profile, reliability, among other need to be appropriately evaluated [1]. A new methodology to optimize the size and location of DG based on the level of power loss reduction has been developed[4].[5] Based on the active and reactive power injection of DG and voltage sensitivity of lines, the optimal operating condition of DG to support voltage in a distribution system was developed . Analytical techniques have been developed by considering constant impedance and constant load models, separately to obtain optimal DG size [6].Minimization of active and reactive power generation costs and DG location, by using Genetic Algorithm (GA), and optimal power flow calculation [7]. In order to minimize the load supply cost the evolutionary programming has been used as optimization technique [8]. Based on the exact loss formula, the analytical expression were used to optimally allocate and DG sizing by minimizing the total power loss in primary distribution system[9].Power flow for radial distribution feeders by considering embedded distribution generation sources and shunt capacitors[10].

Many optimization techniques have been used and discussed in literatures. DG has advantages like power loss reduction, environmental friendliness, and voltage improvement, postponement of system upgrading, and increasing reliability. Genetic Algorithm (GA) has been used only for sitting, sizing has been done by Optimal Power Flow (OPF).The nature inspired known as Swarm intelligence focused on insect behavior in order to develop some meta-heuristics which can mimic insect's problem solving abilities. A new optimization approach that employs an artificial bee colony (ABC) algorithm to determine the optimal DG-unit's size, power factor, and location in order to minimize the total system real power loss. The ABC algorithm is a new metaheuristic, population-based optimization technique inspired by the intelligent foraging behavior of the honeybee swarm. This algorithm makes the programming simpler.

II. PROPOSED METHOD

A).Problem statement:
The objective function is to minimize the total system real power loss:

Objective Function = $$min \sum_{i=0}^{n} \left(\frac{P_i^2 + Q_i^2}{V_i^2}\right) * r_{i+1}$$

Where:

P_i = Real power flows from bus i to bus i + 1.

Q_i = Reactive power flows from bus i to i + 1.

V_i = Bus voltage at bus i.

r_{i+1} = Resistance of line connecting buses I and i+1

The equality constraints are the three nonlinear recursive power-flow equations describing the system:

$$P_i - \frac{r_{i+1}(P_i^2+Q_i^2)}{V_i^2} - P_{L_{i+1}} + \mu_P A P_{i+1} - P_{i+1} = 0$$

$$Q_i - \frac{x_{i+1}(P_i^2+Q_i^2)}{V_i^2} - Q_{L_{i+1}} + \mu_Q R P_{i+1} - Q_{i+1} = 0$$

$$V_{i+1}^2 = V_i^2 - 2(r_{i+1}P_i + x_{i+1}Q_i) + \left(\frac{(r_{i+1}^2 + x_{i+1}^2)(P_i^2+Q_i^2)}{V_i^2}\right)$$

Where i= 0,1,2,3,….n

The inequality constraints are:

$$|V_{min}^{spec}| \le |V_i^{sys}| \le |V_{max}^{spec}|$$

$$S_{i,i+1}^{sys} \le S_{i,i+1}^{rated} \ge S_{i+1,i}^{sys}$$

$$S_{max}^{DG} \ge S_i^{DG} \ge S_{min}^{DG}$$

$$p.f._{max}^{DG} \ge p.f._i^{DG} \ge p.f._{min}^{DG}$$

B).Load Flow Study:

The single line diagram of IEEE 69 bus feeder system and load flow graph for 69 bus system is as below in figure(1) & (2) respectively. The bus voltage should be from 0.95 to 1.05 volt per-unit. From the graph it is clear that there is a drop in voltage below 0.95 between the bus 60 to 69 bus. Thus it is clear that the allocation of distributed generation is in between these buses in the distribution generation. The optimal sizing and allocation of DG in distribution system will be using Artificial Bee Colony Algorithm.

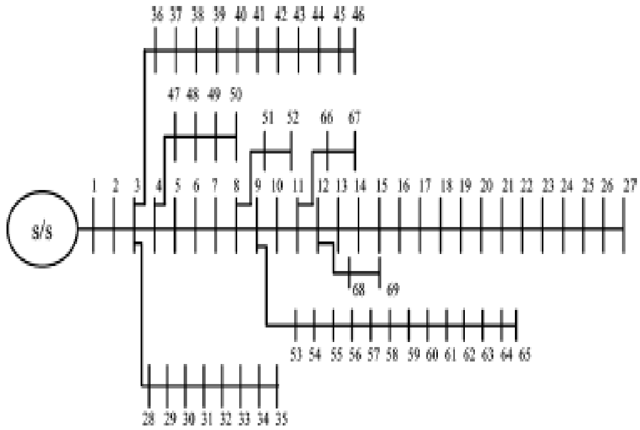


Fig: 1. Single Line Diagram of 69 bus feeder system.

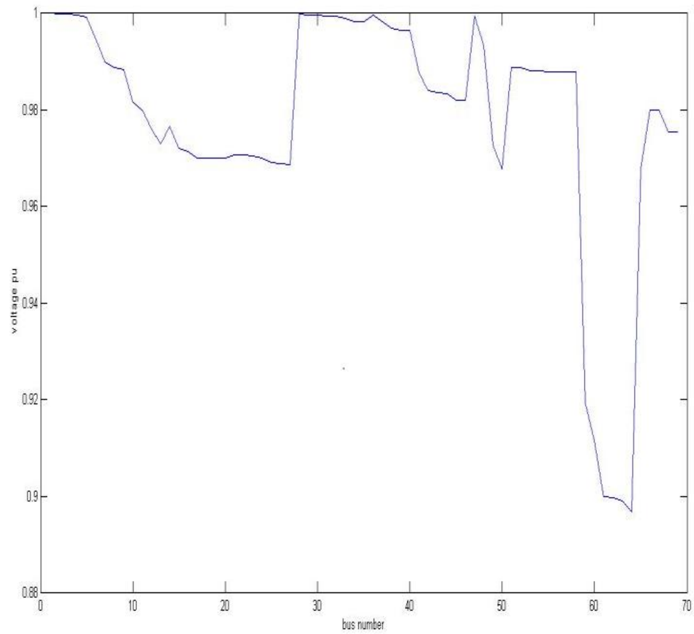


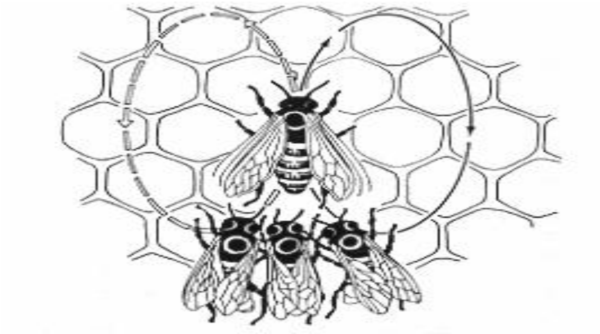
Fig: 2. Load Flow Graph of NR-Method for 69-Radial bus system

Load-Flow Results:

NR LF	Active Power(MW)	Reactive Power (Mvar)
Load	3.802	2.694
Generation	3.892	2.802
Line Losses	0.225	0.202

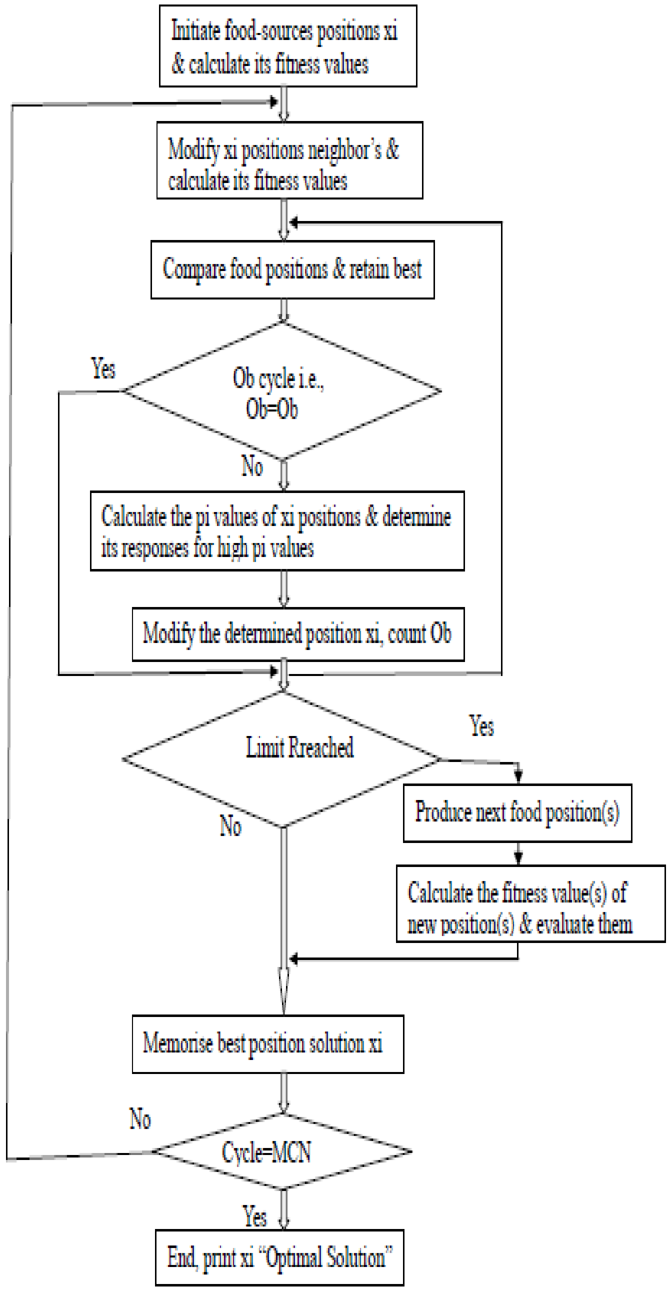
C) ABC Algorithm:

Artificial Bee Colony (ABC) is a relatively new member of swarm intelligence. ABC tries to model natural behavior of real honey bees in food foraging. The information exchange among individual insects is the most important part of the collective knowledge. Communication among bees about the quality of food sources is being achieved in the dancing area by performing waggle dance. Bee system consists of two essential components: Food Sources and Foragers.



Fig(3): Waggle dance of honey bees

The figure below shows the flow-chart of ABC Algorithm.



III. RESULTS AND DISCUSSION

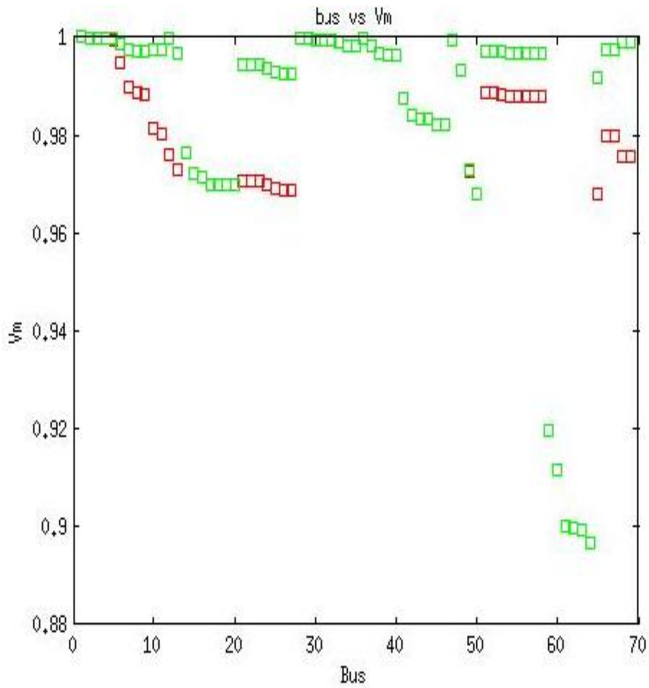
A 69-radial distribution feeder system has considered for different test cases. Two load scenario's scenario-I for Normal load and Scenario-II for 50% extra of normal load, all the three test cases conducted. Test case-1 is with one DG and Test case-2 with 2 DG. Test case-3 with 1 DG and 1 Capacitor. The results are as tabulated below in table (1), and (2).

Senario-I(For Normal Load)			
Test Cases	**Active power losses**	**DG & Capacitor Placed at Bus no**	**% Reduction of Losses**
1). 1 DG	0.08816	61	39
2). 2 DG	0.06739	61 and 12	29
3). 1 DG and 1 Capacitor	0.08252	61 and 04	36

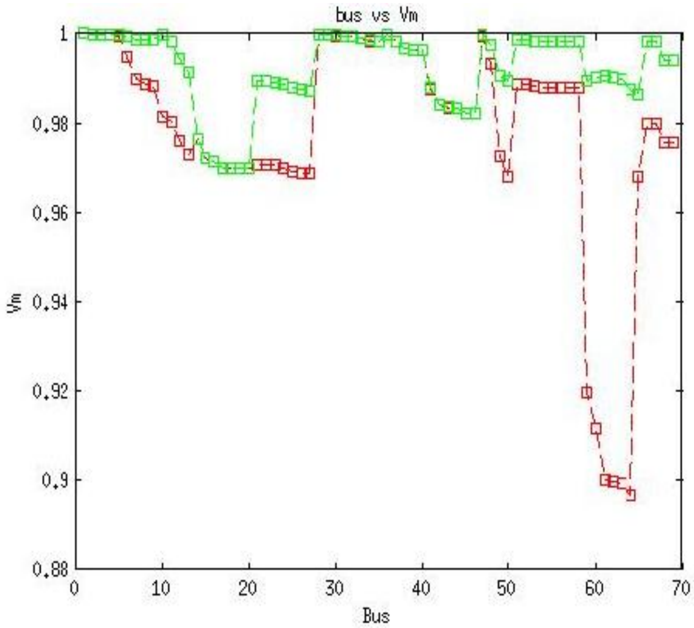
Table: (1) Results for 69-bus feeder systems Using ABC Algorithm

Senario-II(50% Extra of Normal Load)			
Test Cases	**Active power losses**	**DG & Capacitor Placed at Bus no**	**% Reduction of Losses**
1). 1 DG	0.11695	61	51
2). 2 DG	0.09007	61 and 09	40
3). 1 DG and 1 Capacitor	0.11502	61 and 09	51

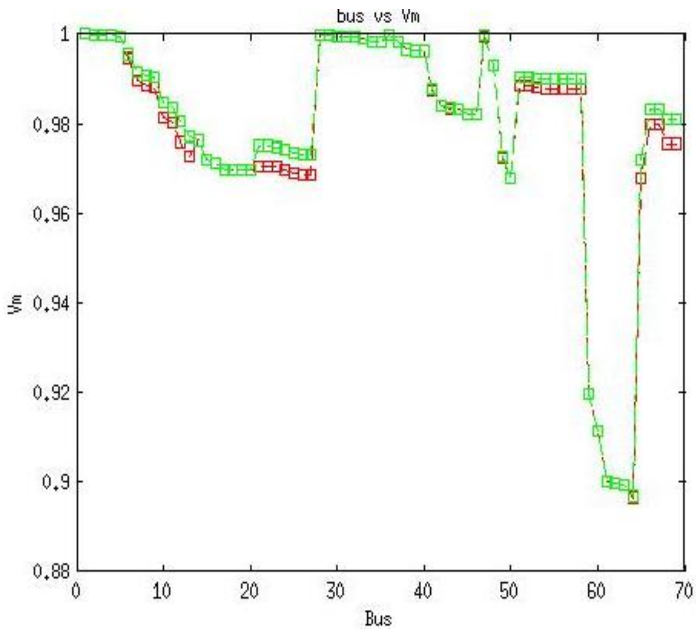
Table:(2) Results for 69-bus feeder systems Using ABC Algorithm



Fig(4): Voltage Profile of 69-bus system for Load Senario-1 for 1 DG



Fig(5):Voltage Profile of 69-bus system for Load Senario-1 for 2 DG



Fig(6): Voltage Profile of 69-bus system for Load Senario-1 for 1 DG and 1 capacitor.

The above figures(4), (5) and (6) shows the voltage profiles of the 69-bus system for different test cases of load Senario-1. The red colour is the default voltage profile, while the green colour shows the enhancement of voltage profile by ABC algorithm. The similar graphs are found for remaining test case-2 and test case-3. The results for all test cases are tabulated as in table-1 and table-2 for scenario-I and scenario-II respectively.

IV. CONCLUSION

The new population based ABC algorithm has been proposed to solve the mixed integer nonlinear optimization problem. The objective function function was to to reduce the real power loss subjected to equality and inequality constraints. The simulation was conducted on 69-bus radial distribution feeder system and the proposed ABC algorithm has successfully achieved the optimal solutions at various test cases. The graphs shows that the test case-2 with 2 DG the loss reduction is more and the voltage profile has also improved.

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Simulation of Three-Dimensional Flow of Light Non-Aqueous Phase Liquids in an Unsaturated-Saturated Zone

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Abstract: - A three-dimensional finite difference model that describes the infiltration and redistribution of light non-aqueous phase liquid (LNAPL) for the state of the three fluid phases; water, oil and air in the unsaturated-saturated zone of the soil is developed. The present model tracks the percentage of oil saturation as well as the lateral and vertical position of the oil plume in the subsurface, resulting from oil spillage, at the specified times with different types of boundary conditions. The flow equations are cast in terms of the wetting and non-wetting fluid pressure heads, respectively. The present model is validated through comparison to a laboratory three-dimensional experiment involving the infiltration and redistribution of kerosene into a sand bed. Results proved that the oil saturation in the upper part of the soil section declined towards a constant value, while the water saturation during the redistribution stage gradually increases in a linear form.

Keywords: - *LNAPL; Oil migration; Sand bed; Numerical modeling; Electrical resistance; Unsaturated zone.*

I. INTRODUCTION

Non-aqueous phase liquids (NAPLs) have been discovered at numerous hazardous waste sites. As compounds such as hydrocarbon fuels, organic solvents, and other immiscible organic liquids migrate through unsaturated-saturated zone they will pollute large extents of soil and groundwater (Fig.1).These organic fluids form a serious threat to groundwater resources, for example one liter of oil can significantly affect the quality of 100000 liters of water and consequently this water cannot be used (Marsman, 2002).

A number of multiphase flow models in the contaminant hydrology literature have been presented. Faust (1985) presented an isothermal two-dimensional finite difference simulator which describes the simultaneous flow of water and NAPL under saturated and unsaturated conditions.. Faust et al. (1989) developed a model that can be used to simulate a three-dimensional two-phase transient flow system based on a finite difference formulation. The governing equations were cast in terms of non-wetting fluid (NAPL) pressure and water saturation. Similarly, Parker et al. and Kuppusamy et al. as cited in Suk (2003) developed a two-dimensional multiphase flow simulator involving three immiscible fluids: namely, air, water and NAPL with the assumption of a constant air phase pressure. Kaluarachchi and Parker (1989) applied a two-dimensional finite element model named MOFA-2Dfor three phases, multi-component, isothermal flow and transport by allowing for inter-phase mass exchange but assuming gas phase pressure gradients are negligible. Pantazidou and Sitar (1993) presented experimental and analytical investigations of the movement of lighter than water organic liquids in the vadose zone. The experiments consisted of physical model tests simulating NAPL spills in unsaturated, two-dimensional domains above the water table. Darnault et al. (2001) developed a method by which fluid content can be measured rapidly in three-phase systems. This method uses the hue and intensity of light transmitted through a two-dimensional slab chamber to measure fluid contents. Kim and Corapcioglu(2003) developed a vertically averaged two-dimensional model to describe a real spreading and migration of LNAPL introduced into the subsurface by spills or leaks from underground storage tanks. This model is represented the transport of LNAPL lens in X-Y plane which is formulated on water table after spill.

Kechavarzi et al. (2005) presented a quantitative two-dimensional laboratory experiment to investigate the immiscible flow of a LNAPL in an unsaturated zone under homogenous soil conditions. An image analysis technique was used to determine the two-dimensional saturation distribution of LNAPL, water and air during LNAPL infiltration and redistribution. Ojuri[10] introduced an experimental and numerical investigation with the aim of characterizing the source, extent, transport and fate of petroleum hydrocarbon contamination in a 3D sand tank model and at the case study field sites, appraising the implication of the results for evaluating remediation endpoints. Singh (2010)presented an analytical solution of 1D solute transport equation to predict the contaminant concentration distribution along and against transient groundwater flow in finite homogenous aquifer. Kamaruddin et al. (2011) introduced the methodology for two-dimensional light non-aqueous phase liquid experiments with the application of light reflection and light transmission methods associated with image analysis methods including the process of visualizing simulation results that has improved on lengthy and tedious conventional methods. Sulaymon and Gzar(2011)studied the dissolution and transport process of benzene as a LNAPL in saturated porous media. This process was studied under unidirectional flow at different water velocities ranging from 0.90 to 3.60 cm/hr in a three-dimensional saturated sand tank with dimensions of 100×40×35 cm.

The significance of the present study is (a) characterization of Kerbala's sand for unsaturated flow of kerosene depended on a physical model that simulates an oil spill into a sand bed in a three-phase three-dimensional system, and (b) demonstrating that the governing equations and their solution procedure is representative of flow behavior of the kerosene in the unsaturated-saturated zone.

II. THEORY AND NUMERICAL FORMULATION

In the present analysis, the pressure gradient in the gas phase is assumed to be negligible so that gas pressure remains effectively constant at atmospheric pressure (Faust et al., 1989). Assuming also an incompressible porous medium and constant fluid properties, the flow equation for water (w) and organic liquid phase (o) may be written in summation convection for a three-dimensional Cartesian domain as (Bear, 1972):-

$$\frac{\partial}{\partial x}\left[K_w \frac{\partial h_w}{\partial x}\right] + \frac{\partial}{\partial y}\left[K_w \frac{\partial h_w}{\partial y}\right] + \frac{\partial}{\partial z}\left[K_w \left(\frac{\partial h_w}{\partial z} + 1\right)\right] = C_w \frac{\partial h_w}{\partial t} \qquad (1)$$

where x, y andz are the Cartesian spatial coordinates; K_w and $K_o$are conductivity tensors for water and oil respectively; h_w and h_o are the water height-equivalent pressure heads of water and oil respectively; ρ_{ro} is the ratio of oil to water density; t is the time. Phase conductivities are assumed to be described by:

$$K_w = K_{ws} K_{rw} \quad , K_o = \frac{K_{ws} K_{ro}}{\mu_{ro}} \qquad (3)$$

where K_{rw} and K_{ro} are relative permeabilities of water and oil respectively, $\mu_{ro}$is the oil and water viscosity ratio, and K_{ws} is the saturated conductivity tensor for water. The terms C_w and C_o are the specific fluid capacity defined as follows:-

$$C_w = \varphi \frac{\partial S_w}{\partial h_w} \quad , C_o = \varphi \frac{\partial S_o}{\partial h_o} \qquad (4)$$

where φ is the porosity of the medium; $S_w$and S_o are the saturation of water and oil respectively.
Constitutive relationships used here to describe three-phase fluid relative permeabilities and saturations as functions of fluid heads described by Parker et al.(1987)which is based on Van Genuchten's (1980) model are:-

$$S_e = \frac{S_w - S_r}{1 - S_r} \quad , S_{te} = \frac{S_t - S_r}{1 - S_r} \qquad (5)$$

$$S_e = [1 + (\alpha h_{aw})^n]^{-m} h_o \leq h_o^{cr} \qquad (7)$$

$$h_o^{cr} = \frac{\beta_{ow} h_w}{(\beta_{ao} + \beta_{ow})} \qquad (8)$$

$$S_{te} = [1 + (\alpha \beta_{ao} h_{ao})^n]^{-m} \qquad (9)$$

where h_{ow} oil-water capillary pressure head (=h_o-h_w);h_{ao} air-oil capillary pressure head (=h_a-h_o);$h_a$the water height-equivalent pressure head of air;S_e effective water saturation; S_r residual water saturation; S_t total liquid saturation; S_{te} effective total liquid saturation and oil saturation S_o=S_t-S_w. Here α, n and m(=1-1⁄n) are Van Genutchten's soil parameters, β_{ao}&β_{ow} are fluid-dependent scaling coefficients. The values of S_r**,** α**,** n, φ, β_{ao},β_{ow},μ_{ro} andρ_{ro} for kerosene-water system in the sand adopted in the present study were 7%, 0.048 cm^{-1}, 2.7, 0.415, 2.75, 1.57, 1.512 and 0.8 respectively(Faisal, 2006).
The solution techniques used here consist of a finite-difference approximation, the Newton-Raphson numerical approach with a Taylor series expansion to treat nonlinearities. These techniques result in the general form of the matrix system:-

$$A^k \delta^{k+1} = -r^k \tag{12}$$

where A is the coefficient matrix for the linearized system and r^k is the residual in node (i,j,l) at iteration k. For each node, there is one linear equation in seven variables $\delta^{k+1}_{fi-1,j,l}$, $\delta^{k+1}_{fi,j-1,l}$, $\delta^{k+1}_{fi,j,l-1}$, $\delta^{k+1}_{fi,j,l}$, $\delta^{k+1}_{fi+1,j,l}$, $\delta^{k+1}_{fi.j+1,l}$ & $\delta^{k+1}_{fi.j,l+1}$. The collection of equations for each solution node leads to a global diagonal coefficient matrix of bandwidth (=2×number of columns of discrete flow domain×number of blocks of discrete flow domain +1). This matrix is solved for δ and then the algorithm enters the next iteration with new values of h_f evaluated as follows:-

$$h^{k+1}_{fi,j,l} = h^{k}_{fi,j,l} + \omega^{k+1}_{f}\delta^{k+1}_{fi,j,l} \tag{13}$$

where ω^{k+1}_{f} is a damping parameter as mentioned by Cooley (1983). The convergence criterion used for a given phase is as follows:-

$$\frac{max.\left|\delta^{k+1}_{fi,j,l}\right|}{max.\left|h^{k}_{fi,j,l} + \delta^{k+1}_{fi,j,l}\right|} \le \varepsilon \tag{14}$$

where ε is the convergence tolerance. A typical convergence criterion for pressure head is 0.001 or less.
Two types of boundary conditions are considered. Firstly, Dirichlet or a fixed head boundary condition and secondly, Neumann or a specified flux condition. The present model ignores the transport of dissolved and vapour plume of NAPL. A computer program written in DIGITAL VISUAL FORTRAN (version 5)was developed to implement the model described above.

III. MODEL VALIDATION

In order to illustrate that the governing equations and the constitutive relationships upon which the numerical model is based correctly represent the intended real-life processes, the numerical model results are compared with results obtained from a three-dimensional sand bed experiment. The laboratory experiment involves a kerosene spillsimulated in a three-dimensional tank 70 cm long, 45 cm high, and 20 cm wide. In all experiments, a total of 5000 cm^3 of kerosene was used; this was equal to approximately 30% of the pore space above the water table. Kerosene was added as needed to maintain the height of the free liquid always at equivalent water pressure head equal to 4 cm above the top of the sand, until all 5000 cm^3 of kerosene was used. The rate at which kerosene was added to maintain the level of 4 cm was dictated by the rate at which kerosene disappeared into the sand. The frame of the tank was made of steel to prevent bending of sides. All sides (front, back, lower and lateral boundaries) were made of 6 mm thick of glass which were transparent to allow for visual observations. The back side of the tank was supplied with a number of openings. Through these openings a pair of probes was inserted, which were connected to a resistance meter. These probes were located in a certain locations in the sand bed (Fig.2). The readings of the resistance meter were used to indicate the degree of water saturation. Two vertical partitions with lower openings that were 10 cm high and 20 cm wide, and covered with steel mesh formulate the lateral boundaries of the sand-filled middle compartment, their dimensions were (60×45×20) cm. The purpose of the two outer compartments was to provide constant head reservoirs for controlling the position of the water table within the sand deposited in the middle compartment. Each outer compartment was 5 cm long, 10 cm high, and 20 cm wide. The tank was placed in a room which was kept at 20ºC. The tank was filled with 40 cm of Kerbala's sand which was used as the porous medium. The sand had a particle size distribution ranging from 50 μm to 1mm (Fig.3) with an effective grain size ,d_{10}, of 180 μm, a median grain size,d_{50}, of 370 μm and a uniformity coefficient, Cu= d_{60}/d_{10}, of 2.2. The permeability of the sand, measured with a constant head permeability test, was 115 cm/hr. Kerosene dyed with Sudan III was used as the infiltrating LNAPL in the experiments.

The degree of water saturation was measured at certain locations through a certain section through-out the sand bed by using resistivity probes connected to a resistance meter. These measurements were based on electrical resistance between the two probes (electrodes). Electrical resistance measurements were converted to water saturation values with the aid of calibration curve determined experimentally for Kerbala's sand and the pore fluid (Fig.4), a 0.01N sodium chloride solution in deionized water used in the present study as recommended by Pantazidou and Sitar (1993). The NaCl solution was preferred to pure water because it delays dissolution of salts from the sand into the pore fluid and therefore provides a fluid of virtually constant electrical properties for which a single calibration curve can be used. On the other hand, Firoozabadi and Ramey in 1988 showed that salts affect the surface properties at high concentrations as cited by Pantazidou and Sitar (1993), the sodium chloride concentration was chosen to be low in order to minimize change of the interficial tension between water and the NAPL. Measurement of water pressure was achieved by using a tensiometer. Water saturation measurements were converted to water pressure values with the aid of a calibration curve determined experimentally for Kerbala's sand (Fig.5). As water saturations were measured with the time at the locations illustrated in Fig.2, the corresponding water pressure can be calculated by using the water pressure-saturation calibration curve shown in Fig.5. By using these values and the constitutive relationships adopted for kerosene-water system in Sec.2, the corresponding oil pressure and oil saturation can be calculated.

IV. RESULTS AND DISCUSSION

The present study provides an example of a fully three-dimensional flow field in laboratory scale in which kerosene, air, and water are present. This problem is reflected the ability of the present model to solve any three-dimensional case subjected to a given geometry, boundary conditions, and initial conditions. The geometry of the flow domain, as described in the Sec.3, is represented by middle compartment of the tank which is the location of the sand bed. This bed has the dimensions of 60 cm long (in x-direction), 40 cm high (in z-direction) and 20 cm wide (in y-direction). Kerosene was introduced into the sand bed from cubic container. This container has the dimensions of 10 cm long, 6 cm high and 5 cm wide. The centerlines of this container coincide with centerlines of the top view of the tank.

The properties of the soil and kerosene used in the present simulation are mentioned in Sec.2. Oil was allowed to infiltrate from the container under a water equivalent oil pressure head of 4 cm to simulate an oil spill. For the water phase, constant head boundary conditions were imposed for the saturated zone. Zero-flux boundaries were used on all other boundaries. For the oil phase, all boundaries except the source were zero flux. For all cases a total of 5000 cm^3 of kerosene was permitted to infiltrate. Redistribution was allowed up to a total simulation time of 24 hours.

The three-dimensional finite-difference grid extends 30 cm from the center of the source in a positive x-direction, 40 cm vertically downward in the z-direction and 10 cm from the center of the source in a positive y-direction, discretizing the field into 315 blocks. The present model assumes a symmetrical grid, therefore, negative x- and y- values are implied and presumed equivalent to the simulated positive x- and y- values respectively. Variable time step sizes (ranged from 0.0001 to 0.1 hrs) were used in solving the present problem.
The present problem was simulated in two steps. The first step established a steady state flow field based on the boundary conditions which was used as initial condition for the transient simulation. The second step, the transient simulation, consisted of two periods. During the first period (21.2 min as calculated from the present model and 23 min as calculated from the present experimental work), leakage of kerosene into the sand bed is equal to 235.78 cm^3/min. Because the present model has the advantage of symmetry in the x and y directions to reduce by quarter the number of blocks, the modeled source rate is 58.945cm^3/min. As illustrated in Fig.6, there is a good agreement between the calculated and measured cumulative oil infiltration. During the second period, there is no leakage of kerosene into the sand bed, but the accumulated kerosene during the first period was allowed to redistribute for a total simulation time equal to 24.0 hours.

The present experimental results of effective water saturation, capillary pressure and oil saturation in locations 1, 2 and 3 are compared with the corresponding computed values as shown in Figs.7, 8 and 9. The following remarks may be made on these figures: - (1) it is seen that there is a good agreement between computed values of effective water saturation and capillary pressure with corresponding experimental values. While the computed values of oil saturation are slightly larger than the experimental values. It seems that this departure of the experimental results from the theoretical model is due to the effect of dissolution and volatilization which are neglected in the present theoretical model. The present model does not consider dissolution or volatilization and, therefore, provides a conservative estimate of the extent of NAPL migration. Kerosene that migrates to a position at or near the ground surface will likely vaporize and enter the atmosphere. This volatilization will effectively reduce saturation levels. Also, relatively soluble chemicals would sustain a loss of mass as the NAPL dissolves and disperses into the surrounding groundwater. (2) As the time is increased beyond the infiltration stage the water saturation increases, the oil saturation decreases and both the theoretical and experimental water and oil saturation versus time relation are, approximately, linear.
According to Fig.10, the maximum kerosene saturation (0.986 at t = 21.2 min) occurred below the line source during the kerosene infiltration. During redistribution, this value at the same position decreased to (0.411 at 24

hours). Also, the reduction in kerosene saturation and the gradual increase in water saturation as the front approached the water table, resulted in a reduction in the kerosene relative permeability and therefore caused a decrease in the front velocity.

V. CONCLUSIONS

(1) The numerical solution based on the potential form of the governing equations using a finite-difference approximation, the Newton-Raphson numerical approach with a Taylor series expansion was shown to be efficient in solving three-dimensional water and LNAPL flow through the unsaturated-saturated zone in a three fluid phase system.

(2) The calculated oil saturations for three-dimensional simulation from the present model were slightly greater than the corresponding experimental values. This departure is due to neglecting the volatilization and dissolution mechanisms associated with the LNAPL transport through the unsaturated-saturated zone of the soil. In real spillage, the part of LNAPL will vaporize into the air phase and, on the other hand, another part will dissolve into the water phase. Consequently, for this reason, the actua1 remaining of LNAPL will less than the calculated values.

(3) As the time is increased beyond the infiltration stage the water saturation increases, the oil saturation decreases and both the theoretical and experimental water and oil saturation versus time relation are, approximately, linear. However, saturation or capillary pressure as a function of time at the chosen points show a rapid early rise followed by an essential uniform plateau.

(4) The reduction in kerosene saturation and the gradual increase in water saturation as the front approached the water table, resulted in a reduction in the kerosene relative permeability and therefore caused a decrease in the front velocity.

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SYMBOLS

The following symbols are used in this paper:

A = coefficient matrix;
C_o = specific oil capacity;
C_w= specific water capacity;
C_u = uniformity coefficient;
d_{10}= effective grain size (L);
d_{50}= median grain size (L);
h_a = air pressure head (L);
h_{ao}= air-oil capillary pressure head (L);
h_{aw} = air-water capillary pressure head (L);
h_f = fluid pressure head (L);
h_o = oil pressure head (L);
h_o^{cr}= critical oil pressure head (L);
h_{ow} = oil-water capillary pressure head (L);
h_w = water pressure head (L);
i,j,l = grid identification in x, y, z directions respectively;
K_o = hydraulic conductivity of oil ($L\ T^{-1}$);
K_w = hydraulic conductivity of water ($L\ T^{-1}$);
K_{ws}= saturated conductivity tensor for water ($L\ T^{-1}$);
K_{ro}= relative permeability of oil;
K_{rw}= relative permeability of water;
k = iteration index;
n, m Van Genuchten's soil parameters;
r = the residual due to approximation;
S_e = effective of water saturation;
S_o = oil saturation;
S_t = total liquid saturation;
S_{te} = effective total liquid saturation;
S_r = residual water saturation;
t = time coordinate(T);
x, y, z= cartesian coordinates;
α=Van Genuchten's soil parameter (L);
β_{ij}=fluid-dependent scaling coefficient;
δ = the difference between the approximation and exact solution (L);
ε = convergence tolerance;
μ_{ro}=viscosity ratiobetween oil and water
ρ_{ro} = ratio of oil to water density;
φ = porosity of the medium;
ω = damping parameter;

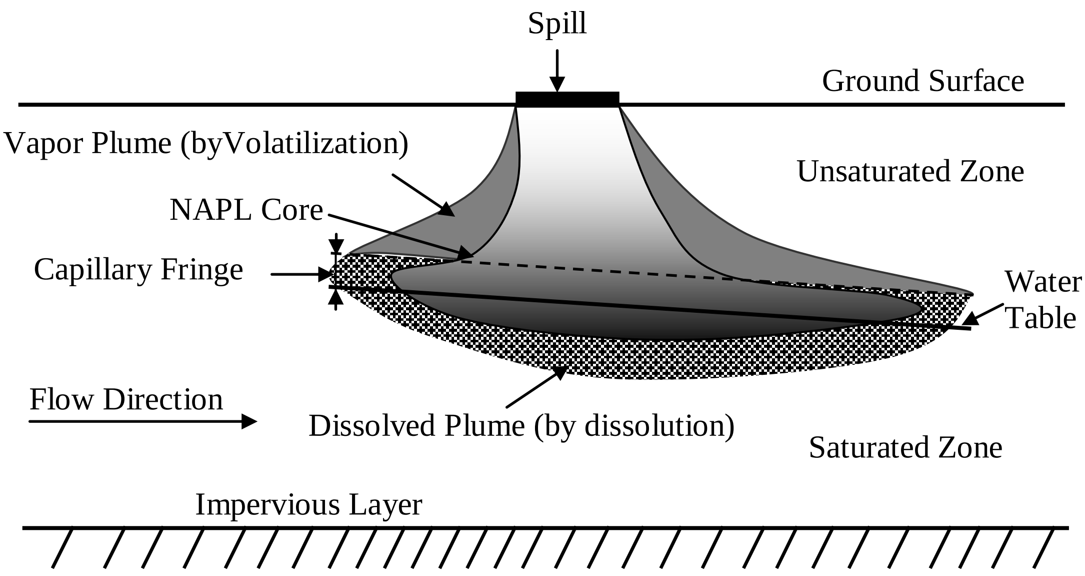


Fig. 1. Conceptualized representation of LNAPL migration and contamination of the subsurface (Faisal, 2006).

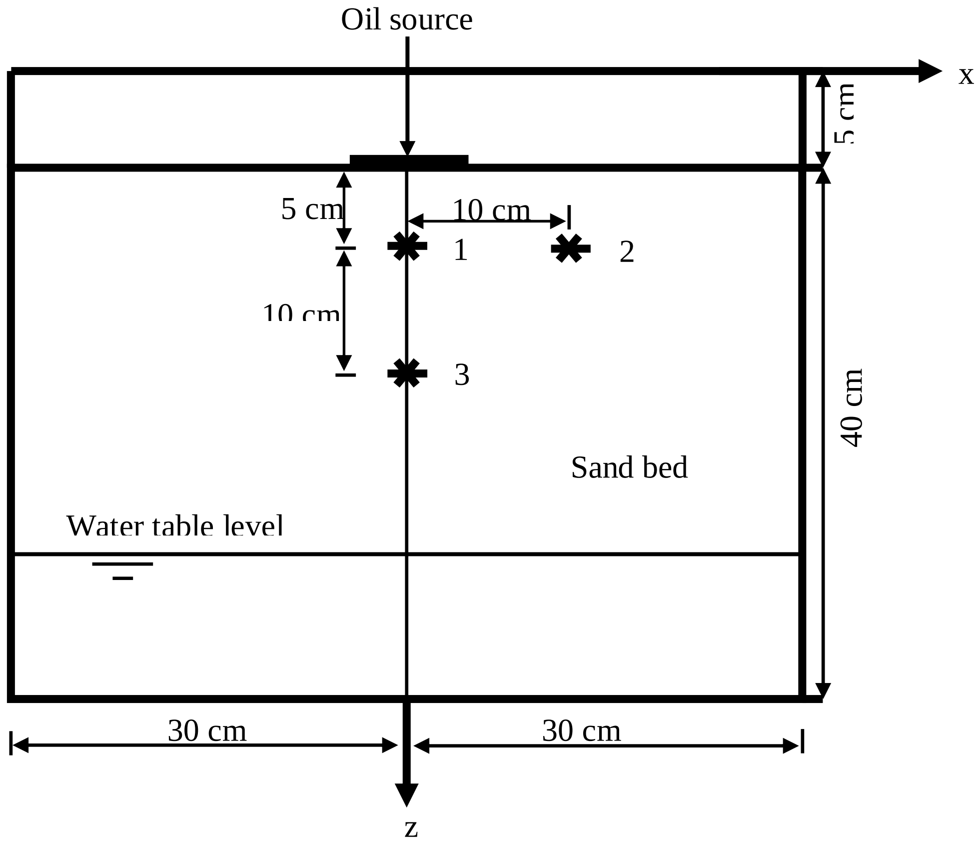


Fig. 2. Selected locations (1, 2 and 3) in the central section for measurement of phases variables during the present study.

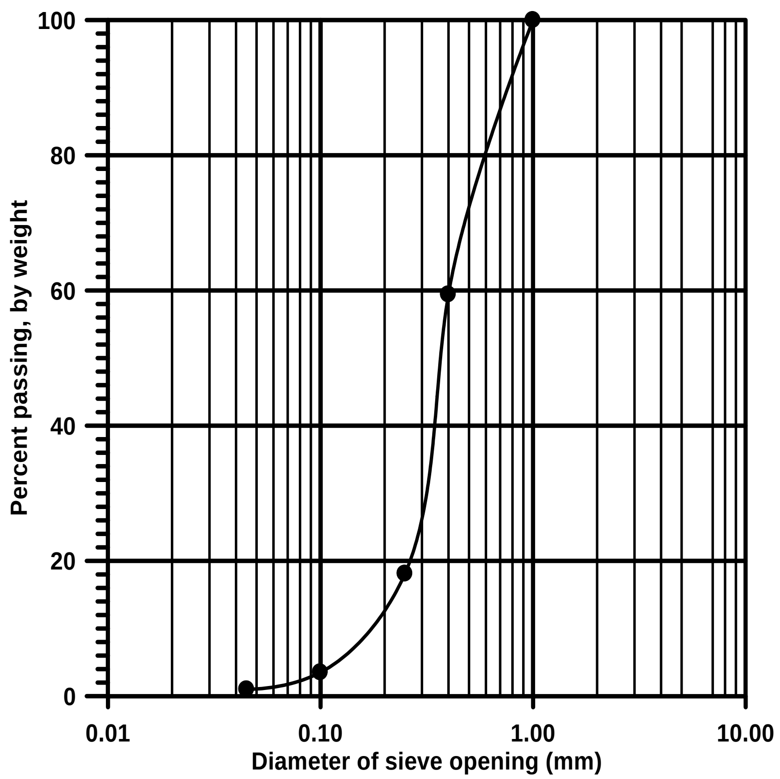


Fig. 3. Gradation curve for Kerbala's sand.

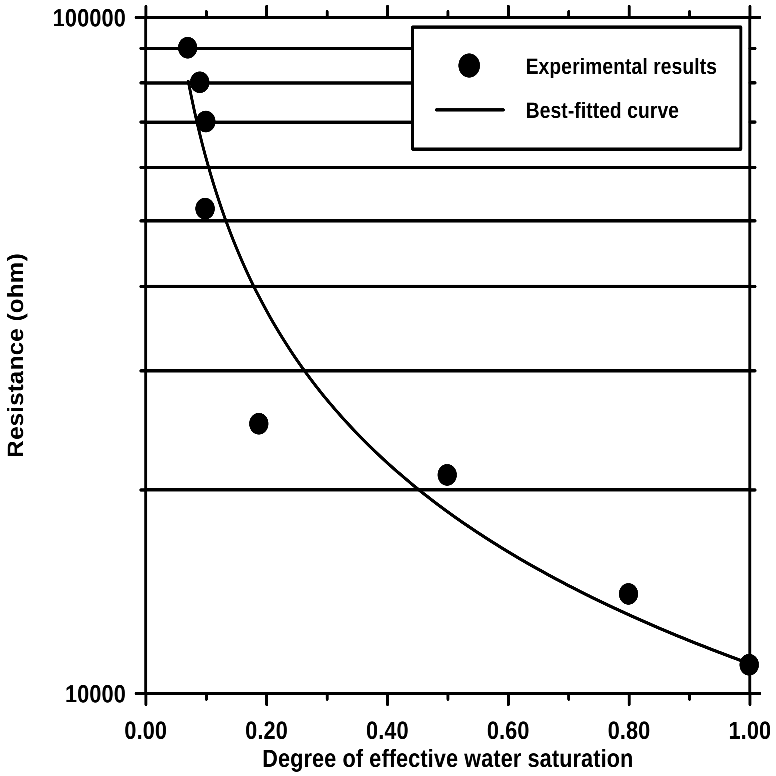


Fig. 4. Electrical resistance-water saturation curve for Kerbala's sand.

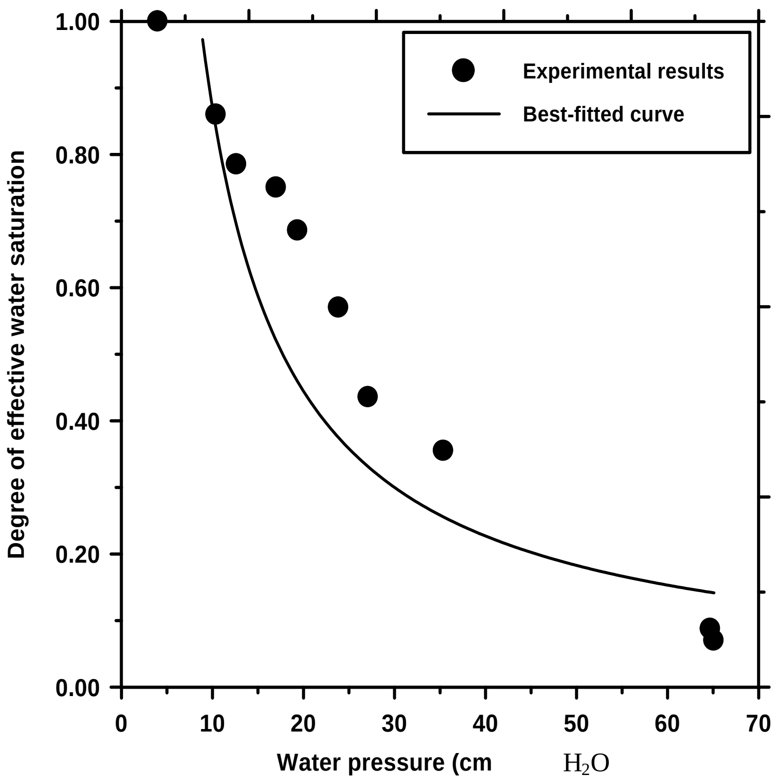


Fig. 5. Water pressure-water saturation curve for Kerbala's sand.

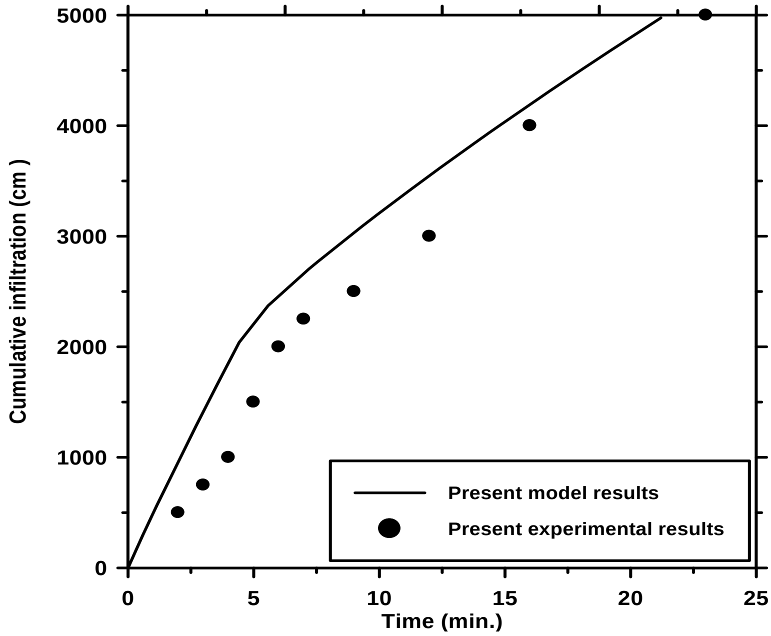
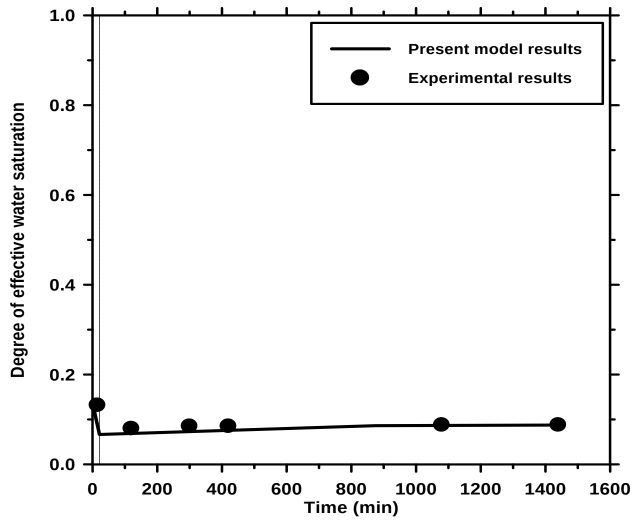
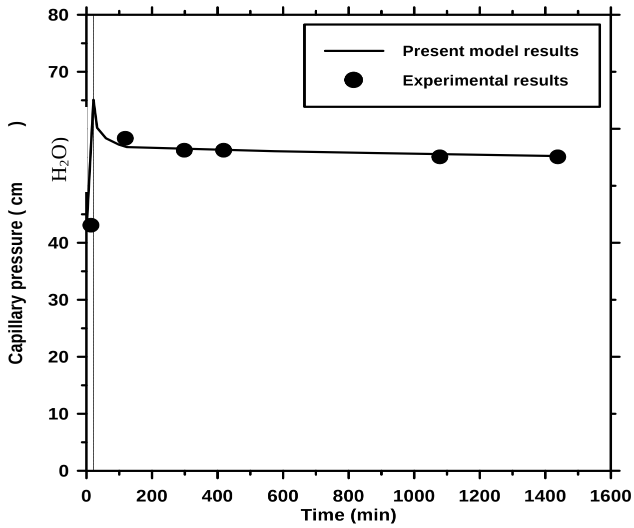


Fig. 6. Cumulative oil infiltration versus time for the three-dimensional simulation.





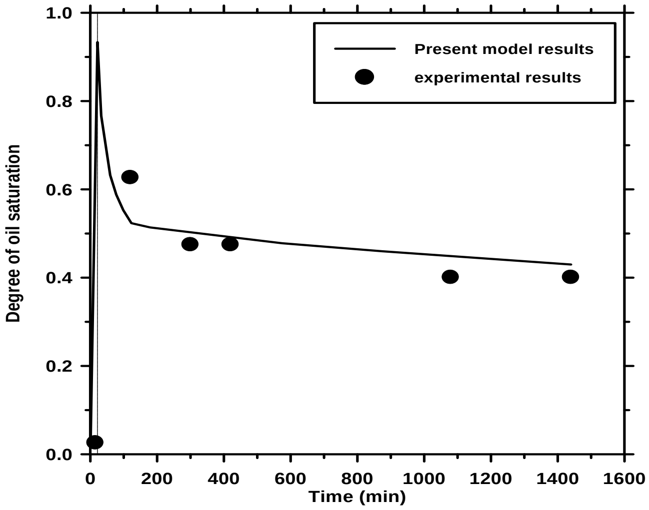
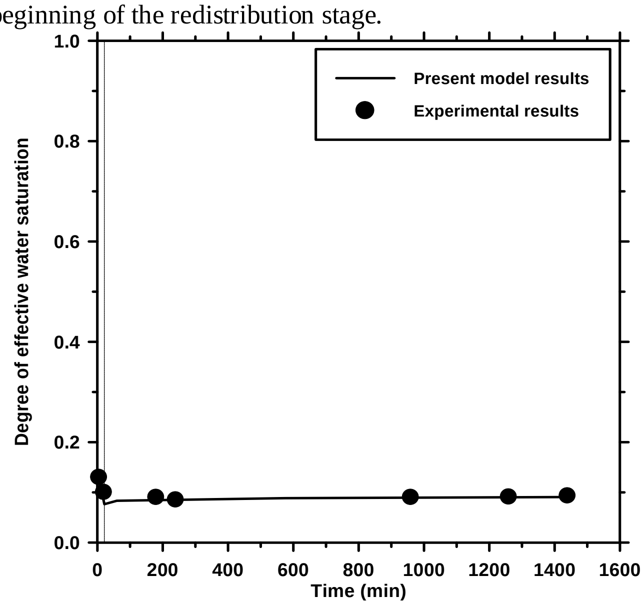
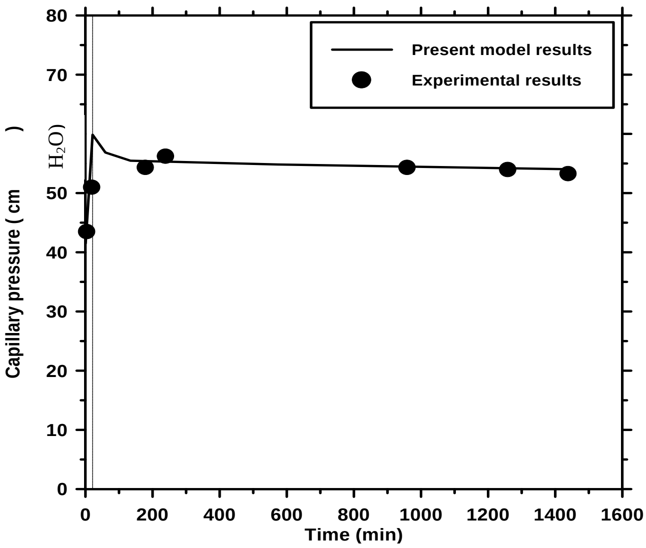


Fig. 7. Water saturation, capillary pressure and kerosene saturation changes with time during kerosene infiltration and redistribution registered at location 1 in the sand bed, dashed line marks the end of the infiltration stage and the beginning of the redistribution stage.





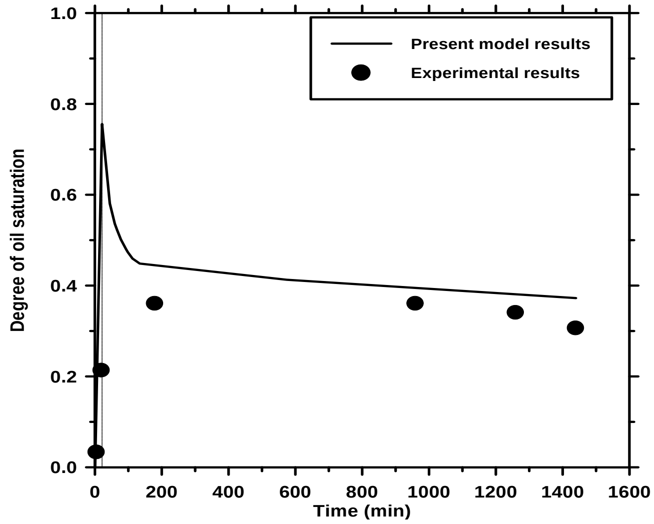
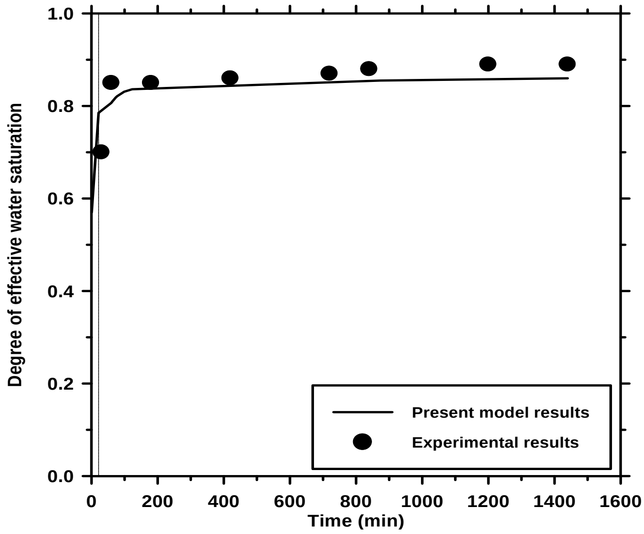
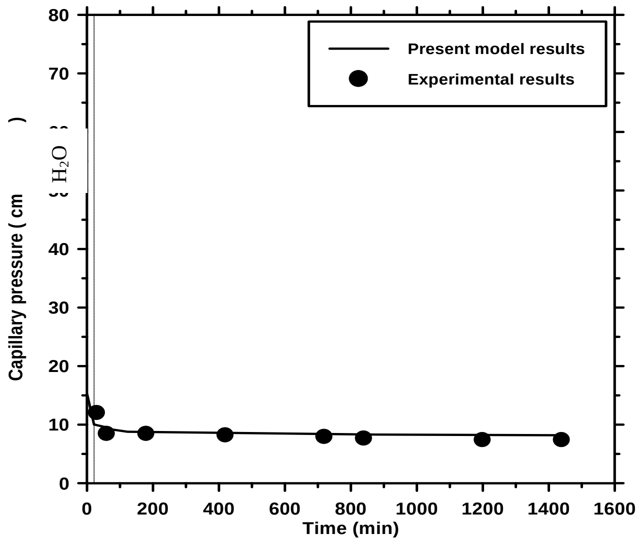


Fig. 8. Water saturation, capillary pressure and kerosene saturation changes with time during kerosene infiltration and redistribution registered at location 2 in the sand bed, dashed line marks the end of the infiltration stage and the beginning of the redistribution stage.





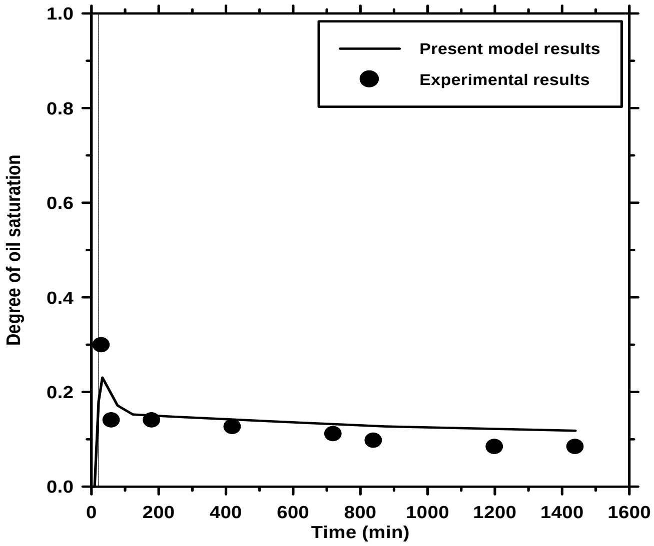


Fig. 9. Water saturation, capillary pressure and kerosene saturation changes with time during kerosene infiltration and redistribution registered at location 3 in the sand bed, dashed line marks the end of the infiltration stage and the beginning of the redistribution stage.

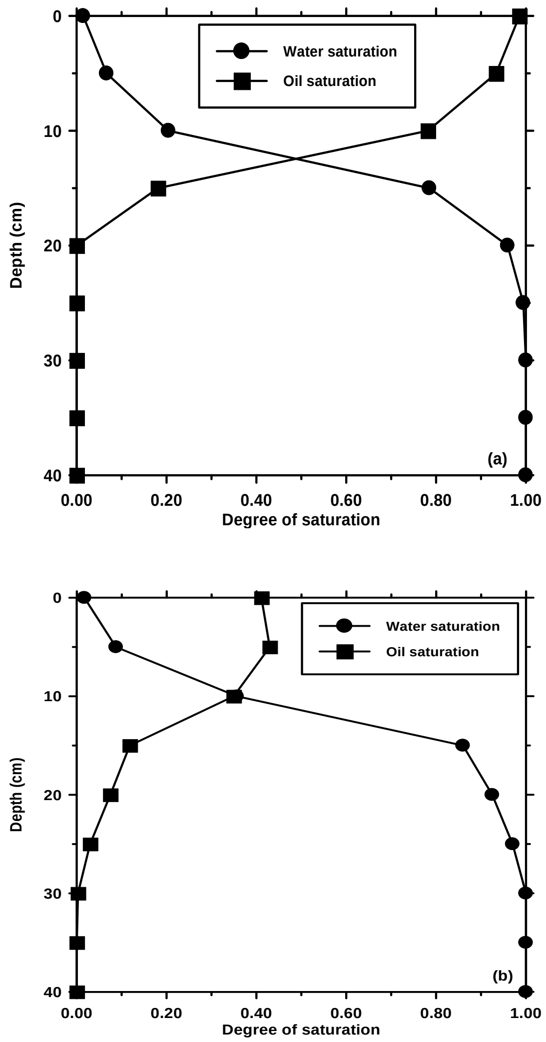


Fig. 10. Kerosene and water saturation profiles calculated on the center line of the tank after (a) 21.2 min and (b) 24 hours.

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Community development strategies codification (physical - spatial) using smart growth approaches

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Abstract: - Urban management structure in recent decades, associated with features and constraints such as non-participatory, focus, system of scheduling, planning top-down, bureaucratic and politicization of the urban development process lacks practical commitment to the principles and applications urban development programs. Hence, it has paused the management strategies developed to resolve these issues and problems at the micro level and neighborhoods. However, despite years of planning, today's cities are growing sporadically. In the past decades, a large amount of agricultural land, gardens and green spaces around the city in order to grow the city is dedicated to building and the day following cities and have been moving more and more toward scattering phenomena and the increasing use of private cars fueled by the fragmentation and is involved on environment quality degradation. Urban Village, new-urbanism, sustainable development, smart growth and the increasing development of all new concepts and approaches that the today's urban problems and uncontrolled expansion of urban areas and put up a new way of development in open areas of the old, the potential uses, increased density and….and each one is complement each loan different from the experiences and achievements of former approaches. the methodology is descriptive-analytical.in this research we try that new approaches are presented in the discussion of urban development and smart growth theory as the main approach to explain the research is and concepts developed and compression is needed to analyze and eventually the criticisms and pudding on smart growth and enumerate the benefits of local sustainable development strategies will be described.

Keywords: *smart growth, sustainable development, neighborhood, uses density, new urbanism*

I. INTRODUCTION

Characteristic of our era in recent decade is urban population, urban population increases and consequently the development of small towns and big. In 1900, only one out of every eight people lived in urban areas (Gilbert and Gagler, 1996) and according to estimates over the period 1990 to 2030, the urban population will grow to about 3.3 billion people which it will be 90 percent in urban areas in developing countries. As migrants in search of jobs, better opportunities, or just food and shelter, continued to migrate to cities, urban infrastructure capacity and are often at reduced pressure, the worse housing conditions and housing are condensed, outdoor raped falls, the streets are congested, air quality has plummeted, declining water resources, surface and ground waters will be contaminated.

Neighborhood Manage is the link neighborhood residents and urban management. If accepted by the city administration to improve the participation of all actors in development, including public, private and civil society is essential, management in the context of the cooperation of all actors and takes place the culture of democratic governance. (sarrafi: 2004).

II. PROBLEMS DEFINED

Rapid population growth and subsequent rapid expansion of cities as one of the main issues raised in the city today is because of lack of planning and efficient management of this phenomenon, cities are faced with the problems that is is known that can be pointed loss of critical habitat, high dependence on private cars, the

rising cost of city government. In response to these problems were discussed new concepts and approaches for the future. One of these approaches is smart growth that is proposed in the face of development patterns of suburban America in the United States has been and it is pausing principles for the development and redevelopment of dense cities and reduces the uncontrolled expansion of urban areas.
Also in Iran, scattered in the development of urban release areas, preparation and public lands and cooperative and… enhanced.

Activities associated with growth, affected such as the isolation of rural communities, threatening the core urban centers and weakened small communities, destruction of open spaces and natural areas are the following.
Tehran metropolis is also not an exception. Uneven development of the city of Tehran and dozens of negative consequences resulting from this development, effects of smart growth and sustainable development in the control of the open space in terms of economic, social and environmental issues as one of the solutions to control the expansion aims.
Smart Growth proper use of resources, increased utilities, development mixed uses neighborhoods, public transportation facilities and the design of sustainable is proposed results on a human scale integrated urban development.
Urban Smart Growth has numerous approaches including: the creation of a mixed use, taking advantage of compact building design, building neighborhoods accessible by foot, and the areas of environmental preservation of open space and agricultural land, providing a variety of modes of transport, emphasis on redevelopment within the context of existing neighborhoods, encourage citizen participation and collaboration....
Smart growth strategies based on the study area (urban, rural or suburban area) are different:

A) The City: The metropolitan area, the emphasis on redevelopment of existing neighborhoods and the context, enhancing the mixing of different land uses and enhance the transportation system, especially walking and public transport.

B) Suburban: suburban area, medium traffic centers have varied access applications through the development of mixed communities are created in the suburbs or planned development based on the principles of smart growth. This method encourages independence and self-reliance and improves the choice of travel destination in the region.

C) Village: rural smart growth strategy includes strategies that helps develop public services to rural areas with mixed land uses become available. (Litman, 2005:6-7).

III. MATERIALS AND METHODS

Methodology is kind of developmental and descriptive - analytical approach.

4-Definitions:

Urban growth:

Urban growth is a spatial process and population that refers to as increase of the concentration of population in urban areas and towns with an economy and society specifically. However, urban growth axis is the composition and spatial dynamics (Seto & Fragkias, 2005)
The pattern of urban growth and urban sprawl, or what new urbanism as smart growth (urban development process and the direct impact on both the city and the neighborhood) describes corresponds. (Bhatta, 2009)

Development

Development is a process by which increases capacity and capability of system and its components in the development process, not necessarily wealth, but also is enhanced the capacity, capability, skill, creativity and knowledge and understanding.
Important consequence of development is enhance the quality of life. Sufficient to achieve the goals and ideals of objectivity and to make wishes. This result enables the system to optimize its resource consumption and increase with reliance on foreign sources in order to their growth and development. (Amir ahmadi: 1996)

Smart growth

Smart growth is not identical with the word growth. Smart growth is kind of development in the economic sphere (market) serves communities and the environment. Smart growth provides a framework for communities to make to adopt appropriate decisions about how communities and where to grow. smart growth enables communities in ways growth that must be optimal given support economic and employment: empowering neighborhoods with alternative housing units (housing), business and Transport and build a healthy community with families in a safe environment. Smart Growth could have been achieved as a reasonable response in the face of those who deal with more dispersed development patterns over the past 50 years (recent). (ICMA.2000).

The United States model of smart growth is defined as: "Smart growth is an urban development strategy that seeks to comfort the living, productivity improvement and environmental sense. smart growth has developed its own fundamental way by urban planners, ecologists and other experts in the United States. (Appleyard, 2007).Smart growth is one of new perspectives on the concept of growth management which has been proposed against suburban development pattern in U.S. A. and poses principles for dense development and redevelopment within urban areas (Talen, 2003).

Urban sprawl

Dispersed urban growth after the Second World War, became the most important issues of urbanization processes in developed countries such as America, Canada and some European countries (Gill; 2008). Sparse growth which has defined as urban sprawl suburbs are as a model of low-density urban development and car-dependent (Bhatta, Sarawati, & Bandyopaddhyay, 2010B). Terms of urban distribution associated with the expansion of cities into suburbs and rural areas and agricultural lands are used. In other words, residents of such areas tend to live in single-family homes and commute daily between their work and their lives.

Physical-Spatial Development

Physical development includes the development and use of town is the city which appears result in factors including increasing population and the need for more urban land uses. In other words, the physical development of the city can be seen as an increase in the urban area. (Sustainable urban development; 2000).

Compact City

Compact cities are high population density, mixed-use, convenient and efficient public transportation system by encouraging walking and cycling. This idea rests based on cities traditional European form. (Burton, 2000). Compact urban form should be scale suitable for walking and cycling and public transport, it must be a level of compactness that encourage social interaction. Compact urban form, not just focus on urban centers and the available land has been abandoned but avoid expanding outside of town is well. (Richards & Rogers, 1999). Such places have high population density and the incorporation of social interaction is the main features of the traditional city permits.

Sustainable Development

Sustainable development is a concept that has been discovered in all the different departments in areas such as land use, particularly when reporting commission Brandt Land is widespread throughout the world, attracted a lot of fans in that order. (WCED, 1987). Brandt Land Commission in its report in 1987, sustainable development is defined as:

"the kind of development which to provide the needs of the present generation without compromising the ability of future generations for their needs." (Brunt land commission)

IV. INNOVATIVE APPROACH IN URBAN PLANNING

- Sustainable Development:

After examining the perilous state of the natural environment and the destruction of the environment, began in 1972sustainable development and attention to environmental issues, the United Nations Conference on the Human Environment in Stockholm, Sweden. More on this meeting to discuss air pollution and exploitation of resources. Following the meeting Stockholm cocoyoc notices published in 1974 and it was proposed to develop ecological and eventually became as sustainable development. (Nasiri, page 191). In 1989 after the conference Brunt land, WCED report was published as the first to document clearly states that sustainable development. A year later published in the CEC green paper reports prepared in 1990 and the Leaders' Agenda 21 was in 1993. (Wily & Son, 2006.456)

Numerous definitions have been proposed of sustainable development, but the most comprehensive and most complete definition of sustainable development is known as the World Commission on Environment and Development Commission, brunt land is "sustainable development is development that meet the needs of the present without compromising the ability of future generations to meet their potential. " In this definition, are allowed the right of every generation have the same amount of natural capital that is available to other results generation recognized and the use of natural capital as its interest (and not its origin that the cause of the destruction of natural capital).

The main objective of sustainable development mentioned meet basic needs, improve living standards for all, better maintaining the future ecosystems and a safer and more prosperous. (Bahraini, 2001, p 44)

Principles of sustainable development policies can be divided into four groups:

- To minimize the consumption of non-renewable natural resources

- Build sustainable use of renewable natural resources
- Keeping limit the amount of waste and pollution absorption capacity of local and global
- Providing basic human and social needs.

Urban Village

In the late nineteenth century urban planners, particularly in Great Britain - followed by more industrialized and urbanized countries in the world - the formation of new towns that were backed against the problems of the industrial age. They hoped that the bustle and rush of modern city with a village-like environment to a greater integration of work and family life and optimal use of the environment to return.
Ebenezer Howard, a British designer was perhaps one of the most effective advocates of this approach. Because of his fear of disorder and chaos, disease, crime and delinquency in modern industrial metropolis, the garden city on the outskirts of the city to support their observational characteristics of cities with a population of about 30,000 people, self-employed and the desired neighborhoods with homes which is surrounded by rural areas. Garden City, he was a model of development that affected designers worldwide soon in America, Germany, Australia, Japan and other parts of the world.

The concept of urban villages affected by this theory and the urban village was introduced in England in the late 1980s and *peter calthorpe* was raised and promoting the idea of relying on public transport, cycling and walking instead of using cars. The urban village concept was guided by a philosophy and set of principles to create to better design, mixed use, sustainable area with a commitment a sense of place and community. (Aldous, 1992) Urban villages are places that have a focus on employment, housing, commercial uses, public spaces; public transportation and walking are activities. They are often within relatively compact geographical areas with different land uses are found together in the same structure.

new urbanism

The default thinking of new urbanism in the 1980s, advent with the of the Sea side in Florida. The argument is based on the idea of the notion of sustainability Jane Jacobs (1961) is based on the incorporation requires user is walking the street pattern and associated communities. New plan - traditional or traditional neighborhood design initially proposed by *Plater Zyberk* know that supported the population in urban centers with mixed use of traditional building types. Transit-oriented development that was being promoted by calthorpe, would suggest that the planners of public transport as a tool for organizing mechanism to determine the density and land use.
In 1993, these individuals came together to form new urbanism Conference and its result were mix of principle together (Leccese & McCormick, 2000) new urbanism Congress has provided the Charter of principles. (CNU, 1996,2000) urban planners agreed CNU Charter that should be explained clearly defines the principles. The list is as follows: metropolitan areas, cities, city, and neighborhoods with identifiable borders and centers, intensive development of the agricultural land and to protect sensitive areas around the development, the increase in the urban centers, returns to life again streets interlocking, friendly, pedestrians and cyclists, mixed-use, smart parking location and parking spaces to avoid creating a landscape dominated by automobiles, transit-oriented development, design and layout of buildings and public gathering places, using buildings, streets and various buildings to create a coherent urban form and ... (Katz, 1994; CNU, 2000)

Figure 1: Sea Side district in Florida - Project development began in the early 1980s by Robert Davis is as the first development project in the United States in field of new urbanism.

infill development

The increasing development, process development and reuse of components (or parts) of empty or unused within existing urban areas that are already developed. This strategy was formed of a severe reaction after 70 AD than uncontrolled growth of cities to deal with this problem. Infill development emphasis on the development of vacant and abandoned the city is trying to load development on these lands (municipal research & services center of Washington, 1997, p.1)

Generally three major movements, sustainable development and smart growth can a move that has prompted increasing discussion of the range. Nowadays the debate on sustainable development, including the benefits to develop the increases to be mentioned, environmental benefits and the promotion of sustainable urban development. On the other hand, due to public transport, pedestrian-oriented, according to the principles of sustainability, and such is the common mentioned also mentioned in the Charter and to promote the increase. It should also be noted that increased following the development of smart growth approach, a single physical action for land use and environmental abandoned and attention was not normal to the values, but undertakes part of the process of development and growth of the city.

Growth Management

Growth management can be defined as a program that government to influence the amount, type, location, pattern, or severity of public and private development costs and on the other hand is designed to achieve the desired goals. Among the objectives of the management plan is followed by transport system can be noted efficient, livable communities, protect natural resources and particularly urban growth.

Including growth management principles that can be followed to achieve them:

-Create meaningful residential areas according to regional scale growth
- Promoting cities as economic engines of urban cores , main streets and livable cities and the city
-Protection of architectural monuments , rural landscapes and natural resources
- New transport link , network infrastructure, water and sanitation, sustainable development and health policy.
-Strategic investment and development effectiveness transportation method.
- Ensure that existing and new community's safe places to live, with high standards of quality of water and air.
- Investment in physical infrastructure of existing communities through the development of a pro-
- Building healthy communities that respond to the needs of new and existing social and cultural rights
- Ensure community support for the release of a variety of mixed- use, dense development and a variety of housing options that are livable communities to meet the need of economic and social.

V. NEIGHBORHOOD DEVELOPMENT

Neighborhood, community

-Neighborhood

Take a look at the various definitions indicate that the main characteristic of a neighborhood place in a context characterized by the existence of social relationships and networks and deep bonds between people so that the neighborhood is a time of special social and cultural sense than living in one place and stream it to come to mind (Nabavi, 2008).

Subdivisions in the neighborhood of a set of services and residential buildings where residents are defined in terms of its social fabric of the place they came from. The neighborhood is made up of a series of building blocks that are separated by a network of neighborhoods and subdivisions of the municipality (Khaksari and others, 2006).

Neighborhood adjacent houses comes up in a specific geographical space and the accumulation of continuity, high or low, close association, neighborhood relationships and alliances among a group of people. In other words, a single neighborhood in a single homogeneous physical and social. Hence is necessary the formation of an urban neighborhood or geographic areas with a more or less extent, the emergence and development of human resources and dependence on a small community and the interaction between them (Shokuei, 1993).

-neighborhood community

Community that is created due to the correlation between living space, a neighborhood demographics and physical forms that can have different sizes. (Sarrafi, 2004) Here is our social context.

What the community is very important in this respect, there is a close relationship; social solidarity is a common fate, so the same can be said of urban neighborhood community in which it is located. Obviously, in such an environment, the relationship is close, face and body cannot be too certain. Because the nature of close relationships and face will fade and so by definition cannot be applied to a community where they live as possible. The definition of community is where it happens in everyday interaction. So that the action is more intense than the action outside of the local community. Hence Community have normative concept that social commitments based on shared values creates for its members and the rights of individuals to be associated with their responsibilities. Where there is an ongoing relationship between humans and the environment, and the correct understanding of the natural and social expectations of appropriate capacity will be followed that In turn, the possibility of social justice and ecological balance and will.

VI. PHYSICAL DEVELOPMENT

Physical development includes the development and use of town is the city of factors including increasing population and the need for more urban arises. In other words, the physical development of cities can be considered increase urban area. (Sustainable urban development; 2000)

Forms of urban physical development include:

- Connected to the city's development
- Develop separate with spaces that are likely to be connected to the city within the time specified.
- Development of a discrete intervals within the time specified in the connection is not possible. Attached and detached areas where development can take the form of direct hinterland towns, because the development is located outside of this range, the Enhancements independent or dependent on other parts of the region. (Listoki, 2005)

Key Factors on physical development are as follows:

- Natural factors: posture and physical development of cities in the first place, their history and geographical circumstances. Adjacent space areas associated with environmental factors, such as ripples, and their proximity to terrain and climate conditions governing them has played a decisive role in how the physical development of cities, towns, so that to grow and develop compliance with these Terms form and they also communicate with each other continue. (Bullard, 2003)
- Economic factors: The foundation of urban studies and urban design of the city's economic base upon which employment, population, revenue, and ultimately is needed determine how much space. (Shieh , 2001) Thus, the fate of the city, with the amount income generating activities and it Basically turns out how, the rise, development and economic prosperity of cities before anything else. (Dalir , 2006), the city that have been on the Silk Road , Port cities and towns along the agricultural and industrial centers have been created , Genesis and regardless of its booming economic activities (services, agriculture or industry) owes factor or factors that to be in place cause earnings .
- Social factors: in urban studies, parallel to the characterization of the natural topography and buildings, it is necessary to pay attention to urban topography social groups. City development in close connection with urban population growth, and in this connection, the natural increase of population, the level of net migration to the city, making the transfer of rural population is a major factor to urban communities and build the city's population. (Rahnamaee, 199.)
- Political factors: different aspects of government policy could be effective in urban development, including the development of administrative, political, economic dependency in the Third World, the dominant social relations of production and the creation of Slums, suburban, urban wear Central banks are creating the ground and control the form of urban development and efficient use of urban land, is involved about balanced distribution of population decentralization and the creation of new cities.

VII. SPATIAL DEVELOPMENT

The space is means combining physical structures in the below and above ground, which is driven by the availability and effectiveness of human activities and objectives of spatial development concept, the definition of long-term model of regional development, which includes improving the economic competitiveness and well quality of life, environmental protection, nature conservation and sustainable use of natural resources, conservation and protection of the cultural heritage against natural disasters and other

integrated hazards. Spatial development as a tool to monitor the state space, the set of user's question, determines the mode of usage of space during the construction process and the implementation of programs and development of the lands.
Number of spatial development priorities as follows:

These results in the development of the integration methods are not scheduled to occur and the problem is exacerbated, and an incredible range of environmental impacts are which to develop services that are not in the short term. To solve this problem, environmental sustainability coordination of spatial planning can have a significant impact on regional spatial development coordinator.

- Depletion of natural resources and agricultural land values: these two basic issues discussed, in relation to the built environment is fragmented and dispersed. As a result of these two approaches, the spatial development of many negative effects on sensitive natural and valuable agricultural land will be eroded. Management of natural resources and agricultural land in the preservation of this valuable resource effectively.

VIII. CRITICISM ON SMART GROWTH

there are considerable controversy regarding the inability to manage urban development. Critics argue that the real benefits of smart growth and smart growth increases the density is very low and worsening living conditions. They claim that smart growth increases traffic congestion, pollution, accidents, costs of public services, crime and poverty.

A major criticism of smart growth, briefly include:

1 - People prefer sprawl and car-based society: the developments of distributed and community-based cars as well as a variety of alternative modes of transportation. In fact, critics are not considered of the many benefits of smart growth, including possible financial savings, increased physical mobility of people, community cohesion and protection of the environment.

2 - Smart Growth increases the amount of regulation and thus reduces the amount of freedom leads to: Opponents believe that smart growth increases and subsequent regulations will reduce individual liberty, However many existing regulations restrict smart growth strategies of taking away freedoms. On the other hand, with activities such as the creation of smart growth development projects and to choose the right people to adopt a flexible way to travel to the release of individual and social leads.

3 - Smart Growth lowers the purchasing power of people: Critics of smart growth by reducing the need for land, housing costs will increase, but is to overlook the growth of the smart ways to reduce household spending.

4 - Smart growth can lead to increased density: Critics of smart growth, traffic density increases and consequently lowers the quality of the transportation system, while smart growth along with increased density to increase accessibility and opportunities for travel leads to a variety. You should also bear in mind that traffic congestion alone is not is a good indicator for judging the quality of the transport system.

5 - The cost of public services: Although many studies showed a decrease in the cost of development and public service in communities that make use of smart growth recommendations, but many critics saying it ignores the fact that the dispersion causes all these services.

6 - Economic Development: Smart Growth Critics claim that the economy strikes. Smart growth seeks to increase economic efficiency and economic growth is associated with high income. (Litman, 2005).

IX. NEIGHBORHOOD DEVELOPMENT INDICATORS

Neighborhood as a social unit - physical examines, therefore, appropriate for a community development must be studied both social factors and the physical parameters. Neighborhood social indicators summarized as follows:

- Character and vitality
- Safety of neighborhood
- A sense of community
- A neighborhood social cohesion
- Homogeneity and cultural heterogeneity
- Neighborhood Partnerships
- Populated locality (Azizi, 2006)

The body index briefly neighborhood include:

- Dynamism and adaptability
- Visual diversity
- Density and bearing capacity of neighborhood
- Neighborhood boundary
- The size of the neighborhood
- Access and communication networks
- Environmental issues
- The physical indicators (Square, mosques, baths, markets, etc) (Azizi, 2006)

X. NEIGHBORHOOD SUSTAINABILITY

It has ever offered compared with the definitions and concepts of sustainable development at the international, national, regional and city, the concept of sustainable development at the neighborhood scale is not yet clear certainty of its concepts and the correctness of the analysis has been (Azizi, 2006). Sustainability requires that decisions and activities, leading to social investment in local capacity to be strengthened in this way, or at least Investment conditions, natural, social, human, social and does not reduce (Eftekhari, 2004).

Many neighborhood stability principles and criteria have been proposed and analyzed. Including the principles and criteria can be identified and vitality, dynamism and adaptability, diversity, fair access, congestion and capacity Neighborhood cited. (Azizi, 2006)

Aspects of sustainable development that can be placed in line with the neighborhood include:

1 - Self-Sufficiency: Independence meet the needs of residents, an important point is stable in environments that vary in scale from one building to the neighborhood, the city and the region is recommended. In this chain, the community can play a key role, although in reality, completely self-sufficient neighborhoods in the city, far-fetched and illogical.

2 - Reduce travel within the city: the cloud - modern city, reducing the need for intercity travel. This can aim be met by encouraging walking, cycling and using public transport. Local service is provided at a threshold of hiking and distribution facilities in the neighborhood, along with a balanced distribution of activity centers in the area can meet such a goal.

3 - The social capability and collective sense: it is also a component of sustainable communities. Sustainability is not only dealing with energy and recycled materials but all aspects of life to achieve a pleasant and safe environment in which it is necessary. The role of social factors, especially when it is highlighted that the people they are involved in decisions about their surroundings. In fact the requirements of sustainable development cannot be imposed and the active participation of local communities is essential.

4 - Sense of place and identity: it is other components of a sustainable environment, having is special a sense of place and identity. It has were established traditional settlements, fitness and a better match between the spatial structure, the element of time, meaning, communication, and social culture. Recently an approach that mimics the look of traditional settlements, to achieve a common identity, location, and characteristics of the individual must identify the actual location specific and relevant to be replaced. A sustainable settlement must seek to upgrade and maintain their positive values and characteristics of the natural environment and cultural synthetic (Houghton & Puncar, 1996)

XI. CONCLUSIONS

Urban management structure in recent decades, with features and constraints such as non-participatory, focus, system of scheduling, planning, top-down, bureaucratic and politicization of the urban development process lacks practical commitment to the principles and applications urban development has been. The management strategies are discussed developed to resolve these issues and problems at the micro level and neighborhoods.

Neighborhoods are considered as the smallest unit divisions. In general, both physical and social perspectives on urban neighborhoods that are in the neighborhood (neighborhood) and the neighborhood community (community) are expressed. Neighborhood perspective refers to the physical standards and the local community on social interactions within the neighborhood, and it emphasizes the social dimension and based on the quality of social relations within the defined neighborhood. However, in recent decades, such as smart growth, new approaches to deal with the problems of modern cities and uncontrolled urban expansion has established and increased the opening of new city development in old areas, the use of the existing potentials, density and knows.

The idea that the uncontrolled expansion pattern is formed, principles and strategies for the development of the community suggest. Principles such as citizen participation in planning, creating mixed use, protecting natural resources and open space, guiding development in existing communities and thus will help the creation of sustainable urban neighborhoods,.

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Dam Safety Instrumentation

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Abstract: - *In most of the cases, the materials are tested in laboratories and designs are based on assumptions that the same results will be met with, during actual construction. As there are always large variations in materials, their properties, construction methods and their control, the actual product defers from the original assumptions. In this paper, instruments required to check the behaviour and stability of dams are discussed with their necessity, use and operation. These instruments prove to be much useful in proper maintenance of dam, and hence they should be installed under the guidance of experts at appropriate places in the dam. A conclusion has been arrived that there should be close co-operation between the designers, instrumentation specialist, expert analysis and site authorities to achieve the goal of instrumentation.*

I. INTRODUCTION

While designing dams, number of factors, parameters is assumed. In most of the cases, the materials are tested in laboratories and designs are based on assumptions that the same results will be met with, during actual construction. As there are always large variations in materials, their properties, construction methods and their control, the actual product defers from the original assumptions. This can be found out by many methods. The engineer must know how the actual constructed dam behaves against the assumptions made. Necessary help from various instruments embedded in a dam body is taken for satisfying structural behavior. This instruments are devices to measure and / or control the variables on each depends the functioning of a structure or a system or the operation of a process.

The principal objectives of a geotechnical instrumentation plan may be generally grouped into four categories: first, analytical assessment; second, prediction of future performance; third, legal evaluation; and fourth, development and verification of future designs.Instrumentation achieves these objectives by providing quantitative data to assess groundwater pressure, deformation, total stress, temperature, seismic events, leakage, and water levels. Total movements as well as relative movements between zones of an embankment and its foundation may also need to be monitored. A wide variety of instruments may be utilized in a comprehensive monitoring program to ensure that all critical conditions for a given project are covered sufficiently.

Instrumentation in dam is necessary for verification of design assumptions, construction technique & modifies design. Data collected from instrument can be extremely valuable in determination of specific cause of failure. By instrumentation constant watch over the performance of the structure during service & obtain timely warnings in respect of distress spots. Safety in dam can be assist by instrumentation.

Recent dam failures in various part of world inspire significant interest in monitoring various parameters as a means for ensuring adequate margin of safety. As per IS specification basic parameters like pore pressure, displacement, seepage, strains, stresses, dynamic load, uplift pressure, temperature can study with the help of instrumentation.

In India there are about 4291 large dams. Out of these 1529 dams are in Maharashtra. There are about 40 Dams are instrumented. The approximate cost of these instruments worked out to 1% of total construction cost. In unusual circumstances it may be 2to 3%.

II. INSTRUMENTATION PLANNING

A. Failure Of Dam

1. Overturning of dam
2. Sliding of dam

3. Crushing of dam
4. Tension failure of dam

Various causes of dam failure in percentage are listed below:

Sr.	Cause	Percentage failure
1	Foundation failure	40
2	Inadequate spillway	23
3	Poor construction	12
4	Uneven settlement	10
5	High pore pressure	05
6	Acts of war	03
7	Embankment slips	02
8	Defective materials	02
9	Incorrect operation	02
10	Earthquakes	01

B. Instruments in Dam

Following table shows the instruments used to obtain parameter:

SR.NO.	PARAMETER	INSTRUMENT
A	Pore Water Pressure	1. Open stand pipe piezometer 2. Pneumatic piezometer 3. Vibrating wire piezometer
B	Surface Displacement	1. Tiltmeter 2. Surface extensometer
C	SEEPAGE	1. "v " notch weir- large Discharge
D	STRESS	1. Total Pressure Cells 2. Jack-Out Total Pressure
G	DYNAMIC LOADS	1. Seismometer
I	UPLIFT PRESSURE	1. For Structures on Permeable Foundation Instruments. 2. Instruments For Structures On Rock Foundations.

III. CASE STUDY- TILARI DAM

SALIENT FEATURES OF DAM:

1. NAME OF DAM: TILARI DAM
2. NAME OF RIVER: TILARI RIVER
3.Location:
Near village Tillariwadi
Tal. Sawantwadi
Dist. Sindhudurg
4. Catchments Area:
A. Main Dam : 301.27 Sq.km.
B. Pick up weir : 88.91 Sq.km.
C. Av. Rainfall : 5588mm to 2280mm
5. Dam & Reservoir:
A. Gross Storage.
1. Main dam : 462.17 M cum
2. Pick up weir : 2.025 M cum
B. Live Storage.
1. Main Dam : 447.29 M cum
2. Pick up weir : 1.845 M cum

6. Type of Dam:
A. Main Dam: Earthen Dam in gorge with gated spillway on Tilaririver in saddle on left Bank.
B. Pick up weir on : Masonary pick-up weir with KharariNalla gated spillway.

7. Height of Dam:

From River Bed		From foundation
A. Main Dam :	71.35 m	73.35 m
B. Pick up weir :	12.52 m	15.40 m

8. Length of Dam:

	Total Length	Earthen	Masonary
A. Main Dam :	900 m	900 m	---
B. Saddle Dam :	300 m	172 m	128 m
C. Pick up weir :	274 m	99 m	175 m

D. Irrigation cum Power Outlet Tunnel with Power House: Length : 900 m
Type : D Type segmental arch fully lined
E. Spillway:
1. Saddle Dam: Gated spillway having 4 nos of radial gates of size 12 m X 6.5 m each.
2. Pick up weir : Gated ogge having 7 Nos. of radial gates of size 12 m X 5 m

9. Outlets:
A. Main Dam :Irrigation cum Power Outlet Tunnel with Power House of capacity of 10 MW.
B. Pick up weir :-
Right side :1. For Irrigation
2. For Hydro Power Generation of 200 KW.

10. Hydro Electric Generation:
A. Main Dam : 10 MW.
B. Pick up weir : 0.2 MW.

11. Canals:

		Total	**Maharashtra**	**Goa**
A.	RightBank Canal :	60Km	25	35
Discharge :	14.5 cumecs			
B.	Left Bank Canal :	71Km	22	49
Discharge :	32.56 cumecs			

12. Command Area:

		Irrigable
Maharashtra state:		6676 hect.
Goa state	:	16978 hect.
Total	:	23654 hect.

A.INTRODUCTION

Tilari interstate project is a major irrigation project and is a joint venture of government of Maharashtra and gov.of Goa. Tilari is a west flowing river originates from Sahyadri rages. In Chandgad taluka of Kolhapur District. An earthen dam is being constructed across Tilari river near village Tilariwadi.Taluka Sawantwadi in Maharashtra state.

Following are major components of project:-
1. Constructing an earthen dam across Tilari river near village Tilariwadi.Taluka Sawantwadi.
2. Masonary –Dam with gated spillway in saddle near village konal.
3. A pick up weir on Khararinalla, near village Terwanmedhe, to utilize the Tail Race release of Tilari Hydro Electronic Project. A small power house 1 x 200 Kw at Terwanmedhepick up weir is also proposed.
4. Irrigation cum power outlet tunnel, which includes construction of power house with an installed capacity of 10MW.
5. Main canals viz. left bank canal 71 kms and right bank canal 60 kms in length.
6. Distribution system to cover the command area.

Total 23654 hect. Area will be benefited in Maharashtra and Goa. The administrative approval is accorded by Govt. of Maharashtra in March 1979. Revised cost of the project at R.S.R. 1993-94 IS Rs. 488.33.corores.

B.NECESSITY OF INSTRUMENTATION

The behaviour of this dam will have to be monitored carefully particularly with reference to the following points:

1. The casing soils are low in permeability and their performance in sudden draw down condition on u /s side needs to be watched.
2. The pore pressure within the body of dam on other zones would be of interest.
3. The dam is located in highly seismic zone, with this point of view and even otherwise,the vertical settelement of dam as well as its horizontal spread on u /s and d /s needs to be monitored, particularly in its early life
4. The behaviour of dam for comparision with design assumptions is to be observed.
5. The Tilari dam lies in heavy rainfall zone both in quantum and intensity. It would be interesting to a certain as to how far does the heavy rainfall affect the saturation of d /s slope even after provision of pitching, backed by quarry spalls on d /s slope.
6. To watch performance of horizontal filters proposed in d /s casing zone to reduce pore pressure with the body of dam.
7. The horizontal filter mat of 1.20 m thk. Has been provided on d/sside. The performance of the same needs to be watched.

C.TYPES OF INSTRUMENTS TO BE INSTALLED:

1. Piezometers for observing pore pressure in embankment and foundation
a. Foundation piezometers
b. Embankment piezometers
c. Vibrating wire type piezometers
d. Pneumatic type piezometers
e. Casagrande type porous tube piezometers.
2. Earth pressure cells for observation of stresses in dam.
3. Surface settelement plugs for measuring embankment movements.
4. Peak recordingaccelerographs to measure the ground acceleration duration earthquake.
5. Seismoscope to determine displacement relative velocity and acceleration response of dam to earthquake.

D.SELECTION OF CROSS SECTION OF DAM FOR INSTRUMENTATION.

In view of present position of work it is proposed to provide the instrumentation at following locations.
I. R.D. 950.00 m
II. R.D. 445.00 m
The depths of overburden at the above locations are 8.0 m and 1.0 m respectively

E.PIEZOMETERS:

It is proposed to provide piezometers both in foundation as well as in embankment.

F.FOUNDATION PIEZOMETERS:

The foundation piezometers should be located slightly above the top of rock. These are spaced at a distance of 60 m,c/c. Alternative piezometers in foundation are associated with pneumatic type and Vibrating wire type piezometers.

G.EMBANKMENT PIEZOMETERS

The embankment piezometers are proposed in the heating zone at the vertical interval of about 12 m and horizontal spacing of 20 m. The piezometers in u /s and d /s casing zone have been proposed at spacing of 20 m and at vertical interval of 12 m. It will thus indicated the control of placing of hearting and casing soils exercised during construction. It also indicates the behaviour of horizontal sand filters provided. Vibrating wire type piezometers and pneumatic type piezometers are to be located alternately on both the sides of inclined filter.

H.CASAGRANDE TYPE POROUS TUBE PIEZOMETERS.
These are installed at R.D. 950m in d /s part of dam and are intended to give information regarding the effectiveness of both, inclined sand filter and intermediate horizontal filter mat and pore pressure developed near the base in d /s casing zone.

I.TERMINAL WELL:
Pore pressure observations are to be taken in terminal well of 4 m x 5 m size at d s of rock toe. The floor of terminal well shall preferably be located 5.0 m. above teil water level so as to be accessible at all times.
Efficient lighting and ventilation arrangement should be provided.

J.EARTH PRESSURE CELLS
Earth pressure cells placed little above G.L. and at intermediate levels at a spacing of 40 m. in u /s casing zone and in hearting zone. They are installed by the side of piezometers. So that effective earth pressure can be obtained.

K.SURFACE SETTELEMENT PLUGS
Surface settelement plugs installed between R.D.315 m to R.D. 815 m at interval of 100 m and at R.D. 950 M. The locations of settelement plugs are to be generally keep on both sides of berm.

L.SEISMIC INSTRUMENTS:
a. Force balance type accelerograph.
b. Peak recording accelerograph.
They are located at intermediate points in between locations of force balance type accelerograph.
Sesmoscope: They are installed on natural ground.
In short, instrumentation in Tilari Dam will give an excellent opportunity for checking various design assumptions made and parameters assumed in the stability analysis

IV. CONCLUSION

- The purpose of the instrumentation program and underlying geotechnical and structural problems that create the need for instrumentation must be clearly defined.
- The instrumentation program must be so comprehensive and carefully planned to include measurements of all the quantities which are essential in the problem to be studied..
- The data collected must be reduced to a convenient form and the results must be available to the concerning authorities without unnecessary delay.
- There should be close co-operation between the designers, instrumentation specialist, expert analysis and site authorities to achive the goal of instrumentation.
- We can obtain real significance of various parameters used in a design and thereby modify procedure and criteria leading to increase the economy and safety.
- We can obtain constant watch over the performance of the structure and timely warnings we can save life of many peoples, farms and various structures in city.

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THE PHILOSOPHY OF "DALIT"?...*(A new theory on "JATIS")*

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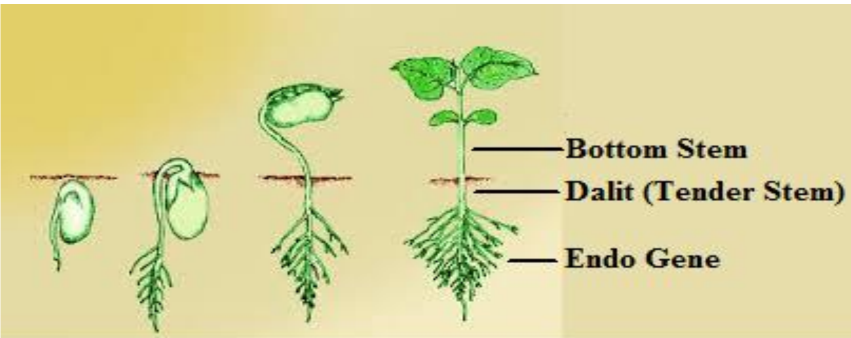
Abstract: - It is focused that in human social system "**Dalits**" are considered as an "**out-caste**" and treated them as "**Untouchables**" and being ill-treated almost in every day of Life. **If so, where did Dalits come from?...**
Since Ancient time global level Scientists, Scholars, Anthropologists could not exactly answer who are Dalits?... Further world wide Untouchability, Casteism discrimination being practiced besides "**BLACK**" and "**WHITE**", ethnics. Further hundreds of castes, sub castes exist within main "**Ethnic frame**" of religions like Hinduism, Christianity, Islam, Buddhism, considering Dalits as distinguished out-caste.
It is focused that in developing countries like "**INDIA**" the sense of "**Casteism**" is more dominant in rural area and the Parents of the Nations, though highly educated, do not know how to grow their children to eradicate the sense of Casteism without understanding the **reality of nature**.

(i) Indians are killing Indians on Casteism.
(ii) Srilankans are killing Srilankans on Casteism.
(iii) Africans are killing Africans on Casteism.
(iv) Afghanistans are killing Afghanistans on Casteism.
(v) Europeans are killing Europeans on Casteism.
(vi) Americans are killing Americans on Casteism.
(vii) Australians are killing Australians on Casteism.

This research further focus that the Philosophy of **"DALITS"** shall be understood and represented in **"BIOLOGICAL LANGUAGE"** as mentioned below. In biological term the **"DALIT STAGE"** shall be considered as invisible existence associated with dirty water and other minerals converted as food for subsistence of life.

It is further focused that the Philosophy of **"JATIS"** might be derived from the Philosophy of **stages of tree.**

(i) Fruit – Brahmin
(ii) Leaves – Kshatriyas
(iii) Branches – Vaishyas
(iv) Upper stem – Shudras
(v) Tender stem – Dalits
(vi) Roots – Endo Gene



(Philosophy of DALIT Evolution)

*The "**DALITS**" are like Image of "**ALIENS**" and considered like "**PLASMA HUMAN**" and fundamental Building Block of all generations of Human races on the "**EARTH PLANET**". "Dalits are like **tender stem of Tree** and thousands of branches shall be considered as generations of races. Dalits are like **stem cells (Umbilical Cell ions)** and thousands of varied cells shall be considered derived from stem cells".*

- Author

Key Words: -
a) Philosophy of "**ENDOS**"
b) Philosophy of "**INDOS**"
c) Philosophy of "**PLASMA HUMAN**"
d) Philosophy of "**THAI-e**"
e) Philosophy of "**THALI**"
f) Etymology of "**DALIT**"
g) Etymology of "**CASTE**"
h) Philosophy of "**DALIT BLOOD GROUP**"
i) Philosophy of "**DALIT EYE IRIS**"

I. INTRODUCTION

It is focused that according to **Human rights watch, UNICEF**, caste discrimination affects an estimated **250 million** people world wide.

In human social system under "**Varna theory**", "**JATIS**" are classified under four major Category **Brahmins, Kshatriyas, Vaishyas, shudras**. Subsequently Dalits term was invented separately as **PANCHAMAS** and considered as out-caste Untouchables just like **"Mother-in-law" ill treating "Daughter-in-law"**.

In 2008 the national Commission of India for SC/ST Seriously observed that the term "**Dalit**" should not be used interchangeably along with other classified classes under the schedule. In general Dalits are also called as **Harijans, Adivashi, Adi Dravidas, Adi Andhras, Adi Karnatakas, Adi Dharmis**.

It is focused that **Ancient Hindu Texts** suggest caste system was not rigid. The Flexibility permitted so called Lower caste "**VALMIKI**" to compose "**RAMAYANA**" which was widely adopted and become a major "**Hindu Practice**".

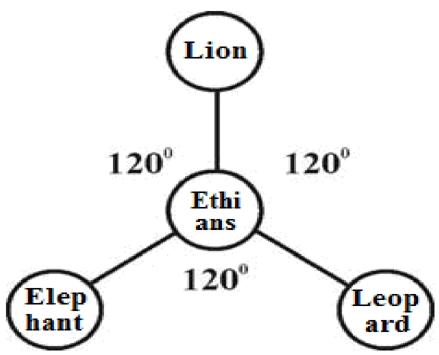
This Scientific research focus that "**ETHIANS**" shall be considered as the **oldest populations** lived on the Earth Planet even before "**SUN EMITS FIRST RAYS**". Ethians shall also be called as "**INDOS**" (or) "**BLACK POPULATION**".

It is further focused that "**ETHIANS**" shall be considered as lived as a "**Single large family**" in Ancient time. During the course of "**Expanding Universe**" the Ethians shall be considered as diversified under "**Three major Ethnic groups**" and become "**THREE JATIS**" during geological evolution.

(ETHIAN LOGO)

(i) INDO – DRAVIDIAN
(ii) INDO – EUROPEAN
(iii) INDO – EGYPTIAN

The Three Ethnic groups shall be distinctly identified with fundamental Ethnic Symbols (i.e) Indo-Dravidian as "**LION**", Indo-European as "**LEOPARD**" Indo-Egyptian as "**ELEPHANT**".



(Three Ethnics Jatis)

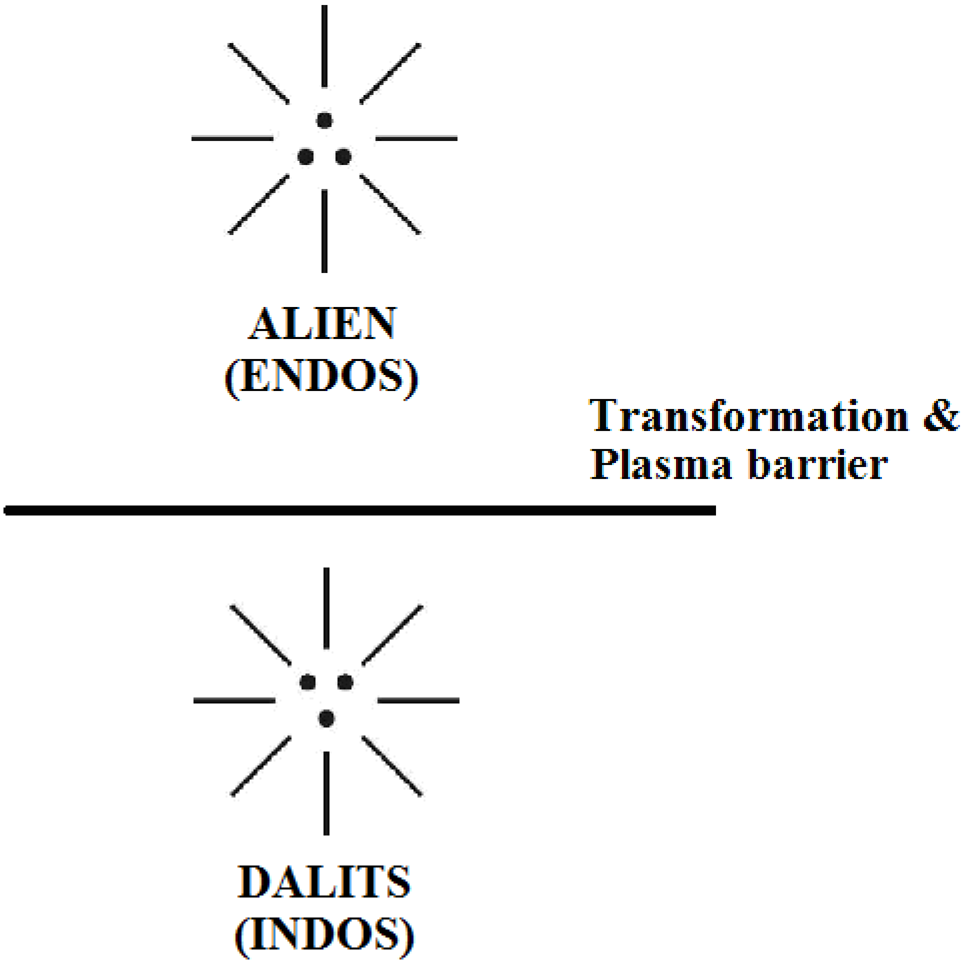
"Thousands of global level Ethnic symbols, Jatis, Castes, sub castes shall be considered derived from the three fundamental Jatis"

-Author

II. HYPOTHESIS AND NARRATION

a) Philosophy of "DALITS" origin?...

It is hypothesized that "**INDOS**" shall be considered as "**IMAGE**" of "**ENDOS**" who lived in "**MARS PLANET**" (also called as EZHEM). During the expanding Universe the ENDOS were considered Transformed as "**PLASMA HUMAN**" and descended to **EARTH PLANET** and become "**INDOS**".



It is further focused that the "**ENDOS**" shall be considered as **genetically** well defined populations also called as "**WHITE POPULATIONS**" (ALIENS). The "**INDOS**" shall be considered as genetically Variant to **ENDOS** having "**Highest genetic value**" of all races of Earth planet. The "**PLASMA HUMAN**" shall be considered as the "**Intermediate stage**" between "**ENDOS and INDOS**". The intermediate stage plasma human shall be called as "**DALITS**".

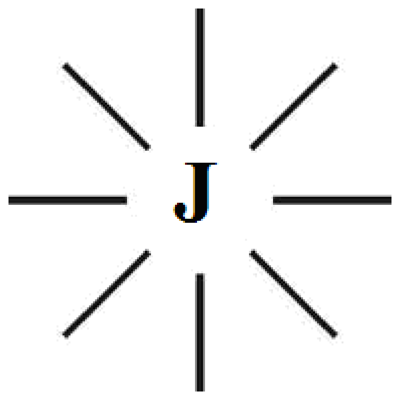
The **philosophy of Dalits** (plasma human) shall be defined within the following scope.

1) Dalits shall mean "**genetically diffused**"
2) Dalits shall mean "**Image of ENDOS**"
3) Dalits shall mean "**Proto – INDOS**"
4) Dalits shall mean "**Utter Black**"
5) Dalits shall mean "**FIRST BORN ON EARTH**"
6) Dalits shall mean "**Thai-e**" (Thai-eth)
7) Dalits shall mean "**Stem cells of Human**"
8) Dalits shall mean "**TRIBE**"
9) Dalits shall mean "**Single Type Blood AB**"

10) Dalits shall mean "**DARK BLACK EYE IRIS**"

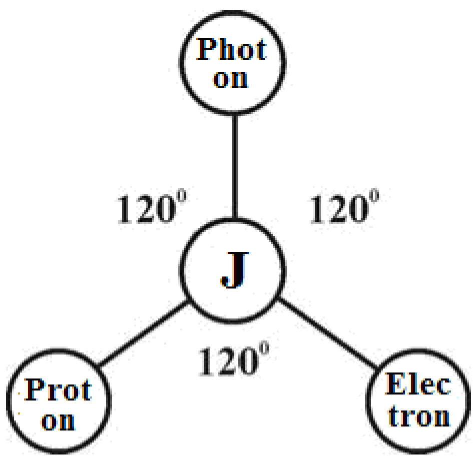
b) Philosophy of ENDOS?...

It is hypothesized that **ENDOS** shall be considered as evolved of "**J-RADIATION**" emanated from "**White Hole**" of Material Universe. The J-RADIATION shall be also called as "**Virgin light**" comprised of fundamental star particles **Photon, Electron, Proton** having **zero mass** and having **optic, electric, magnetic** characteristics. In prehistoric "**Proto-Indo language**" the virgin light shall be called as "**JYOTHI**".



(JYOTHI)

The Etymology of Sanskrit word "JATI", "JATA" shall be considered as derived from proto-indo origin root word "**JYOTHI**", "**CHATHI**". CHATHI shall mean "**Heart**" (White hole), **JYOTHI** shall mean J-Radiation. Further in astronomical language the J-Radiation shall be considered as **"MATH"** (molecular cloud).



(CHATHI)

i) Photon is like "**LION**" (**Indo-Dravidian**)
ii) Electron is like "**LEOPARD**" (**Indo-European**)
iii) Proton is like "**ELEPHANT**" (**Indo-Egyptian**)
iv) "J" is like "**ETHIAN**"

c) Etymology of word "DALIT"?...

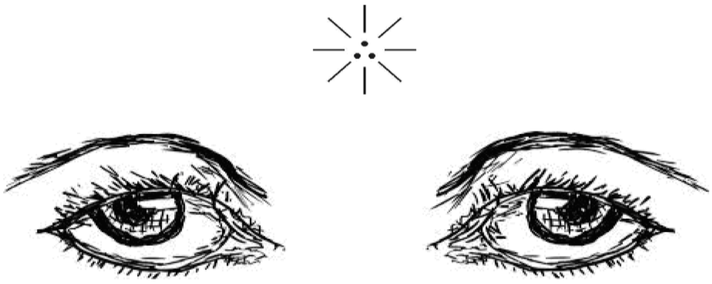
Case study shows that the word "**Dalit**" considered derived from Sanskrit origin meaning ground, suppressed, crushed (or) **broken to pieces**. The word was first used by "**Jyotirao Phule**" in 19th century.

Further the Sanskrit word **JATA** shall mean "**Born**" or brought into existence by birth.

It is hypothesized the **DALIT** might be derived from proto-Indo origin root word **Thai-e, Thalai, Ethu**.

i) **Thalai** shall mean **Head**.
ii) **Ethu** shall mean **Birth**

iii) **Thai-e** shall mean “**Mother of Dalit**”



THAI-e
(MOTHER OF DALIT)

d) Etymology of word “Caste”?...

It is hypothesized that the etymology of word “**Caste**” might be derived from Proto-Indo origin root “**Kalacharam**”, “**Kalai**”. Kalai, Kalacharam shall mean custom, culture, habit.

e) Philosophy of Word “Harijan”?...

Caste study shows that “**Gandhiji**” used the word “**Harijan**” to denote the **suppressed class, untouchables**. Gandhiji coined term Harijan which means Children of God.
It is focused that the etymology of word Harijan might be derived from Proto-Indo origin root word ‘**KARISON**” (KARI + SON).

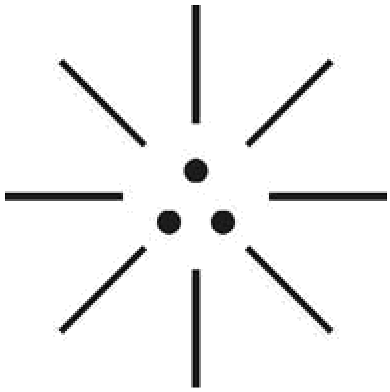
i) “**KARI**” shall mean “**GOD**”
ii) “**SON**” shall mean “**CHILD**”
iii) “**KARISON**” shall mean “**Son of God**”.

f) Case study on Mangala Sudra?...

It is focused that the philosophy of “**mangala Sudra**” shall be referred to uniting the Bridegroom, Bride in the custom of “**Marriage**”.

i) “**Mangala**” shall mean “**Bride**”
ii) “**Sudra**” shall mean “**Bride groom**”

Further the philosophy “**Thali**” refers to “**tying three knots**”. The philosophy of Thali might be derived from the Proto-Indo origin root word “**Thai-ethu**” (Dailit). “**Thai-ethu**” shall mean custom derived from “**Dalits**”.



(Thai-ethu)

“The philosophy of word Thale, Thalib, Thalli might be derived from the root word Thai-e”

– Author

g) Case study on “Chhath”?...

It is focused that the Devanagari word "**Chhatte**" meaning Ancient Hindu Gods **sun God, Surya, Chhathi Maiya** (Goddess Usha) might be derived from the philosophy of Proto-Indo origin root "**Jyothi**".

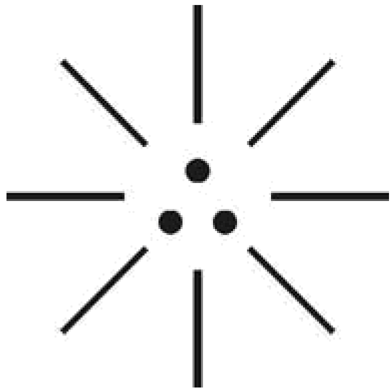
i) **Photon** is like **Sun God**
ii) **Electron** is like **Surya God**
iii) **Proton** is like **Usha God**
iv) "**J**" is like "**Thai-e**"

h) Case study on "Aboriginal Tribe"?...

It is hypothesized that the philosophy of **Aboriginal Tribe**, "**Elem tribe**" in human Anthropological Science shall be considered derived from Thai-e (Dalit) populations. It is focused that **Thai-e** shall be considered as 1st origin of human population on the earth planet.

i) Case study on marijuana plant?...

It is hypothesized that the marijuana plant (**Endo**) shall be considered as the "**Plasma stage**". Endo plant family "**Aceae**" descended from **MARS Planet**. Aceae shall be considered as "**genus**". "**MARIJUNA**" shall also called as "**DALIT PLANT**" considered as having **"Stem cells"** of all the plants on the Earth planet.



(ENDO ACEAE)

j) Case study on DALIT Planet?...

Case study shows that the whole Cosmo Universe consists of many galaxies and the living solar system having 9 planets say Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune being centered with Sun.

It is hypothesized that in the early universe MARS, SUN, EARTH, MOON shall be considered as the integral part of **"SYSTEM UNIVERSE"** called as **"WHITE STAR"** or **"MEGA STAR"** centered by **"MARS PLANET".** The MARS planet shall also be called as **mother planet** of Universe. During the course of expanding Universe the formation of **comets, asteroids, meteoroids** shall be considered as genetically diffused **species** of MARS planet and also called as **"DALIT PLANETS".** During three geological evolution three galaxies shall be considered as evolved due to change in relative position of MARS, SUN, EARTH, MOON which might have lead to formation of other planets which exists with different genetic characteristics in the respective galaxies as described below.

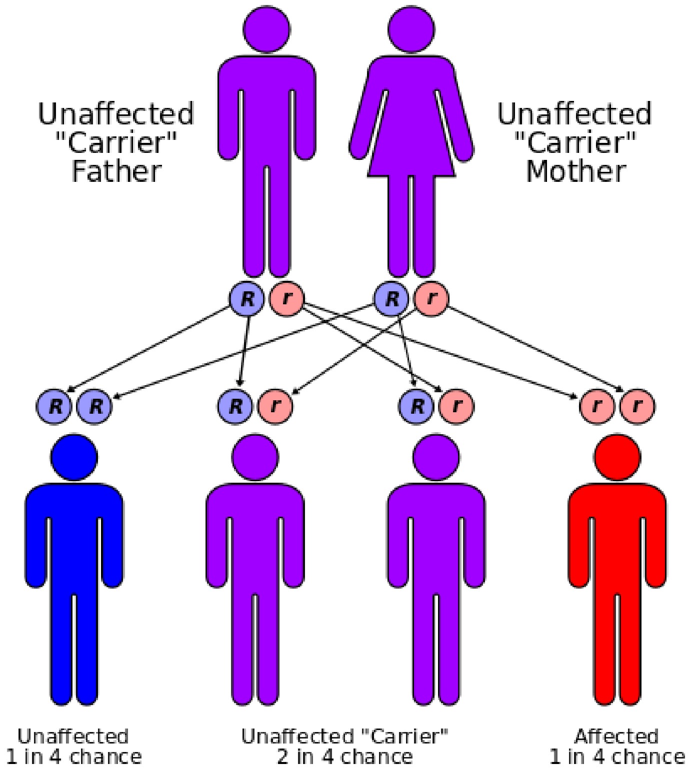
(i) White Star System - Comprising of Genus planets MARS, SUN, EARTH, MOON
(ii) Dalit Star (Black Star) - Comprising of Comets, Asteroids, Meteoroids
(iii) Blue Star System - Comprising of Blue MARS, Blue SUN, Blue EARTH, Blue MOON
(iv) Green Star System - Comprising of Green MARS, Green Sun, Green Earth, Green Moon
(v) Red Star System - Comprising of Red MARS, Red Sun, Red Earth, Red Moon

k) Case study on Thallus (Biology)?...

Case study shows that **Thallus** is considered as undifferentiated vegetative body of **alage, fungi, lichins**. The plant has body without true stems, leaves, vascular system, characteristics of Thallophytes.
It is focused that "**Thallus**" shall be considered as "Dalit **plant species**" on the earth planet.

l) Case study on Thalassemia?...

Case study shows that "**Thalassemia**" are forms of inherited autosomal recessive blood disorders that originated in the Mediterranean region. In thalassemia the disorder is caused by weakening and destruction of **red blood cells**. Thalassemia is caused by variant (or) **missing genes** that affect how the body makes Hemoglobin. Further alpha thalassemia, beta thalassemia, delta thalassemia shall be considered as having three ethnic disorders derived from three different lineages.



(Alpha, Beta, Delta Gene dissorder Analysis)

It is hypothesized that Thalassemia shall be considered as genes transformed from "ENDO Origin" to INDO origin through "**PLASMA STAGE**".

*"Thalassemia dissorder shall be considered as "**DALIT SYNDROME**" (Stem cells) due to lack of gene transfer to **Ethians**".*

- Author

m) Philosophy of Dalit Blood Group?...

It is hypothesized that Ethian (Proto-Indo) shall be considered as the 1st Generation population on earth planet having only single type blood group "**AB**" (universal acceptor) derived from **DALIT POPULATION** (plasma human). The other blood type **A, B, O** shall be considered evolved in three lineage of population in three geological evolution i.e. A-type shall be derived from Indo-Dravidian origin, B-type from Indo-Europe origin, O-type from Indo-Egypt origin.

n) Philosophy of Dalit Eye Iris?...

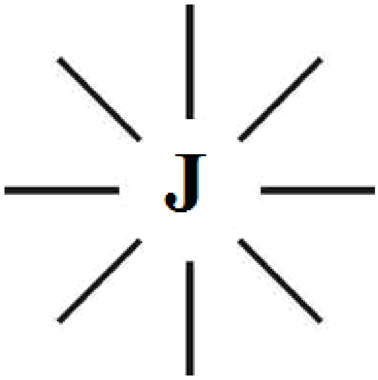
It is hypothesized that the Eye Iris of Dalit population shall be considered as "**DARK BLACK IRIS**". During the course of expanding Universe the different races having different Eye Iris shall be considered as evolved in different geological period due to varied environmental conditions as detailed below:

(i) Dark blue iris -Indo Dravidian origin
(ii) Dark Green iris -Indo European origin
(iii) Dark Red iris- Indo Egyptian origin

III. CONCLUSION

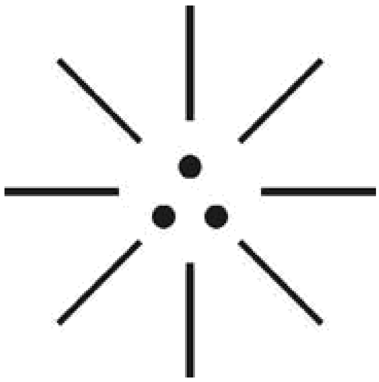
It is focused that "**Dalit**" shall be considered as Plasma human just like "**Infant**" transformed from **Mother's womb** through plasma region of **birth canal** to become "**Child**". The Infant, child are considered as having distinguished genetically varied characteristics. "**Mazhalai**" shall be considered as **Intermediate stage** between infant and child also called as "**Dalit**" (Plasma human). Further the Philosophy of word **"TALLIT"** (Tzitzit) in Jewish / Hebrew custom might be derived from the Philosophy of **Dalit** (Thai-e).

(i)



(CHISU)

(ii)



(TALLIT)

In proto-Indo language "**Mazhalai**" shall also be called as "**CHISU**". CHISU shall mean diffusion stage of infant to become child called as "**MOTHER SUPREME**".

IV. PREVIOUS PUBLICATION

The philosophy of origin of first life and human, the philosophy of model Cosmo Universe, the philosophy of fundamental neutrino particles have already been published in various international journals mentioned below. Hence this article shall be considered as **extended version** of the previous articles already published by the same author.

[1] Cosmo Super Star – IJSRP, April issue, 2013
[2] Super Scientist of Climate control – IJSER, May issue, 2013
[3] AKKIE MARS CODE – IJSER, June issue, 2013
[4] KARITHIRI (Dark flame) The Centromere of Cosmo Universe – IJIRD, May issue, 2013
[5] MA-AYYAN of MARS – IJIRD, June issue, 2013
[6] MARS TRIBE – IJSER, June issue, 2013
[7] MARS MATHEMATICS – IJERD, June issue, 2013
[8] MARS (EZHEM) The mother of All Planets – IJSER, June issue, 2013
[9] The Mystery of Crop Circle – IJOART, May issue, 2013
[10] Origin of First Language – IJIRD, June issue, 2013
[11] MARS TRISOMY HUMAN – IJOART, June issue, 2013

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[15] Prehistoric Akkie Music (IJST, July issue, 2013)
[16] Barack Obama is Tamil Based Indian? (IJSER, August issue, 2013)
[17] Philosophy of MARS Radiation (IJSER, August 2013)
[18] Etymology of word **"J"** (IJSER, September 2013)
[19] NOAH is Dravidian? (IJOART, August 2013)
[20] Philosophy of Dark Cell (Soul)? (IJSER, September 2013)
[21] Darwin Sir is Wrong?! (IJSER, October issue, 2013)
[22] Prehistoric Pyramids are RF Antenna?!... (IJSER, October issue, 2013)
[23] HUMAN IS A ROAM FREE CELL PHONE?!... (IJIRD, September issue, 2013)
[24] NEUTRINOS EXIST IN EARTH ATMOSPHERE?!... (IJERD, October issue, 2013)
[25] EARLY UNIVERSE WAS HIGHLY FROZEN?!... (IJOART, October issue, 2013)
[26] UNIVERSE IS LIKE SPACE SHIP?!... (AJER, October issue, 2013)
[27] ANCIENT EGYPT IS DRAVIDA NAD?!... (IJSER, November issue, 2013)
[28] ROSETTA STONE IS PREHISTORIC "THAMEE STONE" ?!... (IJSER, November issue, 2013)
[29] The Supernatural "CNO" HUMAN?... (IJOART, December issue, 2013)
[30] 3G HUMAN ANCESTOR?... (AJER, December issue, 2013)
[31] 3G Evolution?... (IJIRD, December issue, 2013)
[32] God Created Human?... (IJERD, December issue, 2013)
[33] Prehistoric "J" – Element?... (IJSER, January issue, 2014)
[34] 3G Mobile phone Induces Cancer?... (IJERD, December issue, 2013)
[35] "J" Shall Mean "JOULE"?... (IRJES, December issue, 2013)
[36] "J"- HOUSE IS A HEAVEN?... (IJIRD, January issue, 2014)
[37] The Supersonic JET FLIGHT-2014?... (IJSER, January issue, 2014)
[38] "J"-RADIATION IS MOTHER OF HYDROGEN?... (AJER, January issue, 2014)
[39] PEACE BEGINS WITH "J"?... (IJERD, January issue, 2014)
[40] THE VIRGIN LIGHT?... (IJCRAR, January issue 2014)
[41] THE VEILED MOTHER?... (IJERD, January issue 2014)
[42] GOD HAS NO LUNGS?... (IJERD, February issue 2014)
[43] Matters are made of Light or Atom?!... (IJERD, February issue 2014)
[44] THE NUCLEAR "MUKKULAM"?... (IJSER, February issue 2014)
[45] WHITE REVOLUTION 2014-15?... (IJERD, February issue 2014)
[46] STAR TWINKLES!?... (IJERD, March issue 2014)
[47] "E-LANKA" THE TAMIL CONTINENT?... (IJERD, March issue 2014)
[48] HELLO NAMESTE?... (IJSER, March issue 2014)
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[51] THE ALTERNATIVE MEDICINE?... (AJER, April issue 2014)
[52] GANJA IS ILLEGAL PLANT?... (IJERD, April issue 2014)
[53] THE ENDOS?... (IJERD, April issue 2014)
[54] THE "TRI-TRONIC" UNIVERSE?... (AJER, May issue 2014)
[55] Varied Plasma Level have impact on "GENETIC VALUE"?... (AJER, May issue 2014)
[56] JALLIKATTU IS DRAVIDIAN VETERAN SPORT?... (AJER, May issue 2014)
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The evaluation criteria for community development (physical - space) utilizes the principles of urban smart growth Case study: Jolfa district of Isfahan

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Mohammad Amin Khojasteh Ghamari

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Abstract: -Growth and uncontrolled urban development and its consistent withandincreased populationhas created, heterogeneous and undesirabledistributionin thestructure of cities. Inrecent years, horizontal expansion of cities especially in developed countries and indeveloping countries and developed some what illogicaltowardouterfringe areashave beensporadically. For prevention of negative impactsconsidered a series ofmeasuresand solutionsthat smart growthis one of them.UrbanSmart Growthisone of theworld'smost characteristictopicsof formation andimplementationthat background coming back 1960seasidein Florida.Smartgrowth isanewperspectiveon theconcept ofgrowth management which hasbeenposed against spreadingsuburbspatternand it's describe principles fordevelopmentandredevelopmentdenseurbanareas.Over time thisapproachhas appeared indifferent countriesand regions. Iranalsoisused this approachinrecent yearsin thedebate ofsustainabledevelopment. Methodology ofthestudywas exploratoryresearch, and a part of research has applied data collection method- documentlibrary. Researchaimed atapplying theprinciples ofsmartgrowth,guidanceandpoliciesin this areais thedevelopment of the city.
In the stud yarea, eventually after than the recognition of the existing studies and regional studies concluded that the areais one of the places approach isthatit canreasonablybe achievedin the future tocreate adesirableneighborhoodandhas helpedthepotentialusing thisnewsystem andopportunitiesfor improvementin otherareas,suchasstreamlinedmodel. Studiesshowthat this approachcanserve as a modelinthe studyareaislocatedintheneighborhoodmay be consideredto fulfill theideals andthesustainable developmentof citieswill be useful.

Keywords:- *Physical Development-Spatial, mixed-use, smart growth, sustainable development,Jolfadistrict.*

I. INTRODUCTION

In recent decade characteristic ofour era isurbanpopulation, urbanpopulation increasesand consequently thedevelopment ofsmall andbig towns.In 1900, only one outofeveryeight peoplelivedinurban areas(Gilbert andGagler, 1996) and according toestimatesover the period1990 to2030, theurbanpopulationwill growto about3.3billion peoplewhich it will be90percent in urban areasin developingcountries.

Modernismhas been of the firsttheoristsofurbanland usesthat arebelievedland uses should be uniformandrefused variationland usesandthis ideaisgrownintheestablishment ofland usesin each ofthe metropolitanareashelped of sustainabilityshape theland use. In contrast, postmodernismrejectsthe uniform idea ofland usesandbelieved thatthemix land usesin urban ax and establishment ofmultipleland usesineachthe centerof city andurban areasrow greater can be created more accesstoservices and facilitiesin less time.

However,despiteyearsof planning,today'scitiesaregrowingsporadically. In thepast decades,a large amount ofagricultural land, gardens andgreen spacesaroundthe cityin order to growthe cityis dedicatedto building andthedayfollowingcitiesandhave beenmovingmore and moretowardscatteringphenomena and theincreasing useofprivatecarsfueled bythefragmentationanddegradationof the environmentisinvolved.

However,inrecent decades, such as smart growth, new approachesto deal with theproblemsof moderncitiesanduncontrolled expansionof urbanareasintheleftleg andtheopeningofnewcity developmentinolderareas, the use of the existingpotentials, increased densityandmixed. The idea thattheuncontrolled expansionpatternis formed,principlesand strategiesfor thedevelopment of thecommunitysuggest. Principlessuch asmixeduse, creatinga range ofhousingopportunities andchoices, creating apedestrian-oriented neighborhood, strengthen the senseof place,protectopenspaceand agricultural land, providing alternativetransportation andencouragetheparticipationof communities.

Definitions:

Urban growth:

Urban growth is aspatialprocess and population that refers to as increase oftheconcentration of populationinurban areasand townswith aneconomy and society specifically. However,urbangrowthaxisis thecompositionand spatialdynamics (Seto&Fragkias, 2005)

The pattern ofurbangrowthand urbansprawl, or whatnewurbanismassmart growth(urban development processandthedirect impactonboth thecity andtheneighborhood) describescorresponds. (Bhatta, 2009)

Smart growth

Smartgrowthis not identicalwith thewordgrowth. Smart growth is kind of developmentin theeconomic sphere(market) servescommunities and theenvironment. Smart growth providesa framework forcommunitiestomake to adoptappropriatedecisionsabouthowcommunitiesand where togrow. smart growth enablescommunitiesin waysgrowth thatmustbeoptimalgiven supporteconomicand employment: empoweringneighborhoodswithalternativehousingunits(housing), business and Transportandbuild ahealthy communitywithfamiliesinasafeenvironment. Smart Growthcould have beenachieved asa reasonableresponsein the face ofthosewho deal withmoredisperseddevelopmentpatternsover thepast 50 years(recent). (ICMA.2000).

TheUnited Statesmodel ofsmart growthis defined as: "Smart growthisan urbandevelopmentstrategythat seekstocomforttheliving, productivityimprovementand environmentalsense. smart growth has developedits own fundamentalwayby urban planners, ecologistsand otherexperts in theUnited States. (Appleyard, 2007).Smart growth is one of new perspectivesonthe concept ofgrowth management which has been proposedagainst suburbandevelopmentpatterninU.S.A. andposes principles fordensedevelopmentandredevelopmentwithin urbanareas(Talen, 2003).

Urban sprawl

DispersedurbangrowthaftertheSecond World War, became themost importantissuesof urbanizationprocessesindeveloped countriessuch asAmerica, Canada and someEuropean countries(Gill; 2008). Sparsegrowth which has defined as urbansprawlsuburbsareas a modeloflow-densityurban developmentandcar-dependent (Bhatta, Sarawati, &Bandyopaddhyay, 2010B). Termsof urbandistributionassociated with theexpansion of citiesintosuburbs andrural areasandagricultural landsare used. In other words,residentsof suchareastend to liveinsingle-family homesandcommutedaily betweentheirwork andtheir lives.

Physical-Spatial Development

Physicaldevelopmentincludesthe development anduseoftownis thecity which appearsresult in factorsincluding increasingpopulationand the need formoreurban land uses. In other words,the physicaldevelopment ofthe citycan beseen asan increase intheurbanarea. (Sustainable urban development; 2000).

Compact City

Compactcitiesare high population density, mixed-use, convenient and efficientpublic transportationsystembyencouragingwalkingand cycling.Thisidea rests based on cities traditionalEuropeanform. (Burton, 2000).Compacturbanform shouldbe scalesuitable forwalking andcycling andpublic transport,itmustbea level ofcompactnessthatencouragesocial interaction. Compacturbanform, not justfocus onurban centersand theavailablelandhas been abandonedbutavoidexpandingoutside oftowniswell. (Richards & Rogers, 1999).Such placeshave highpopulation densityandtheincorporation ofsocial interactionisthe mainfeatures ofthe traditionalcitypermits.

Sustainable Development

Sustainable developmentis a concept thathas been discoveredinallthe different departmentsinareassuch asland use, particularlywhenreportingcommissionBrandtLandis widespreadthroughoutthe world, attracteda lot offansin that order. (WCED, 1987). BrandtLandCommissionin its reportin 1987,sustainable developmentisdefined as:

"The kind of development which toprovide the needsofthe present generationwithoutcompromising the ability offuture generationsfortheir needs." (Brunt land commission)

Explaining theconcept ofurbansmart growth

Smartdevelopmentis amajor part ofitsdevelopmentwhich has based ontransport andreduced environmental impact. (Cowan Robert). Smart Growthis a set ofprograms andpoliciesofthe localgovernmentis that by thelocal governmentand local communitiesto preserveand developeconomicand cultural holisticresource including visioninformed decisionsabouthowand wheredevelopmentispossible. Developmentthatis includeseconomic development, creatinganeighborhoodenvironment, a rangeofhousingoptions, creates apublichealthanda cleanenvironmentbuilt. In other words, smart growthsolutionformany of thecommunity's concerns about the importantfeaturesofthe scatteringpatterns ofthe past 50 yearsoffers. However,communitiesare investigatingthe economic costs ofdistributionand reconstructionof infrastructure inurban andremotelocations, the need toincreasethecostoftraffic andakilometers of distance,carlock,order to reach aneareststore,Proceduresabandoningbrown fields in oldercommunitiesand the development ofopen spaces andfarmland, followed by the cityand surrounding areasareendangeringthe environment. Asthe quality of lifeissuesareincreasinglyimportanttocommunities, local and statepolicymakers, planners, contractors andothers areturning towardsmart growthis as one of thesolutionsto these challenges.

Smart Growth is strategy for urban development that improves living comfort, efficiency and helps the environment in urban areas. Originally smart growth was formed by urban planners and environmental experts and other professionals in the United States, and is spreading compact city with mixed land suitable alternatives to car use.

Assmart growthis reaction againstthe sparse development ofunstable, thus presentapproachhas been describedasurban sustainable development. Thisconcept ofsustainabilityis nota newcomposition,but it is a newreflectionof it.

Gylham 7 key items affecting the smart growth plan proposes the following:

- Protection of open space
- limiting Boundaries of growth extent
- Compact development with mixed land
- Revitalization of older urban centers, inner-ring suburbs, and launched commercial districts within the city.
- durablePublic transport to reduce dependence on cars.
- Regional Coordinator Development (especially transport and land use).
- Equal share of tax sources and providing of financial expenditures, including the empowerment of housing sector in across metropolitan areas.

Smart growthmovementbeganin 1996, when was formedthe Smart GrowthNetworkin theUnited States of America.This approachthefirst timeasapolicyby thestate of Marylandin 1997was usedoriginally to protectneighborhoodsandsmart growth.

Principles ofSmart Growth

-Mixeduse

Mixed-use in neighborhoods, or places thatareaccessibleby bikeorfoot, can lead to thecreation ofa dynamic anddiversecommunities. Inother sectors, mix land usehas caused attract people toshop, visit friends, and live inneighborhoods.Mix land uses are crucial to achieveplaces to live, work, andplaythemonthe principlesof smartgrowthencourages it.

Today,land useand othervariables in themodel of land developmentwerecombinedtoconvert transport to walkingand cycling model. While theseparation oflandoriginallyhad intended toprotectcommunitiesfromindustrialpollutionand busywork,shops, itwouldlead tomodel ofurban developmentthat,schoolsandhousingwereoftenlocatedfaraway fromthecitizenscouldonlybe accessedusingthe car.Smart growth to support of mixed land uses composition ofcomplexapplicationsincommunitiesasa crucialcomponentfor achievingbetter place for live. Mixedusealsocarriessignificant tax andeconomicinterest. Commercialusesadjacent toresidential areas, the most have valuable propertiesand thushelpto raiselocalperceived. Whenmore peoplearebuyinginthe area, there ismoreeconomic activityandmobility, as well as traditionalcenters ofcitiesortowns24hours. Thisapproachisaprincipleforbusinessesthatarelocatinginthese communitiesbecausethesecitiesaresourceof investment opportunitiesinareassuitablethat propose multi-dimensional context shoppingand entertainment. Compactbuildingdesignduring thelast two decades ofthe twentieth century, development of landshave been inAmericathree timesinthe othercountry.Some of thisgrowthhas been theresult ofconsumer demand, butsome other due tonon-marketincentivesis included such aszoning andcutmajorcomplications thatpromoteshousing.

Smartgrowthcommunitiestoencourage determinehow and wherethey wanttogrowth. An important part ofachievingsmart growthis compactbuildingsthat aresuitableto builda communitycenterthat peoplearewillingto help. Compactbuildingdesignoffers as well ascomprehensiveopportunities forthe development ofmore effectiveusesof the land. The population densityneeded tocreatecompactcommunitiesto achievesustainableand efficienttransportationoptionshelpsassessedthat peoplewillinglytodestinationsbuy ortransportstationsthatare locatedwithin a radius ofa quarterto a halfmilewalktowork. California's experience shows thatdoublingresidentialdensityto createmore compactcommunities with twice building density reducetravelby car, about 20 to30percenthave been effective and peoplewere ableto usecheaperandbetteralternatives tocaruse. Furtherintensive communities are requiringlinefacilities(such as water,sewage, electricity, telephone, etc) compare with arelessdispersed.

-Createa range ofhousingopportunities andchoices

Usingsmart growthapproachesto createa widerrangeofhousingchoices, communities canbegin tobecome moreefficient useoftheirinfrastructure resources, desirableform ofhousingneedfor all citizensto prepare, andtohelpsenior citizensstayin their own homes. Housingis avital part ofcommunitygrowth trajectory, as existingand develops newstructurecombines.

Providingquality housingfor peopleat every level ofincome,is an integralcomponentin anysmartgrowth strategy. In additiontoimproving the quality ofresidentiallife, housing canprovidea better balancebetween workand homeandvaluablefindingssupportfreightstationneighborhoods, commercial centers, and other servicesacquired,and therebythe environmentalcostscaused byautomobile-oriented developmentease.Opportunitiescreated bythe wideninghousingchoicesareendless.Different choices of housing in the new development could modify the pattern of land use, to protect the green land area is suitable. This communities also can choose from a wider spectrum, by changing the zoning and building code to increase the type and amount of housing units provided to beneficiaries. This could be another advantage. Buildings incorporating single - and multi-family housing developments and existing neighborhoods can help reduce the severity of poverty.Furtheropportunities forcommunitiestogradually increasedensityinexistingneighborhoodswithoutmajor changesin the landscapeareais created. Newresidentialbuildingscanbefoundaseconomic incentivesforbusinessesthat are alreadyactiveduring theworkday butthelack offoot trafficand customerssufferduring theevening andweekends. Most importantly,a range ofhousingoptionstoallowall householdshavetheir place in thecommunityof smartgrowth-whethergardenapartments, rowhouses,orhousesaretraditionalsuburban-And yetto adapt themselves with growthprocess.

-Create awalkingneighborhood

Until the mid- twentieth century, communities and neighborhoods focused on walking.These neighborhoods because they were designed to move people toward their destination.However, in the last fifty years, scattered and isolated land development patterns lead to excessive dependence on private cars and removal of protective features is walking communities. Today, walking communities are quite to achieve smart growth goals because they have to increase mobility, reduce negative environmental effects have a stronger economy and support the strengthening of communities that have promoted social interaction t. Communitiesto increasepedestrianaccess itprovidesthemany benefits for environment. Forexample, reducingtheneedtouse the carfor anyjourney,pavementdesigncanincreaseair quality. In addition tothesestrategies,benefits andeconomicbenefitssuch asqualitycommunity’sbetter weather, lowertransportationcosts, increasedhealth and fitnessof individuals, andhasa range ofoptionsto consumers. Conventionalland useregulationsoftenpreventmixing oflanduses, resultinginlongtripsandwalkingisa viable alternative todriving. Conventionalstreetdesign, widestreetswithhighpedestrianintersections, building blocks, long walksandlimitedinfrastructure-includingsidewalks,trafficcalmingthemiddle of theboulevardorobstacles-itsuggests. Welldesignedresidential developmentof conventionalattemptto standasa barrier forpedestrianactivity. Thisproves thatthe barriers toland useandcommunitydesignplaysa crucial roleinencouragingwalkingenvironment.

-learningdistinctive and attractive communitieswitha focus onsense of place

Commonpattern ofdevelopment helps tocreate a network ofmajorshopping centersand thedevelopment oflarge singlehouseinthe suburbs, which arecharacterizedbysmall changesingrooming. While thisapproachmayreducedevelopmentcosts makeituseful insome respects, butsense of proudcitizen or tostrengthentheless sense of placethan in any community citizens.

Smartgrowth also support ofideas thathebelieves development must not onlyrespondto the needs ofinstitutional, commercial or housing, but alsoneedto help createa distinctand uniquecommunities.

Smartgrowthseeks to kind of physical environment that make asense ofpride intheof thecitizen, and thussupportsthefabric ofinterconnectedcommunities. As a result increases the economicbenefits ofa good and will be createdcommunitieswith high qualitynatural andarchitecturalfeaturesthat reflect theinterestsofall citizens and also it’smore effectivein maintaining thevitalityandeconomic valuesat all times.

Communities that have a strong sense of place and also they are reflects the values of their citizens , and reflect the unique historical, cultural , economic and geographic regions. They are defined and used from natural and man-made boundaries and landmarks to create a sense of neighborhood, urban areas. These societies by a vision of where and how they have adapted the principles of smart growth and development can capitalize on an area that already reflects a strong sense of place to lead. However, these communities can forward develop around for a better effort to create distinctive and unique urban assets.

-Protectopen space, farmland, natural beauty, areas ofcriticalenvironmental

Modern societieshave foundthat the preservation ofopen spaceisan importantcomponentin achievingbetter placeto live. Openspace support fromsmart growthgoalsbystrengthening thelocal economy, protect the environment,critical areas, providing opportunitiesreinvented, andsteernew developmentintothe existingcommunity. Preservation ofopen spacecanhavesignificant effectsonquality of life incommunities, and thusbringeconomicprosperity. Inaddition topreserving theoutdoorenvironmentto combatair pollution, noise reduction, airflow control, prevent erosion, and moderatetemperatureshelpful.

-Strengthening anddirectingdevelopment inexisting communities

During the post-World War II urban communities that have experienced rapid expansion in the edges , often were saw a reduction in investment in urban core and first ring of suburbs . They had been abandoned due to scattered and low density new development in the border town. This growth pattern incredible had impacts on economic and social viability of many urban cores. Also lead to significant effects on the environment resulting in the development of open land, which could reduce animal habitat , reduced quality and quantity of water resources , and transportation options to will reduce the impact on air quality and climate change also increase the risk . Modern societies are investigating the environmental and economic reasons for abandoning neighborhoods,sidewalks, and water and sanitation services in urban centers and older suburbs only for its rebuilds.

Smart growth directs communities towards development. Encouraging development in existing areas , communities will benefit from more efficient tax base , proximity to work and services, increase the efficiency of the developed land and existing infrastructure , reducing development pressure on marginal areas , and the preservation of agricultural land and open spaces. Auto and ultimately leads to an increase in air quality. In most localities the ability to adapt to many kinds of growth factors to the development of communities need them through increased open brown land development, and rehabilitation of existing buildings.

However,a number ofobstaclesthatunderminedevelopment inexisting communities, such assomezoningplans, policies and government regulations, taxdonationsreflects thatencouragesgreenlanddevelopmentedges. Furtherdevelopmentof greenlandhas remain for developersand constructionforease of access, lowcostland,andthe potentialto createlargerareasattractive.

However, by encouraging development inexistingareason the one hand, we can benefitfromexistinginfrastructureandtheexpansion ofthe cityto preventexcessive and increase on the otherby creatingmoreoptionsfor local and regionaltransportation,airqualityand water.

-Providea varietyof transportationoptions

Prepare people with more choices in housing, shopping, transportation is starting to help smart growth. Communities are increasingly seeking these choices - especially a wider range of transportation options - are trying to improve the overall transportation system. In fact, knowledge management and traffic forecast has been work because the citizens have observed over the years that capacity building is almost as fast as new roads built.As a result, communities are beginning to use approaches in transportation planning, the coordination between land uses and transportation, increased access to transit service quality, create more abundance, mobility and continuity of transportation, and the relationship between the implementation on cycling, transit and road facilities sure did. In short, they was grafted approach the multi model transportation and land use patterns which support a wider range of options to build transportation.

Someofthe policieshave been developed toexpandtransportationoptionsinthis sectionasmeaningthatcommunitiesidentifyopportunitiesto improvethetransport network,helping.

-Fairdevelopmentdecisions,valuable, predictable and effective

Forasuccessfulimplementationofsmart growthapproaches,goals, and actionsmustbeacceptable tothe private sector. Private sectorplays a decisive role pay lotsofmoneyandspecialconstructiontomeetthegrowingdemandforsmart growthdevelopmentis needed. Ifcapitalists, banks, developers, builders,andothersto obtainthe benefit ofpermits, it will be built a bitofsmart growthprojects. Fortunately, thegovernment canwill reduceprofitability present obstaclesin the way ofsmart growthdevelopmentpractices.

To advance smart growth, local and central governments should make efforts to develop solutions that support innovation in solutions at lower cost and more predictable Bynytr is for developers to adopt. With environmental protection compression settings, pedestrian-oriented, mixed-use projects more attractive investments in smart growth and governments can to make contribute to the private sector is more willing.

Bonestructure ofthe immediatearea(Jolfaneighborhood)
Withincase study parametersfollowingplaya major roleinbone:

• Chaharbagh axis effect as the principal element skeleton city played a central role within the hive of action - body sway. Hakim Nezami andTohidaxis parallel toChaharbagh both length of monotheism influences motor function in the region. Nazarstreet aseast-west axis which passes of the northern limit of the range and the historical district of Jolfaas well influence as a performance axis .

• Distinctive context and influential of physical of Jolfa, is considered of vision functional and symbolic as influential area within the immediate area.

.

• In terms of regional centers can affect the Vank Cathedral , Hawass pointed out that in the area including physical and symbolic value affecting the spatial organization of the area. Other hubs influential can notedShariati Hospital in administrative center of in the area of coarse centers Chaharbagh.

Providing criteriaproposed

In this section , in relation to the smart growthis considered for providing theoretical approach developed chased to the three main activities of the project and performance, environmental perception , spatial index to evaluate the intelligent development of Jolfa district of Isfahan. Activity indicators and performance measures will be include the incorporation of a user, the active edges, activities and public open spaces and activities 24 hours. Branch offices under the criteria of peripheral sense of identity and arereadable. Physical indicators include the availability criteria, the sidewalks, the neighborhood revival of old tissues, public transport efficiency, safety and welfare of the environment. In Table 1 the following standards and criteria are depicted.

Table 1: Proposed criteria for evaluating local development of smart

criteraia	Under the proposed evaluation criteria for local development of smart	reference
Activity and Performance Indicators	Mixing applications	www.smartgrowth.umd.edu
	Active edge	www.planetizen.com
	24 activities	www.smartgrowth.umd.edu
	creation of public spaces	www.smartgrowth.umd.edu
Physical indicators	Availability	www.SmartGrowth.org
	Ability to walk	www.smartgrowth.umd.edu
	The revival of the old tissues within a neighborhood	www.smartgrowth.umd.edu
	Public transportation	www.smartgrowth.umd.edu
	Security	www.planetizen.com
	Climate comfort	www.smartgrowth.umd.edu
	density	www.planetizen.com

II. EVALUATION OFCRITERIA

Tocompile theoreticalapproachesofproject,is considered the threemainand practices, environmental perception, spatialindexto evaluatethe intelligentdevelopmentof Jolfadistrict ofIsfahan. Activityindicatorsandperformancemeasuresincludetheincorporation ofa user, the activeedge, work24-hour public openspaces andphysicalindicatorsinclude thefollowingbenchmarksavailabilitywill be...abilitysidewalk,thedistractionoldtissuesrevivaltransportationpublicefficiency, safety and welfare of theenvironment.

III. ACTIVITIES AND PERFORMANCE CRITERIA

Within the project area with 34 acres is allocated, 2 percent of the total area of the region. residential users has covered with 48.2 percent of its largest accounts. Subsequent passages with 24 percent of business users, with 13 percent , with 2.8 percent of Bayer 's historic 5 percent and 2 percent, the most important educational username comprise the study area . Historical land area of trans-regional and national performance.Regional cross- functional experience and range of applications as well as commercial city is considered one of the poles. As noted above, most of the residential areas and other land use in the surrounding streets are in, and particularly in view of the streets adjacent to commercial use have a strong role. Nazarstreet, passing the church andJolfa Square and the mixing rate of the active 24 hours were studied

Physical criteria

for this criteria are considered sub-criteria of ease access , pedestrian movement , public transport , endogenous development , climate comfort and security densities. Measure the movement and access, existing access roads to the neighborhood examined Hakim Nezami and Tohidplay a role in the neighborhood as Class 2 arterial pathways, and those have in spades of the traffic, and to have heavy traffic are hard to reach places . Axis and passing Vank Cathedral is mostly used for pedestrian sidewalks and safe pedestrian, but the relatively poor quality of the floor and interfere with the important problems in margin of parks. Internal development is one of the main criteria of smart growth. Comfort climate on criteria that included several factors such as ghosting,wind, and radiation fashion intended ... Jolfa neighborhood green capita is very low,with its converting into space we can increase assign a part of moorland green capita.

Densitycriteria

Densityinthis area face tothelow-density, 1or 2-storey buildings,withlower classesgenerallyare,of course,mustbe considered inthiscontextishistoricaland cannot beraisedhighdensity, to this end,detailed designcriteriashouldbeusedformaximum density.
Thetissuehasbeenremoveddue toa fieldwithoutmuchofmoorland that consideringthedensity oftheupstreamprojectsand encouragehomeownerstoretrofitexistingkernelscanachievethe desired goal.

Evaluationcriteriapresentedwithin the context

Evaluation criteria of activity
- Mixed use
- Active edge
- Activities 24 hours
- Creating public open space

Table 2: Evaluation criteria of activity

criteria	excellent	**good**	**average**	**Rather weak**	**weak**
Mixed use		✖			
Active edge		✖			
Activities 24					✖
Creating public open space		✖			

By:Author

This table isbased onthe studyoftissueand functionthanadecentneighborhoodonsmart growthprinciples thatimportantin this context,we are witnessingandinthesetableshave beengoodmixed use which has caused the ofthepeoples presencewithin context.Havingan activeedgeto yourbusinessis also astrong pointforthetissuecounts, butweneed towork24 hoursforkeepingthistissue. Accordingly,has been considered to promotethe activities andperformanceoftheproposed policy.

Physicalmeasures

Table 3-physical criteria assessment

criteria	**best**	**good**	**average**	**Rather weak**	**weak**
Availability			✖		
Ability towalk				✖	
The revival ofthe oldtissueswithina neighborhood					
Publictransportation			✖		
Security			✖		
Climatecomfort					✖
density			✖	✖	

BY:Author

This table isbased onspatialindexstructurein this studyissomewhat weak andthewalk capabilityis not desirablebecauseconsidered of severeinterferencecavalryandinfantry, and the lack ofpedestriansafety, especially on the streetlookingcaseareJolfathepresence of vehiclesone ofthedilemmas

IV. CONCLUSIONS

Late twentieth century, cities has experienced a surge in population . So that the world's urban population has more than doubled in 40 years .improve services and to evaluate the needs of the residents take wayso that should instead develop distributed applications and middleware development increases the mixing and filling the tissue and increase the density and tissue repair worn to a degree appropriate to achieve the stability . Urban Smart Growth is one of the world's most characteristic topics of formation and implementation of the 1960 cc side back in Florida. This approach, over time, in different countries and regions has appeared. Iran is also important in recent years in the areas of sustainable development is used. But unfortunately , because it 's about our city and the principle of sustainable development have been less successful is not dumb .Shopping and Sales favorable situation in the region and the residents of the city are alive and well as the dynamics of the main elements used .in other areas such as these helped to improve .One of the criteriaconsideredin theresearchactivity andperformanceindicatorsare that Thefollowingcriteriaarecouched insuchmixedresidential userswithinthe studyareaaccounted forthe largestpercentageand thesecondisof pathwaysthatcan beactivatedto helpimproveoutdoorlogicand dynamics ofurban centers; And thenthe thirdis locatedin thecommercialcenter oftheadvantagewhich canbe consideredto fulfillthe 24-houractivecenters.Hereis abrief referencetotheapplicationwe havediscussedthekeyissues ofurbanizationinthe world. Aswe knowfrom thestudiessuggeststhatthediscussion ofitemsandmixingperformance benchmarksUsergood performanceshowingthe variation intheregionofthe diversityof adequate access toneeded servicesapplicationsmodestTimepossesses ; Edgedue tothe formation ofactiveurbancommercial centersinthe city andimprovethemobilityedgehasperformed relatively well.Publicopen spacesalsoplaysits roleas well asthecompliance withthe spaceandcreatingopen spacesforpeople tocometogethertopromotea sense of placehelps; However,therelativelypoorperformanceof the24activitiesarenotsuccessful andthis type of activitybecausethey are notactiveat all timesand maybe activeatcertain timesoftheday andforthe restof thestate,we are seeingaslowdownturnintherespective catchmentheterogeneity.

Therefore, toimprove theperformance and activitiesof thefollowingcriteriaintheface canmaintainthediversityofmixingland usesand urban centersbecomeactive andsilentpartsvibrantcitycenters dull andmonotonousfunctionsand also changethe orderof businessinthe areatoaccommodatethecrowd andcreatea strongersense of placecan be wastelandsthathavea history ofcivil engineeringand construction creating anattractiveurbanlandand favorableconsiderationoutdoorreasonableandadequate parkingintightplacessuchasvitality anditsmode ofactionand thedullmonotonyand stagnationremoved and In the future,one of themost activeurban centersby creatingregularorderof businesswastakingactiveedges.

Proposed policies to promote local activities and performance indicators:

-Maintaining diversity in land use
- establish measures for the paper to become abandoned units to storage
- deploy applications Leisure
- Considering the many hours of the day be active .
-Avoid using office applications and timing in the body proximate
- Avoid land use that provide the off idle and deactivate spots
-prediction of to active land use in the night, like the theater and…
-Create a fantastic opportunity for makers and vendors
-political freedom to hold cultural festivals of various social groups

The proposedpolicy ofphysicalmeasure

-Observe thehierarchy ofaccess
-Createtheofaccessto nodes andperipheralmainroute
-Ability tocreatea visualrelationshipbetweenthe pathand the body
-Improvingpathways
-Establishmentwalkin the area
-Separatingtheroadwayfrom thesidewalk
-Avoid of roadway interferencecavalryandinfantrymovement
-properlightingforpedestrianmovement

-Regenerativerepair ofoldand historicalcontext
-Through thecreationand design ofphysicalinteractiveelements
-Through the creation and design of physical interactive elements
-Architecture model fits the context of the historical identity
-Create a variety of public transportation options to facilitate the movement of people
-Encourage citizens to use the public transport system
-Placing windows and doors facing the street
-Removing visual barriers , corners , and hidden angles
-Ability to create spaces that bring people around to stop people and Monitoring
-Through optimal use of climate in the area of public open space design , including wind direction andthe amount of ghosting
-The presence of natural elements and vegetation
-Create a place to pause and relax
-Removal of Noisy activities

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Municipal Solid Waste Management: Household Waste Segregation in Kuching South City, Sarawak, Malaysia

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Abstract: **-** Malaysia is faced with daunting challenges relating to household waste segregation. Due to an increase in population, economic growth, enforcement, infrastructure, public attitude, awareness and participation among others, source segregation is considered a crucial issue in Malaysia, particularly in urban settings. This paper presents the key findings of the quantitative (questionnaire) survey administered among 235 households in Kuching South City and qualitative (interview) survey with the Natural Resource & Environmental Board (NREB) and Kuching South City Council. This survey attempts to identify the limiting and motivating factors on the part of households to waste segregation. The result shows that age, sex, race and education is insignificant towards waste segregation. The result also shows a significant difference between waste segregators and non-waste separators on their level of perception towards implementation of laws for source segregation. Result also shows that the ease of access to facilities and the methods of collection are the major limiting factors preventing households from waste segregation in Kuching South City.

Keywords: *- Awareness, Enforcement, Infrastructure, Participation, Source segregation*

I. INTRODUCTION

A recent interview with Natural Resource and Environmental Board-NREB (whose mission is to efficiently regulate and enforce environmental laws for the protection of the environment and well-being of Sarawak) revealed that landfill still remains the most common waste treatment method in Kuching South City, whereby more than 70 percent of wastes are disposed using this method. However, this problem faced is particularly common among developing countries, especially Asia, which usually result into short lifespan of landfill and high consumption of landfill space. This problem of disposal to landfill is often compounded by trends in consumption, production patterns, continuing urbanization and most importantly the attitude and involvement of the waste generators and the communities at large towards source segregation of waste and in recycling. Legislative restrictions in many developed countries now mandate costly design and testing criteria for landfills. For instance, the German government sets high standards for access to a final storage site where all material designated for landfills has to be checked and must not contain substantial amounts of soluble salts [1].

Incineration, another common waste treatment method, is always criticized unsuitable nowadays due to air pollution problems and high construction and operation costs [2]. As Malaysia falls within the tropical rainforest region with high humidity, the solid waste has very high moisture content. Therefore, burning such waste in the incinerator consumes much energy than waste from drier region. In view of this, recycling is much more than an alternative landfill and incineration. Recycling helps to direct materials from the waste stream so that they may be re-used and turned into another material. The benefit of recycling are in many forms, such as reduction of environmental damage, energy saving, resources conservation and saving collection and disposal costs [3]. Besides that, the recycling of waste materials, if organized and managed properly can lead to gainful employment [4]. In addition, for recycling to be effectively managed, waste segregation needs to be inculcated in its curriculum.

Although, waste segregation at source has been acknowledged an efficient strategy for recycling, hence its full potential and benefits are yet to be realized or utilized and the rate of public participation has continued to remain low in Kuching South City due to waste generators perception and attitude towards it. In addition, there is no handy and dependent guideline for municipal solid waste management planners interested in designing a waste segregation initiative in Kuching City to lay hand on. In household waste management policy, the development of valorization techniques for municipal solid waste management must be supported by convenient instruments and incentives [5]. In view of this, waste segregation needs to be adequately communicated to the public, so that residents' habits, behavior and traditions can be changed for the better, thus enabling local authorities to achieve government goals towards solid waste management [6].

Periodic research has been performed where new methods and technologies have been developed to find a friendly solution to the issue in waste segregation particularly involving the waste generators to separate their recyclables. However, the growing trend and concern about the environmental sustainability, public awareness and community involvement in waste segregation has continued to mount more pressure in Malaysia municipal solid waste management. Attitudes and perceptions toward waste segregation at source and rating of waste disposal issues in people's minds and in the scheme of official development plans have not been adequately considered which has thus led to the recent upsurge in waste disposal problems in developing countries [7]. Communities don't have the attitude as long as their wastes are collected, "I don't care about what comes out of the waste, where and how those wastes are disposed as long as they are collected from my surrounding". The perception of the community in waste segregation cannot be denied and is important to examine for the purpose of improving the municipal solid waste management strategies to manage, prevent and mitigate excessive waste disposed to landfill thus extending the lifespan of the landfill.

Based on these challenges in the attitude towards waste segregation that this study was necessitated. As can be seen in a wide spectrum, source segregation are not given adequate attention to, as the waste generators are not considered in its planning and design stage because their "felt needs" are not highlighted and determined. This paper presents a preliminary studies carried out to determine households perceptions; their limiting and motivating factors toward waste segregation and also to determine whether there are existing infrastructure and legislative setup to support household participation in waste segregation in Kuching South City.

II. MUNCICIPAL SOLID WASTE SOURCE SEGREGATION

Source segregation refers to the separation of the proposed 'useful' materials from the waste stream at the point of generation. Segregation of waste can save valuable resources in the form of saved hours required to deal with the un-segregated waste. With the segregation of waste at the source point, the amount of waste going to the landfill is greatly reduced [8]. Further, in the absence of the waste segregation, composting or recycling is not possible. In addition to this, the environmental damage and filth associated with un-segregated waste poses a health threat to the people, which can be avoided by proper segregation method [8].

Discarded products and waste materials potentially still have some economic value if reused or returned to the technological cycle. However, source segregation is one of the prerequisites for successful and economically feasible recycling activities. Rather than considering MSW simply as residue to be thrown away, it should be recognized as resource materials for the production of energy, compost and fuel depending upon the economically viability, local condition and sustainability of the project on long term [9] which can be made effective by source segregation. The common MSWM problem of developing countries, especially in Asia is that waste segregation is either not yet started or not optimized enough to allow proper waste treatment. Recyclables are not separated at source and are mixed with organic waste thus making it difficult to separate. Additionally, the moisture level of the mixed waste is high. This high moisture level is true especially in countries like India, Indonesia, Sri-lanka, Bangladesh, Malaysia and Thailand. However, the potential of these high moisture waste to be made into compost is ruined by the contamination of hazardous waste which is included in the mixed waste, making it a lower quality, if not, toxic containing compost that farmers are reluctant to buy and apply to their crops [10].

III. CONSTRAINTS TO PARTICIPATION IN SOURCE SEGREGATION

The perception of one's capability is said to set a limit to do what to do and untimely what can be achieved [11]. The influence of perception which describes how a person views himself and the world around him and how it tends to govern behavior is explained by Anomie theory [12] which explains that deviance can arise by accepting culturally determined goals without the acceptability of cultural means. In this case, it translates to either paying for MSWM service or the total rejection of its cost recovery methods. In this wise, individual's perception of (touching issues of taxes revenues, government sincerity, etc) will influence the cultural values, responses, and success of the municipal solid waste management system. Hence, people's perception on fees and on waste collection services is primordial for its willingness to pay. More importantly, when it is perceived by the people that waste services is paid for through taxes or even considered as a social service to be paid for by the government.

Some scholars have identified factors influencing the elements of the waste segregation systems. Households attitudes related to separation of waste are affected by the active support and investment of a real estate company, community residential committees' involvement for public participation [13] and fee for collection service based on the waste volume or weight [14]. Gender, peer influence, land size, location of household and membership of environmental organization explain household waste utilization and separation behavior [15]. In relation to recycling, social influences, altruistic and regulatory factors are some of the reasons why certain communities develop strong recycling habits [16]. The authors also showed that people who frequently go to the bins to dispose of general refuse are more likely to recycle some product at home, and in most cases, as the distance to the recycling bins decreases, the number of fractions that citizens separate and collect at home increases. In order to increase recycling rates, the government should encourage markets for recycled materials and increasing professionalism in recycling companies [17]. Other factors mentioned by other scholars are financial support for waste segregation & recycling projects and infrastructures [18], recycling companies in the country [19], drop-off and buy back centers [20] and organization of the informal sector [21]. Household waste segregation is also affected by the aspects of enabling factors that facilitate the performance of the system. They are: technical, environmental, financial, socio-cultural, institutional and legal. Literature suggests that technical factors influencing the system are related to lack of technical skills among personnel within municipalities and government authorities [22], deficient infrastructure [23], poor roads and vehicles [19], insufficient technologies and reliable data [24].

The lack of coordination of coordination among the relevant agencies often results in different agencies becoming the national counterpart to different external support agencies for different solid waste management collaborative projects without being aware of what other national agencies are doing. This leads to duplication of efforts, wasting of resources, and unsustainability of the overall municipal solid waste management programmes. The lack of effective legislation for solid waste management, which is a norm in most developing countries, is partially responsible for the roles of the relevant agencies not being clearly defined and the lack of coordination among them [25].

IV. MUNICIPAL SOLID WASTE SEGREGATION IN MALAYSIA

The way humans respond and co-operate on waste management issues is influenced by their education [26], therefore, the public's education is an essential element of the success of any waste management program [27]. In Malaysia, environmental awareness among the public generally is still not adequate. In 1988, The Government of Malaysia had introduced the Action Plan for a Beautiful and Clean (ABC) Malaysia, followed by a recycling campaign in consecutive years. However, the campaigns do not lead to a positive result due to minimal responses from the public [28].

Several studies in Malaysia on household participation in recycling/buyback at designated centres show low participation. A study by [29] on the recycling program in Pandan Indah residential area in Selangor showed inconsistency in the operational schedule of the recycling/buy-back centre due to the high operational costs. The buy-back centre was managed by Alam Flora Sdn Bhd (AFSB), a private solid waste concessionaire with the responsibility to manage, collect and dispose solid waste. Another problem identified was difficulty in locating recycling bins in a study of residential areas in Selangor, Ampang Jaya and Subang Jaya [30]. In 2001, a recycle campaign was launched in Penang State with the aim to encourage Penang residents to recycle at least 1% of their daily waste generated. However, the campaign with the motto of "Kembalikan Sinar kepada Pulau Mutiara" (Restore the Shine to the Pearl of the Orient) had not made a positive impact on Penang's waste management problem. The recycle bins had been misused where about 40-60% of the contents were found to be non-recycle items [31]. In 2007, a recycling bank programmme was launched in two schools in Balik Pulau, Penang title "Turning trash into treasure" where recycling banks were made available for the two schools. This programme succeeded in getting minimal attraction of the pupils likewise also faced management challenges as the recyclables received from the participating students were salvaged by the school cleaners [32]. Likewise in 2008, a composting programme in Subang Jaya with the Motto "Source Segregation of food waste from Hawkers –turning waste into compost". This programme didn't yield a positive outcome as the food waste bins provided were mixed with non-food waste such as Fork, spoons, straws, chopsticks, etc. Other factors such as Poor awareness & training and lack of Incentives to encourage the Hawkers were identified [33]. Other programmes that faced similar challenges such as low awareness and lack of encouragement to the generators were " Glass recycling in Kuantan in 2008" [34], "Composting – closing the loop in Majlis Bandaraya Petaling Jaya (MBPJ) in 2008" [35]. Generally, Malaysian still have very low awareness on the importance of involvement in recycling programs.

It is clear to see that the current practice does not reflect waste management policy in place. Factors such as lack of implementation, weak enforcement, uncertainty over roles and responsibilities amongst governing authorities and limited stakeholder coordination have all contributed towards this disconnect between policy and practice. Furthermore, despite efforts by the MHLG, public awareness of the Municipal solid waste is low. However, the Malaysian Government recognizes that appropriate waste management is essential in achieving sustainable development as highlighted by the Malaysian Government Model [36].

To be successful, recycling programs require active and sustained participation of people [37]. As part of these efforts, households are being encouraged in several countries to start recycling through the separate collection of different materials [38]. A statistical study on factors affecting recycling activities in a Malaysian middle-class municipality in Subang Jaya, Selangor, identified that awareness creation should be given high consideration [39]. The study suggested an increase in recycling facilities. Another study also suggested monetary incentives approach to boost recycling activities at the household level [40]. None of the various studies conducted locally, investigated in detail the problems of the households carrying out recycling activities, considering the various recycling methods and socio-economic background and demography of such households.

V. RESEARCH METHODOLOGY

In order to produce both quantitative and qualitative data, a range of research methods covering questionnaires, interviews and document reviews were used in this study [41]. An outline of the approach used in the planning and execution of the data collection process is listed in Table 1.

For the household survey (see Item 1 in Table 1), a sample size of 235 households was determined based on statistical method for stratified sampling according to the areas (high, middle and low income areas). Trained research assistance was employed for both surveys due to the fact that the researcher is an international student. Interviews were conducted with Natural Resource & Environmental Board (NREB) and MBKS Municipal council officials.

The administered open-ended questionnaires were examined to check completeness, accuracy and consistency of responses in order to detect and eliminate errors. The Statistical Package for Social Sciences (SPSS) was used to process the quantitative data. The data were processed into statistical tables and charts for interpretation and discussion. Processed data were analyzed both quantitatively and qualitatively.

Table I: Data collection planning outline

No	*Method of data collection*	*Description*	*Corresponding objectives*
1	Household survey (quantitative approach)	Administration of a questionnaire (235 households selected by stratified sampling.	Public perception, attitude and their expectations towards waste segregation.
2	Interview with local authority staffs (qualitative approach)	Interview on the issues relating to waste segregation practices with NREB and Kuching South City officials.	Current practices adopted. Practical difficulties. Existing legislative support. Existing Infrastructure available.
3	Reviewing documents and reports on waste management (quantitative & qualitative data)	Publications of the Natural Environmental & Resource Board, Danish International Development Assistance (DANIDA) and Kuching South City report.	Waste statistics. Identified waste segregation problems and proposed solutions. Explanations of local authorities for poor waste segregation initiatives.

VI. FINDINGS AND DISCUSSIONS

6.1 Waste Segregation Awareness in Kuching South City

Public awareness and attitudes to waste can affect the population's willingness to cooperate and participate in waste segregation practices. General awareness and information on the social, economic and environmental benefits of the successful practice are important factors which need to be continuously communicated to all sectors of the population. Knowledge is important to predict waste segregation behaviour. Basically increasing knowledge will translate into a change in behaviour. Knowledge of household segregation is about where, what, when and how to practice in a real life [42].

A general question was designed in order to explore the level of awareness of respondents. To the question "Have you heard about waste segregation?" The responses obtained were analyzed and the results shows that 86.3% (196) of the respondents indicated that they have heard the news or in conversation about waste segregation, while 13.7% (31) have never heard of waste segregation. The result indicated that the respondents had adequate awareness on the current waste segregation scenario. Nonetheless, publicity is essential in providing motivation and reinforcing positive behavior. The fact that households have heard about the practice does not guarantee a strong and direct view towards participation and involvement. A broad test of the effectiveness of such publicity aims to find out the source of waste segregation information. Out of 196 respondents that are aware of this practice, the result shows that major news about waste segregation was sourced through Education from schools (49.8%). However, Municipal leaflet only constitutes 3.2% of the responses, indicating that the existing information/news by the municipality needs to be reviewed with focus on waste segregation. 3.2% of the respondents have heard about waste segregation through friends/neighbors still pointing to the fact that publicity through the municipality leaflet still needs severe improvement. When neighbours are practicing this initiative, there is a tendency for easy passage of this lesson to others neighbours/friends within the vicinity. Hearing the information/news from schools does not guarantee the successful practice, as not all the respondents have access to higher learning.

In addition to the assessment of the publicity on waste segregation in Kuching South City, it is important to identify the awareness of households about the leaflets on waste segregation provided by MBKS. As can be seen in Table II, only 3.2% claimed they have received leaflet from the municipality.

Table II: Communication media on waste segregation

Media	*Percentages (%)*
Education from school	49.6
Municipal leaflet	3.2
Radio/Television	18.1
Newspaper & articles	19.4
Neighbours/Friends	3.2
Others (internet, conference, etc)	6.5

According to the interview with MBKS, several awareness programs have been organized basically in direct dialogue and seminars within the community. The purpose of these programmes was aimed to give the community the privilege to ask direct questions from the MBKS staff regarding the waste segregating practice thus allowing the community to learn the knowledge concerning the waste segregation concept. It was also noted that most of the information regarding this programmes is found on the council's website. Although, this proves to be a good initiative from the municipality council but more attentions need to be directed in their communication media as lowest rate is found in the area of Municipal leaflet and through Neighbors/friends. Municipal solid waste management is meant for the public, and, without the public's cooperation, the system cannot be operated or maintained appropriately. Hence, it is necessary to make the public aware of waste segregation practices through liable communication channel and active participation in the system. In practice, system efficiency is directly proportional to the number of participating citizens for waste segregation. Without the general public participation, it may be difficult to maintain efficient MSWM services, and resource recovery systems may become less effective if wastes are poorly separated at the source. Therefore, to have an effective channel of communication, the media of communication of waste segregation initiatives needs to be bridged and looked into adequately.

6.2 Participation in Waste Segregation in Kuching South City

Source separation also called "in situ segregation of domestic waste" is the sorting out of individual waste types into separate storage containers at the point of generation. From the questionnaire survey, it was revealed that 42.4% (95) of the respondents are separating their waste at their residence while 57.6% (129) do not separate waste at their household. The level of household participation in waste sorting is alarmingly low in the study area. This low participation in waste sorting in the entire sample area could allude to a low level of awareness of environmental issues and low environmental education (formal and informal) which may cultivate into apathy towards waste sorting. However, these further analyses showed that respondent do not have sufficient knowledge on waste segregation. Even though recycling activity in Kuching City is increasing, thus the recycling initiative still needs to be enhanced. The Malaysian's attitude towards waste segregation and recycling is higher, but only few practice it [43].

6.2.1 **Limitations to participation in Waste segregation**

Concerning the reasons for not practicing waste segregation at respondents residence. Out of 129 respondents who are not practicing source segregation, majority (29.2%) claimed that the lack of facility (see Table III) was their major limiting factor towards this practice. This reason was also mentioned by [30] in a residential area in Subang Jaya, Selangor, Malaysia which shows that the lack of recycling facilities in KLFT and Selangor areas is an inhibitors towards waste recycling. This same reason was also stated by non-recyclers in the study by [44] as "no storage facility" to keep the recyclable items at home. Followed by other variables, such as Inconveniencies (ease of access), no collectors, no interest, not aware, no idea on how it is done, no incentive and no time which constitutes 18.6%, 13.0%, 11.2%, 10.6%, 8.1%, 6.2% and 3.1% respectively.

Table III: constraints towards waste segregation practice

Limitations	*Percentage (%)*
No facility	29.2
Inconveniencies	18.6
No collectors	13.0
No interest	11.2
Not aware	10.6
No idea	8.1
No incentive	6.2
No time	3.1

Generally, those who perceived time used in waste separation as a constraint had a high opportunity cost of time and were thus less likely to sort the wastes. This is in agreement with a number of studies on recycling behavior where time is looked at as an important inconvenience factor [45, 46, and 47]. The reasons for the Inconveniencies in major responses were due to the method of collection as well as problems associated with waste management such as the distance to the recycling bin/ buy-back centres, systematic operations, failure of collection time and odour.

According to the interviews with MBKS, the strongest reason for the low participation in source segregation of recyclables was determined as the ease of access to recycling centers and also the transport of this recyclables to recycling company at the peninsular (West Malaysia). Financial restraints and a limited number of workforces in the process were both assessed as potential reasons with the MBKS Waste Manager. This automatically can lead to households not showing interest in this practice. This is also in line with the finding of [48] whereby lacking awareness and interest create barriers to sustainable behavior.

6.2.2 Households' Motivations in Waste Segregation

For the assessment of the existing efforts done by MBKS, majority of the responses were not favorable, with most of the respondents (89.2%) felt that MBKS had not done enough to encourage and develop waste segregation practices effectively and efficiently in the municipality. What this implies is that most people in the neighbourhood were either unaware of the activities of the local authority towards waste segregation or do not believe they are doing much in terms of promoting waste segregation. On what needs to be done to encourage waste segregation in the study area, 24.3% of the respondents suggested that the Provision of facilities (bins and more recycling centres) within their vicinity would definitely make waste segregation and recycling more convenient (Table IV). This variable has the highest percentage among all the variables. This implies that provision of more facilities and more recycling centres in housing areas/estates will be of a strong encouragement for them to participate in waste segregation. Similarly, most of the households also required the collection authority to pick up their segregated recyclables regularly, preferably on the same day with the conventional solid waste collection. However, this may reflect more effective publicity associated with household waste segregation. Apart from having a separate bins, it is also important that these bins must be made attractive to complement the waste segregation initiative. It was suggested by some households that the design of the recycling centres be changed from the ordinary, dull looking enclosed box type to high visibility type. They also felt that segregating bins should be labeled in all local languages so that residents of various ethnic backgrounds will understand what the receptacles are for and therefore they will not treat segregating bins as ordinary trash bins.

22.5% of the respondents suggested that MBKS should provide more awareness for them. This is pointing to the fact that household see recovery of waste as benefits to the government involved. Households should not only be aware of this practice, they should be as well aware of the social, economic and environmental benefits associated. Likewise 17.5% of the respondents suggested that MBKS should regularly conduct workshop and exhibition on waste segregation, majority of them suggested it to be conducted on weekly basis. This is because lack of knowledge is one of the main reasons why households did not separate their household waste and there should be an ongoing effort to educate those that are not separating at their residents and also reinforce the lessons to those separating at their house.

According to the interview with MBKS, result shows that there are existing recycling activities (such as home composting and buy-back programmes) already in place at the South City. MBKS uses the concept of coupon-based redemption system for its buy-back scheme where the residents get an exchange for recyclables dropped in for household items (such as detergents, toothpaste, toothbrush, Tissue, etc). Even though this programmes seems to be visible and available in recent, yet majority of the respondents seem not be aware of such service which point to the fact that more awareness strategies needs to be inculcated (T.V, newspapers, Municipal leaflets). Among this media, more concentrations needs to be on Municipal leaflets and should be distributed on regular basis.

The percentage of making waste separation mandatory is low (10.4%). Most of the respondents claimed that waste separating activities should be made on voluntary basis as though it is still at its peak in Kuching South City. Those respondents who agreed to laws being enforced were basically aged respondents as they felt it is individuals' responsibility to separate waste at house, that until when there are bylaws, the youths will continue to be ignorant of waste segregation. Few of the households also showed concern towards the introduction of laws as regards the PAYT, that if imposed would not yield good result thus awakening the illegal dumping of waste. This shows that households are not ready to accept this service if imposed. This is due to their increase in financial burden.

Concerning households willingness to separate in the absent of incentives, financial incentives such as tax reduction were perceived a great strategy to increase their uptake.11.7% agreed that Incentives and bonus be given and also increased. Even though this Coupon-based scheme seems encouraging, it still needs to be reviewed and targeted to encourage majority in the City. The impact of incentives as one of the basic factors towards household waste recycling was observed in the study by [46], [44]. This is also streamlined to the fact that majority of the households still see waste recovery as a benefit to the government. Nevertheless, until households start seeing the purpose of waste segregation a benefit to them as well, the participation would still be low. Regular collection of segregated materials at every residence often will definitely make the practice more convenient. However, this will increase the cost of waste management.

Based on the interview with MBKS council, it was noted that there is no national policy on MSWM and in waste segregation. Nonetheless, the ABC has become their de facto guideline for MSWM activities by the State and Local Authorities. The ABC, however, was formulated on the basis that action plans would be executed by the local authorities with guidance from federal agencies. The success of the federal government privatization programmes has shown that the private sector can play a key role in rejuvenating sectors for the economy, which have been retarded when under government control. With the increased participation of the private sector, through privatization, various aspects of the ABC will require amendment. Furthermore, the creation of a new policy for MSWM in Malaysia is important as a part of the legislation approach to support an integrated approach for better MSWM. With the existence of government action to ban materials such as glass, plastic, paper, organics and others to disposal sites, this will encourage the community to practice recycling and composting. When people start to take part in any activities related to waste segregation, recycling and composting, this will be very good strategy for Malaysia in future to decrease the total MSW generation to the disposal site.

Table IV: Motivating factors to participate in waste segregation

Requirements to participate	***Percentage (%)***
Provision of Infrastructure (bins, collections)	24.3
More awareness/campaign be provided	22.5
More Workshop & Exhibition	17.5
Regular collection of separated waste	13.6
Give/Increase Incentives	11.7
Legislation be enforced	10.4

6.3 Influence of demographic factor and regulations on waste segregation in Kuching South City

The following factors were tested for this study;

6.3.1. There is no significant relationship between age, sex, race, education to participation in source segregation.

It is often believed that those that are ignorant to separate their recyclables at home are the older generation. However the result of the correlation test indicates that P>0.05 (see Table V), that is there is no significant relationship between age to participation. This is because age is no barrier towards waste segregating activity.

Likewise this test show insignificant relationship between Sex to participation in waste segregation in Kuching South City. Although some researchers have proved that female tend to be involved in such recycling activities than in male. This result is not in agreement with studies by [49] and [50] who found women more involved in source separation of wastes than men. Therefore there is no condition of sex towards waste segregation at source in Kuching City. Waste segregation can be practiced irrespective of the sex.

Also, this test shows insignificant relationship between race and education to participation in waste segregation. This test prove that waste segregation if well communicated to the household using a simple language can be practiced without necessarily learning it from schools. In summary, household do not need any form of degree/certification and do not need to belong to a particular tribe or ethnic group before they can practice waste segregation.

Table V: Correlation test of age, sex, race and education to participation in waste segregation

Variables	*Pearson's Correlation (r)*	*Sig.(P)*
Age	*-0.055*	*0.607*
Sex	*-0.0233*	*0.739*
Race	*0.081*	*0.242*
Education	*-0.109*	*0.116*

Not significant at P>0.05 level

6.3.1. There is generally a significant difference between waste separators and non-waste separators in respect to their views towards legislation.

The difference between waste separators and non-waste separators on their view towards legislation was determined by conducting an Independent t-test. The result shows a significant value of P<0.05 that is {t (213) = -2.893, P=0.004}. This shows that there is a significant difference in their opinion towards implementation on legislation. However waste separators felt they are participating in this segregating activity because they are aware of the impacts and benefits to the environment and are also supportive towards government initiative. Therefore, they felt making the scheme mandatory for the public would make those that are ignorant of this practice to participate, thereby changing their thoughts and behaviours. They also felt it is individual's responsibility to practice waste segregation towards a better sustainable management system as this process involves recovering the excessive amount of waste disposed to the landfills thus conserving the landfill space. This point to the fact that waste segregators have good knowledge on the social, economic and environmental benefits of waste segregators. The non- waste segregators are not willing to accept laws as they felt practice waste segregation is by choice as it is government's responsibility to manage the environment efficiently without the involvement of the public. Non-waste separators also felt that if laws are impose, it would rather de-motivate those that are contemplating to engage in the practice or those have learnt through friends and neighbours in this practice.

VII. CONCLUSION

In reality, the MSW generation and management cannot be avoided completely as long as humans exist and this issue will always arise simply because societies will continue to generate trash due to increasing populations and the growing demand of modern society [51]. The results support the common assumption that when citizens who are environmentally concerned have bins near to their home, they appear to be willing to recycle more fractions than when they have to walk for a longer time to drop off the waste, due to the inconveniencies [52]. As we have seen in this study, the importance of ease of access to the bins is obviously an incentive to waste segregators. Once more, this is also consistent with the results obtained by [53].

The source separation of the recyclable material can be achieved by increasing awareness among the public. Household support is essential to the effectiveness of any program aimed at recovering recyclables at its source. A well informed and concerned public greatly facilitates program implementation and ensures its success. However, the success of such schemes will depend on the participation rate of households. Also to achieve the objectives of waste segregation scheme, community-based solid waste management has to be sustainable. Active support and involvement of the real estate company and the community residential committee play a crucial role in achieving the fundamental goal of source separation by increasing public awareness and the participation rate. However, the involvement of active environmental organizations, women's clubs, church organizations and other associations is necessary. Generally, campaigns should target both men and women due to the complementary nature of their roles with women more likely to carry out waste separation while men provide the labour necessary in waste management activities like composting which requires more physical effort.

In general, source separation at the household level can only become part of a new waste management policy or bye-law to enhance reuse provided there is Incentive driven initiative for the waste generators, Infrastructures such as (bins, collection centres and regular collections). More also needs to be done in research that would result in a design of convenient in-door bins for the households that will reduce the ease of access limitation from households.

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Investigation of Radiation Problem for two Separated Mediums

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Abstract: The Hertzian potentials are used to determine the electric and magnetic field components. Moreover, it is possible for the radiation to start with the dipole to be observed at much greater distances than would be possible if the waves were generated in an infinite homogeneous medium. In this paper we present the problem of communication of aradiation in a conducting medium. The problem is analyzed in terms of a dipole radiation in a homogenous medium separated by a plane boundary from a dielectric half space. Expressions for the Hertzian potentials of the dipole is reduced to integrals which was obtained by Sommerfeld equations multiplied by an exponential depth attenuation factor. The analysis is described for both magnetic and electric, vertical and horizontal dipolesFinally, accurate numerical analyses are derived to illustrate the above statements.

Keywords: *- Sommerfeld radiation problem, Dipole radiation, Hertzian potentials*

I. INTRODUCTION

The so - called 'Sommerfeld radiation problem' is a well – known problem in the field of propagation of electromagnetic (EM) waves for obvious applications in the area of wireless telecommunications [1], [2]. Furthermore, Sommerfeld expanded his original work to take into account vertical and horizontal, electric and magnetie dipoles above a plane earth. In 1909, Sommerfeld stated the existence of a surface wave in the radiation of a vertical Hertzian dipole over a plane earth [1]. The solution of the boundary value problem was based on the evaluation of Fourier-Bessel integrals which were the solutions of the wave equation. In 1953, Wait discussed an insulated magnetic dipole in a conducting medium, showing that the fields are independent of the characteristics of the insulation for an antenna diameter much less than the radiation wavelength in the conducting medium [4]. Analyzed magnetic dipole solution of a semi-infinite medium including special cases of frequency, antenna depth, and separation between antennas was discussed [5]. It can be noticed from [6], [7] that a horizontal electric dipole in a conducting half space was carried out by a mathematical analysis. Also, the exponential increase of the attenuation with depth was experimentally verified. In [8], [9] the engineering application of the above problem with obvious application to wireless telecommunications was discussed and provided approximate solutions to the above problem, which are represented by rather long algebraic expressions.

II. PREFACE OF RADIATION PROBLEM

The geometry of the problem is given in Figure 1. It is assumed that the dipole is oriented either horizontally in x-direction or vertically in the z-direction. It can be noticed that the important direction for transmitting dipole radiation is directly toward the surface of the sea because of the mode of communication. Furthermore, magnetic and electric fields have been calculated for both the vertical and the horizontal dipoles.

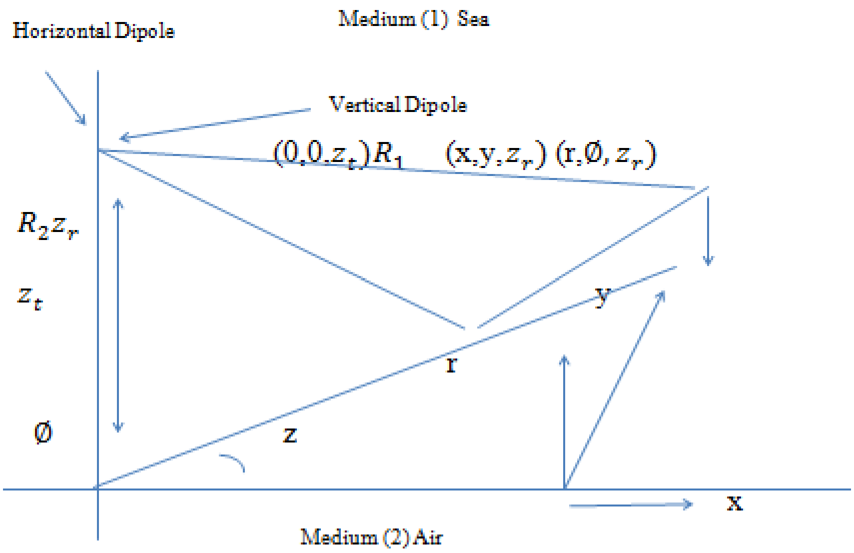

Figure 1. Geometry of the radiation problem considered in this paper

The theory of a conducting half space and electromagnetic radiation in a conducting medium are discussed in [9,10].

III. ANALYSIS OF RADIATION PROBLEM

3.1 The two Hertzian functions for the two mediums have to meet the following conditions, [1]:

$$\Delta\pi_1 + k_1^2\pi_1 = 0\,, \qquad z > 0$$

(1a)

$$\Delta\pi_2 + k_2^2\pi_2 = 0\,, \qquad z < 0$$

$\pi_1 = \pi_2\,,\ \frac{1}{k_1^2}\frac{\partial\pi_1}{\partial z} = \frac{1}{k_2^2}\frac{\partial\pi_2}{\partial z} \quad at \quad z = 0$

(1b)

$\pi_1 = 0, \qquad z > 0, \qquad r = \infty\,, \qquad z = +\infty$

$\pi_2 = 0,\ z < 0,\ r = \infty\ ,\ z = -\infty$ (1c)

where

r = cylinder radius , R = distance of the point from the transmitter which lies on the origin (z = 0 , r = 0). As in Figure 2.

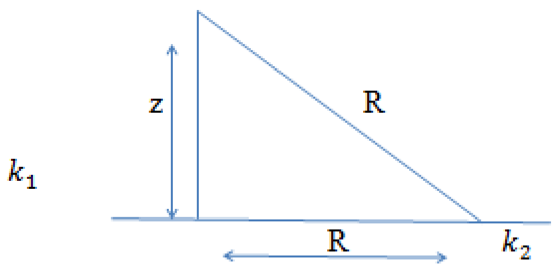

Figure 2. Dipole position

Then, Sommerfeld obtained his well-known solution in the form of the following integral, [2]:

$$\pi_1 = 4\int_0^\infty \frac{(k_1^2 + k_2^2)e^{-z\sqrt{\lambda^2 - k_1^2}}\,(J_0\lambda r)}{3k_1^2\sqrt{\lambda^2 - k_1^2} + k_2^2\sqrt{\lambda^2 - k_2^2}}\lambda d\lambda (z > 0) \qquad (2)$$

1.2 The Maxwell equations for a conducting medium are given by, [2], [3]:

$\nabla^2 E = j\omega\mu\sigma E$ (3)
where
H is the magnetic field and E is the electric field.
Furthermore, by taking into account a plane wave travelling through the positive z-direction we get the following equations

$$E = E_0 e^{-(1+j)z/\delta} \quad , \quad H = e^{-j\lambda/4}\sqrt{2}\frac{n * E}{\mu\omega\delta} \qquad (4)$$

where
n is the unit vector in the direction of propagation

$$\delta = \sqrt{\frac{2}{\mu\omega\sigma}}$$

The Hertzian potentials $\prod$ and $\prod^*$(the Green's function for a dipole source) for the electric and magnetic dipoles respectively, in the infinite, conducting medium are, [2], [11]:

$$\prod = P_1 \frac{e^{-k_1 jr}}{R} \quad , \quad P_1 = \frac{\prod^{em}}{4\sigma\pi} \quad (5)$$

$$\prod^* = P_1^* \frac{e^{-k_1 jr}}{R} \quad , \quad P_1^* = \frac{\prod^{mm}}{4\pi} \quad (6)$$

where
$\prod^{mm}$ is the magnetic moment = NIS
I is the current.
N is the number of turns in the magnetic loop.
S is the loop area vector.
$\prod^{em}$ is the electric moment.
R is the distance from the dipole to the observation point.
In this paper, the Hertzian potentials are used for both the electric and magnetic dipoles. It can be easily found that the electric and magnetic field vectors are functions of the Hertzian potential as follows, [5], [12]:

For the Electric dipole:

$$H_1 = \nabla\sigma * \prod \quad , \quad E_1 = \prod * \nabla\nabla + k_1^2 \prod (7)$$

For the Magnetic dipole:

$$H_1 = \nabla\nabla * \prod^* + k_1^2 \prod^* \quad , \quad E_1 = -j\omega\mu\nabla * \prod^* \qquad (8)$$

where

$$k_1 = \sqrt{-j\omega\mu\sigma}$$

Moreover, the electric and magnetic fields in an infinite, nonconducting medium are as the following equations:
For the Electric dipole:

$$H_2 = \nabla j\omega\epsilon_0 * \prod \quad , \quad E_2 = \prod * \nabla\nabla + k_2^2 \prod \qquad (9)$$

For the Magnetic dipole:

$$H_2 = \nabla\nabla * \prod^* + k_2^2 \prod^* \quad , \quad E_2 = -j\omega\mu\nabla * \prod^* \qquad (10)$$

where
$k_2 = 2\pi/\lambda_0$, is the wave number
λ_0 is free space wavelength

Therefore, the Hertzian potentials in this case for the electric and magnetic dipole respectively, are as the following equations, [4]:

$$\prod_2 = P_2 \frac{e^{-k_2 jr}}{R} \quad , \quad P_2 = j\,\frac{\prod^{em}}{4\omega\pi\,\epsilon_0} \qquad (11)$$

$$\prod^*{}_2 = P_2^* \frac{e^{-k_2 jr}}{R} \quad , \quad P_2^* = \frac{\prod^{mm}}{4\pi} \qquad (12)$$

Then, by taking into account the modification for the case of a source in a conducting half space separated by a plane boundary from a nonconducting half space. Therefore, the source (transmitting dipole) is located in the conducting half space at coordinate position (0, 0, z_t) from the boundary. Similarly, the point of observation (receiving dipole) is located at coordinate position $(r, \emptyset, z_r)$, as shown in Figure 1. Moreover, the Hertzian potentials for the conducting and nonconducting half space must satisfy the wave equation (condition A below), the radiation condition at infinity (condition B) and the radiation condition near the source (condition C) below [1], [13]:

For condition A:
$\nabla^2\Pi_1 + k_1^2\Pi_1 = 0$, $\nabla^2\Pi_1{}^* + k_1^2\Pi_1{}^* = 0$, $z_r > 0$ sea medium

$\nabla^2\Pi_2 + k_2^2\Pi_2 = 0$, $\nabla^2\Pi_2{}^* + k_2^2\Pi_2{}^* = 0$, $z_r < 0$ air medium

For condition B:
$\lim_{R\to\infty}\Pi_1 = 0$, $\lim_{R\to\infty}\Pi_1{}^* = 0$, $z_r > 0$ sea medium

$\lim_{R\to\infty}\Pi_2 = 0$, $\lim_{R\to\infty}\Pi_2{}^* = 0$, $z_r < 0$ air medium
where
$R = \sqrt{r^2 + (z_t - z_r)^2}$

For condition C:
$$\lim_{R\to 0}\Pi_1 = \frac{e^{-jk_1R}}{R} = \lim_{R\to 0}\Pi_1{}^*$$

Moreover, the electric and magnetic fields must satisfy the boundary conditions at the surface of the sea. Therefore, the boundary conditions for the components of the Hertzian potentials and their derivatives are as the following described equations, [3]:

$\Pi_{z1}{}^* = \Pi_{z2}{}^*$
$-jg\Pi_{x1}{}^* = \Pi_2{}^*$
$$\frac{\partial\Pi_{x1}{}^*}{\partial z} = \frac{\partial\Pi_{x2}{}^*}{\partial z}$$

$$\frac{\partial\Pi_{x1}{}^*}{\partial z} + \frac{\partial\Pi_{z1}{}^*}{\partial z} = \frac{\partial\Pi_{x2}{}^*}{\partial x} + \frac{\partial\Pi_{z2}{}^*}{\partial z}$$
where
$g = \frac{\sigma}{\omega\epsilon_0} = \frac{k_1^2}{k_2^2}$,-jg is an approximation for the complex index of reflection.
By this way, we have to describe that the Sommerfeld has shown that only Π_z component of the Hertzian potential is required to describe the fields of a vertical dipole [2].

3.3 Related to the integral calculations of Hertzian potential, the Hertzian potential can be obtained in integral form for the four basic dipole configurations: vertical and horizontal, electric and magnetic dipoles. The method used here for obtaining the potential integrals was first used by Sommerfeld [1,3]. Thus, a general Hertzian potential for each of the four dipole configurations is obtained satisfying conditions (A) through (C). So, the Hertzian potentials for the observation point in the sea are presented in integral form for the four basic dipole configurations as follows, [3], [8]:
For vertical dipole:
$$\Pi_{z1} = L + I_{a1} \quad , \quad \Pi_{z1}{}^* = L + I_{b1} \tag{13}$$

For horizontal dipole:
$$\Pi_{x1} = L + I_{b1} \quad , \quad \Pi_{x1}{}^* = L + I_{a1} \tag{14}$$

where
$$L = \frac{e^{-jk_1R_1}}{R_1} - \frac{e^{-jk_1R_2}}{R_2} \quad , \quad R_1 = \sqrt{r^2 + (z_r - z_t)^2} \quad , \quad R_2 = \sqrt{r^2 + (z_r + z_t)^2}$$

$$I_{a1} = 2\int_0^{\infty} \frac{e^{-FJ_0}}{3F - gjG} \quad , \quad I_{b1} = 2\int_0^{\infty} \frac{e^{-FJ_0}}{4F + G} \quad (15)$$

$$I_{c1} = 2\,(-gj - 4)\int_0^{\infty} \frac{e^{-FJ_0}}{(F - gjG)\,(F + G)} \quad (16)$$

where

$$G = \sqrt{£^2 - k_2^2} \quad , \quad F = \sqrt{£^2 - k_1^2}$$

It should be noticed that the function L has two parts: exp $(-jk_1R_1/R_1)$ which represents the primary source at the position (0, 0, z_t), and exp $(-jk_1R_2/R_2)$ which represents a secondary source at the image position (0, 0,$-z_t$). Moreover, at the ease of the horizontal electric and the vertical magnetic antennas, the secondary source represents the image of the primary source, but in the case of the vertical electric and the horizontal magnetic antennas, the secondary source represents an image dipole of the opposite polarity. As shown in Figure 1, the primary source radiates over the direct path R_1 , and the secondary source radiates over the reflected path R_2. Consequently, the integral in every case represents the major contribution to the Hertzian potentials if r $>>(z_r + z_t)$. By considering (-jg-1) = -jg as g >> 1 for the frequencies and conductivity in this paper, it can be shown that for $z_r > 0$, $z_t > 0$, [9], [11]:

$$I_{c1} = \frac{\partial}{\partial z_r}\left[-\frac{2}{k_1^2}\frac{e^{-jk_1R_2}}{R_2} + I_{a1}\left\{\frac{1}{k_2^2} + \frac{1}{k_1^2}\right\}\right] \quad (17)$$

$$I_{b1} + \mathrm{jg}I_{a1} = \frac{\partial I_{c1}}{\partial z_r} \quad (18)$$

Also, the integrals I_{c2}, I_{b2} and I_{a2} are interdependent. So, it can be shown that for $z_t > 0$, $z_r < 0$

$$I_{c2} = \frac{1}{k_2^2}\left[\frac{\partial I_{a2}}{\partial z_r} + \frac{\partial I_{a2}}{\partial z_t}\right] \quad (19)$$

$$\frac{\partial I_{c2}}{\partial z_r} = I_{b2} - I_{a2} \quad (20)$$

Furthermore, by taking into account calculating the fields in the sea and at the surface of the sea to concentrate on the integrals I_{b1} and I_{a1}. Moreover, all the fields which will be discussed in this paper can be expressed in terms of integrals I_{b1} and I_{a1}. Then, by replacing I_{b1} and I_{a1} with the two new integrals I_a and I_b as follows, [2], [13]:

$$4\int_0^{\infty} \frac{e^{-L\mathfrak{z}}\,(\rho\Psi)}{2L - jMg} = I_a \quad (21)$$

$$6\int_0^{\infty} \frac{e^{-L\mathfrak{z}}\,(\rho\Psi)}{3L + M} = I_b \quad (22)$$

where

$$\rho = \frac{\omega}{c}\,r = r * \frac{2\pi}{\lambda_0} \quad , \quad \mathrm{c = speed\ of\ light}\,, \quad \lambda_0 = \mathrm{wave\,length}$$

$$\mathfrak{z} = \frac{\omega}{c}\,z = z * \frac{2\pi}{\lambda_0} \quad , \quad \Psi = \frac{c}{\omega}\,\mathfrak{z} \quad , \quad z = z_t + z_r$$

$$M = \frac{c}{\omega}\,G = \sqrt{\Psi^2 - 1} \quad , \quad L = \frac{c}{\omega}\,F = \sqrt{\Psi^2 + gj}$$

The factors $\mathfrak{z}$ and ρ are used to express r and z in terms of free space wavelength divided by 2π. So, the electric and magnetic field components in the sea as functions of the integrals I_a and I_b are as follows, [11]:

For the Vertical dipole at Electric dipole, [2]:

$$E_z = \frac{\omega^3}{c^3}\left[\frac{\partial I_a}{\partial z^2}\right] \quad (23)$$

$$H_\varphi = -\frac{\omega^2}{c^2}\,\sigma\,\frac{\partial I_a}{\partial \rho} \quad (24)$$

$$E_r = \frac{\omega^3}{c^3}\frac{\partial^2 I_a}{\partial\rho\partial z} \quad (25)$$

For the Vertical dipole at Magnetic dipole, [6]:

$$H_z = \frac{\omega^3}{c^3}\left[\frac{\partial I_b}{\partial z^2}\right] \quad (26)$$

$$E_\varphi = j\,\frac{\omega^3}{c^2}\,\mu\,\frac{\partial I_b}{\partial \rho} \quad (27)$$

$$H_r = \frac{\omega^3}{c^3}\frac{\partial^2 I_b}{\partial\rho\partial z} \quad (28)$$

For the Horizontal dipole at Electric dipole, [10]:

$$H_r = \frac{\omega^2}{c^2}\,\sigma\sin\varphi\left[\frac{1}{\rho}\frac{\partial^2 I_a}{\partial\rho\partial z}\right] \quad (29)$$

$$H_\varphi = \frac{\omega^2}{c^2}\,\sigma\cos\varphi\left[\frac{\partial^3 I_a}{\partial\rho^2\partial z}\right] \quad (30)$$

$$H_z = -\frac{\omega^2}{c^2}\,\sigma\sin\varphi\frac{\partial I_b}{\partial \rho} \quad (31)$$

$$E_r = -2\frac{\omega^3}{c^3}\cos\varphi\;gj\left[\frac{\partial^2}{\partial \rho^2} + I_b\right] \quad (32)$$

$$E_\varphi = 5\frac{\omega^3}{c^3}\sin\varphi\,gj\left[\frac{1}{\rho} + I_b\right] \quad (33)$$

$$E_z = -\frac{2\omega^3}{c^3}\cos\varphi\frac{\partial^2 I_a}{\partial\rho\partial z} \quad (34)$$

For the Horizontal dipole at Magnetic dipole, [12]:

$$E_r = -j\frac{\omega^3}{c^2}\,\mu\sin\varphi\left[\frac{1}{\rho} + \frac{\partial I_b}{\partial z}\right] \quad (35)$$

$$E_\varphi = -3j\frac{\omega^3}{c^2}\,\mu\,sin\,\varphi\left[\frac{3I_a}{\partial\rho^2\partial z} + \frac{\partial I_b}{\partial z}\right] \quad (36)$$

$$E_z = j\frac{\omega^3}{c^2}\,\mu\,sin\,\varphi\frac{\partial I_a}{\partial \rho} \quad (37)$$

$$H_r = -\frac{\omega^3}{c^3}\cos\varphi\left[\frac{\partial^2 I_a}{\partial \rho^2} + I_a\right] \quad (38)$$

$$H_\varphi = \frac{\omega^3}{c^3}\sin\varphi\left[\frac{1}{\rho} + I_a\right] \quad (39)$$

$$H_z = -5\frac{\omega^3}{c^3}\cos\varphi\frac{\partial^2 I_a}{\partial\rho\partial z} \qquad (40)$$

It can be mentioned from the above equations that the electric and magnetic fields in the air at the boundary can be calculated from the fields in the sea and the boundary conditions. Moreover, the fields are expressed through the boundary conditions as follows, [13]:

$$E_{z2} = -gjE_{z1} \quad , \quad E_{i1} = E_{i2} \text{ as } i = r,\varphi \quad , \quad H_{i1} = H_{i2} \text{ as } i = r,\varphi, z \qquad (41)$$

Related to the calculations of the integrals, asymptotic expansions for I_a and I_b can be determined by the method of critical points [12]. In the case of which the source and point of observation both lie on the boundary, it will be possible to reduce the integrals I_a and I_b to those obtained by Sommerfeld [3], [11]. The coordinates of branch points 4 and 2 are given by $\psi = 1 - jx/2$ and $\psi = -1 + jx/2$, respectively. where x is a very small value associated with the conductivity of air. Moreover, the poles occur when (L-gjM) = 0, exactly when, [15]:

$$\psi^2 = \left[1 - \frac{j}{g}\right]\frac{g^2}{1+g^2} \quad (42)$$

where $g \gg 1$ for the conductivity and frequencies considered in this paper. It can be easily found that to evaluate the integrals by contour methods it is convenient to write these integrals in forms such that the path of integration lies along the entire real axis. Therefore, it can be done by the conversion of the Bessel functions of the first kind into Hankel functions of the first kind to become as follows, [10], [13]:

$$\int_{-\infty}^{\infty}\frac{e^{-Lz}J_0 H_0}{2L - jMg} = I_a \quad (43)$$

$$\int_{-\infty}^{\infty}\frac{e^{-Lz}J_0 H_0}{5L + M} = I_b \quad (44)$$

whereM is a pure imaginary part.

Morefore, it is possible to close a contour by tottering a semicircle, whose radius is unbounded from the positive real axis to the negative real axis through the upper half plane. Then, by taking into account a highly conducting medium, we can observe that the contribution to the integral along branch line 1 is negligible. Furthermore, in order to integrate I_a and I_b with respect to the conductivity and frequency range considered in this case, it can be written such as the following equations, [3]:

$$2e^{(-1-j)\sqrt{g/2z}}\int\frac{H_0^1\,(\rho\Psi)}{2L - jMg} = I_a \qquad (45)$$

$$2e^{(-1-j)\sqrt{g/2z}}\int\frac{H_0^1\,(\rho\Psi)}{5L + M} = I_b \qquad (46)$$

where

$L = \sqrt{jg}$

Then, as a conclusion in the case examined here, it can be easily realized that I_a and I_b in case of $0<\rho<1$, T=1 can be written as:

$$I_a = 5j\,\frac{e^{4j\rho}}{2g\rho}\,T \qquad (47)$$

$$I_b = 8\,\frac{e^{7j\rho}}{(jg-3)\rho^3} \qquad (48)$$

IV. PHYSICAL INTERPRETATION OF THE DERIVED EXPRESSIONS OF A DIPOLE RADIATION PROBLEM CONSIDERED IN THIS PAPER

1. It is deduced from our analysis that the path of electromagnetic energy between the transmitting and receiving dipoles in the conducting medium is as the following : (a) propagation from the transmitter directly to the surface, (b) propagation along the surface of the medium allowing refraction of the energy back into the homogeneous medium, (c) propagation descending into the inhomogeneous medium to the receiver.
2. From equations (43) – (48), we can realize that the energy traveling directly through the sea between the transmitter and receiver is neglected and the ratio of the magnitude of the direct wave through the sea over the surface wave is of the order of $e^{-\frac{z}{\delta}}$ where z and δ are respectively antenna depth and skin depth.
3. The analysis shows that the main path of communication between antennas is composed of three parts as follows: (a) energy flow from the transmitting dipole directly to the surface of the sea, (b) creation of a wave that travels along the surface refracting back into the sea, (c) energy flow normal of the surface to the receiving dipole. Moreover, from equation (13) – (14), it can be observed that the Hertzian potentials is composed of three components: (a) a primary source function, (b) a secondary source function, and (c) an integral.
4. The boundary conditions in equation (41) state that the magnetic fields and the tangential electric fields in air are equal to those in the sea, and that the vertical electric fields in the air are related to those in the sea by the proportionality constant - jg.
5. The z-components of the fields in the conducting halfspace in sea are small compared with the horizontal components and therefore they have not been included. On the contrary, the z-component of the electric field in the air, for the horizontal dipoles, is the predominant component [15]. Moreover, it can be observed that the fields of the horizontal dipoles are stronger than those of the vertical dipoles, as would be expected because of the vertical nulls in the radiation from the vertical dipoles.

V. CONCLUSION

As a matter of fact, any practical medium even air has some conductivity and therefore the effective permittivity must contain a small imaginary component. Furthermore, each of the field expressions may be considered to consist of 3 parts: a multiplying factor which includes the dipole strength and parameters such as frequency and conductivity of the medimn; an exponential attenuation factor whose exponent is the sum of the distance from the dipole to the surface and from the surface to the point of observation; and a factor associated with variation in the horizontal direction. In this paper analytical expressions of the dipole radiation problem in a conducting half space were introduced. It is obvious from the limits of the integrals that the path of integration must lie along the real axis. Thus, this branch point appears to lie on the real axis because of medium 2 has been assumed to have zero conductivity. Furthermore, as a conclusion in the case described here, it can be easily noticed that the wave propagates at the dipole and proceeds by the shortest path to the surface, then the path of minimum attenuation is refracted at the surface and travels along the surface as a wave in air, then comes to the point of observation by the path of the least attenuation.

VI. FUTURE RESEARCH

In the future, research should be focused on the solution of the corresponding problem for horizontal radiating Hertzian dipole above flat and lossy ground propagation in isotropic and anisotropic crystals.

VII. ACKNOWLEDGEMENTS

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BACKGROUND OF AUTHORS

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Estimation of Potential Load Demand of Local Government Areas of Ekiti State, Nigeria

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Abstract: - The estimation of the potential load demand of local government areas in Ekiti State, Nigeria, was carried out using per capita demand estimate of a fully electrified urban area and population data. The pessimistic load demands of the local government areas were calculated through the use of per capita of a rural community in Ekiti state. This was achieved through the injected powers and the State's zonal population. The study demonstrated that there is wide difference between the projected load demands and the actual supply; thus impairing rural electrification of the State.

Keywords: - *injected power, load centers, load demand, power balance.*

I. INTRODUCTION

Efficient power management is prerequisite in maintaining consumer confidence. One form of maintaining or at least controlling power is by injecting sizeable power into the zone substation. Often this form of power augmentation is needed for relatively short period where substations supply large load components. A small quantity of about 3 to 4 MW was released by the Akure injection substation at night periods, when the entire state depended on 132/33kV injection substation at Akure.[1] The zone substation has been supplied from a long transmission from Oshogho axis. Power injection variations that occur in power systems are generally nonlinear [2].It was noted that low load allocation on most of the 33kV feeders varied and particularly more pronounced on the Akure—Ado-Ekiti feeder.[3] Variations occur in other injection substations within the state and that connecting to adjoining states with maximum injected power ranging from 4MW to 12.7MW. The load on power station varies from time to time due to uncertain demands of the consumers and is known as variable load on the station [4]. The maximum injected power is the highest power supply for a distribution network over a period of time [5]. The maximum injected power is the highest power supply for a distribution network over a period of time. This study examines the load power balances of sixteen Local governments of the Ekiti State Senatorial district depicted in Figure 1.

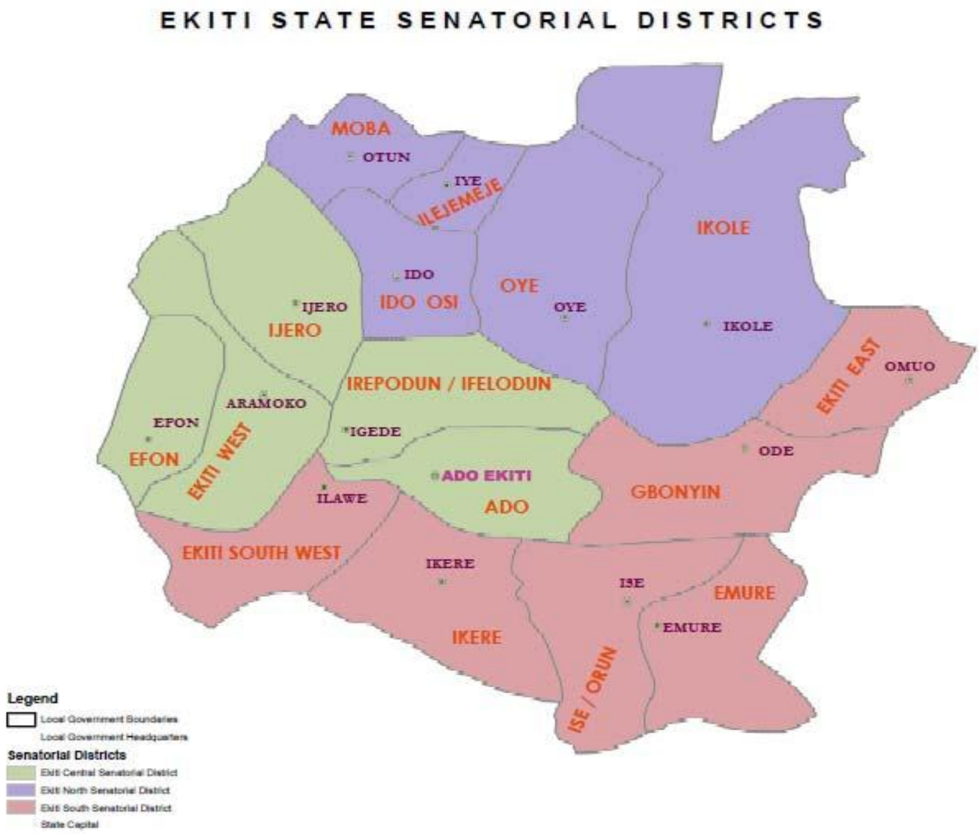

Figure 1: Local Government Areas in Ekiti State

Electrical power balance is the mathematical difference between the injected powers and the (power demand) load on the busses. For example, the power balance for Ado-Ekiti depends on the difference between the summation of the injected powers from Osogbo and Akure and the summation of loads on busses in that region. The power flow could be calculated using successive approximations method, which this study adopts. Whilst power utility companies envisage making a healthy profit for their operations, the bottom-line would still be healthy as long as substantial power needed to meet the load demands is injected into the distribution network. Inadequate power injection creates power failure to the consumers as well as incurring loss of revenue to the power authority. Ekiti has a tropical climatic condition of rainy and dry seasons of April-October and November-March respectively [6], temperature ranging from 21^0C to 28^0C with high humidity, with varying power demands.[7]

II. MATERIALS AND METHODS

The following sets of data were obtained from the Power Holding Company of Nigeria (PHCN)Ado-Ekiti, namely:(i) the injected power into the state; (ii) the load demand at the various 33 kV load centers and (iii) the distribution network diagram. The consumers' population dataset of the local government areas(LGAs) of interest was obtained from the Ministry of lands and National Population Commission, Ado-Ekiti.
The per capita demand for each LGA was estimated using:

$$per\ capita\ demand = \frac{power\ \ supply\ \ to\ selected\ \ area}{population\ \ of\ selected\ \ area} \qquad (1)$$

To make relative comparison with that obtained by [8] for a fully electrified urban community with known supply from PHCN and population, per capita demand estimated for Ado-Ekiti was 0.064 kW, which is lower than that obtained for Oluyole load center (Oyo State) of 0.094 kW as estimated by [9]. Figure 5 shows a one-line diagram of Ekiti State 33kV network with associated nodal power distribution, i.e. $S_{ii} = P_{ii} + jQ_{ii}$, where P_{ii} and Q_{ii} are active and reactive powers respectively[10]. From Figure 5, expression for the power balance per LGA can be deduced. As an example, the power balance for Ado-Ekiti LGA is S_{21},noting that in real operations, the Iyamoye – Ido (2) line (from Fig. 5) is opened, which is estimated as follows:
(a)By power balance, the per capita demand for Ekiti State, Nigeria is expressed as:
$S_{21} = (S_0+S_{18}) - (S_1+S_4+S_5+S_{20}+S_{24}+S_{26}+S_{32}+S_{35}+S_{37}) = 19.662 + j15.741$ [8]
(b) Per capita demand =0.064 kW per capita.

(c) The power demand for each LGA is computed using:

$$demand = per\ capita\ demand \times population\ of\ LGA \qquad (2)$$

3.0 Results and Analysis

3.1 Results

Estimations of potential load demand for Ekiti local government areas are presented in Table 1.

Table1 Expected Maximum Demand at the 33kV load centers

	Ekiti State LGA	Headquarters	2006 Population Census (LGA)	Pmin, MW	Pmax, MW
1.	Ado-Ekiti	Ado –Ekiti	308,621	19.752	29.010
2.	Efon Alaaye	Efon-Alaaye	86,941	5.564	8.172
3.	Ekiti West	Omuo-Ekiti	137,955	8.829	12.968
4.	Ekiti South West	Ilawe-Ekiti	165,277	10.577	15.536
5.	Ekiti West	Aramoko Ekiti	179,872	11.512	16.908
6.	Emure	Emure Ekti	93,844	6.006	8.825
7.	Gbonyin	Ode Ekiti	148,193	9.484	13.930
8.	Ido/Osi	Ido Ekiti	159,114	10.183	14.957
9.	Ijero	Ijero Ekiti	221,405	14.170	20.812
10.	Ikere	Ikere Ekiti	147,335	9.429	13.851
11.	Ikole	Ikole Ekiti	168,436	10.780	15.833
12.	Ilejemeje	Iye Ekiti	43,550	2.787	4.094
13.	Irepodun/Ifelodun	Igede Ekiti	129,149	8.266	12.140
14.	Ise Orun	Ise Ekiti	113,754	7.280	10.693
15.	Moba	Otun Ekiti	146,496	9.376	13.771
16.	Oye	Oye Ekiti	134,210	8.589	12.616
Total				152.586	224.116

3.2Analysis of Expected Maximum Demand at the 33 kV Load Centers

An expected total power demand for Ekiti State that will accommodate rural electrification, based on results tabulated in Table 1, is estimated as 224.12 MW (optimistic) as drawn in Fig. 3 and 152.6 MW (pessimistic) as drawn in Fig. 2. The interception of maximum demand of both optimistic and pessimistic estimation is presented in Fig.4, which shows a clear difference in the values of power demands at individual points of the chart. These demands are significantly in excess of the present connected demand. The progressive pessimistic and optimistic power demands for all the local government areas are clearly stated in Table 1. The connected demand of Ekiti local government areas presently is 37.5MW.

A random look at two local government areas: Ado-Ekiti and Ilejemeje LGAs. Ado-Ekiti LGA, for instance, has a population of 308,621[11] with a pessimistic power demand of 19.752 MW while the optimistic power demand is 29.01 MW. This is grossly in variance with the estimated maximum demand. This implies that the present demand is even insufficient to adequately supply Ado-Ekiti load center. The maximum demand (pessimistic) for this load center is 19.8MW signifying that the present demand can sufficiently supply Ado-Ekiti only at base loads.

For Ilejemeje, the optimistic maximum demand and the pessimistic maximum demand are 4.1MW and 2.83 MW respectively. This load center at both peak and base values can be sufficiently supplied by the present demand connected.

In essence, for the Ekiti State, the presently connected demand of 37.5MWis far below the total power demand of 224.12MW that will accommodate rural electrification of the state.

III. CONCLUSION

The study has shown that the presently connected demand of 37.5MW is far below the total power demand of 224.12MWrequired to accommodate rural electrification of the Ekiti State. For the anticipated economic growth of the State, it is pertinent that efforts to supply the required power demand by the three tiers of government and the concerned power authorities should be intensified.

IV. RECOMMENDATION

1. The reconfiguration of the present Ekiti network will improve the power distribution to the consumers.
2. The required 224.12MW for adequate power supply to the consumers should be provided by the the three tiers of government, individuals and corporate organizations.

V. ACKNOWLEDGMENT

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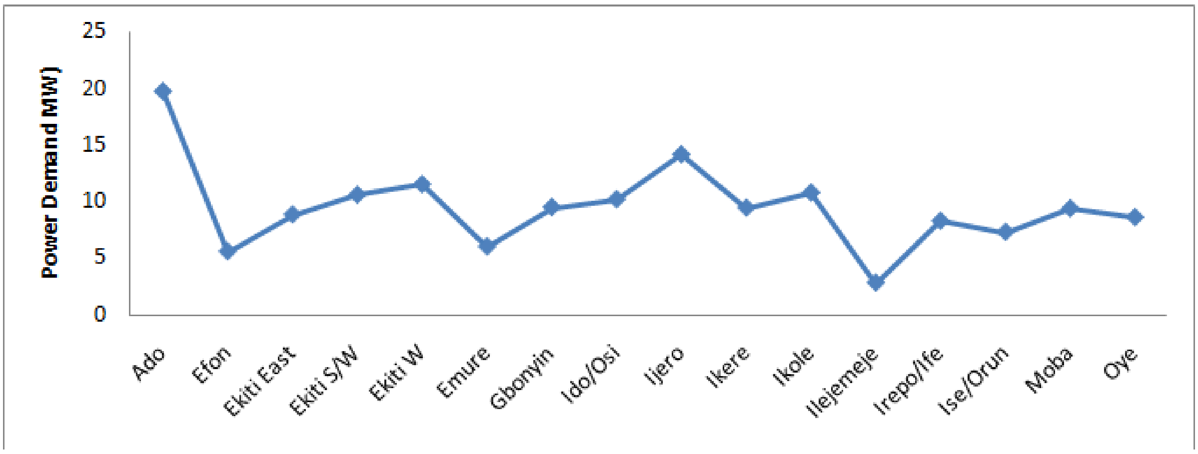

Figure 2: Estimated Maximum Demand (pessimistic) at 33kV Load center

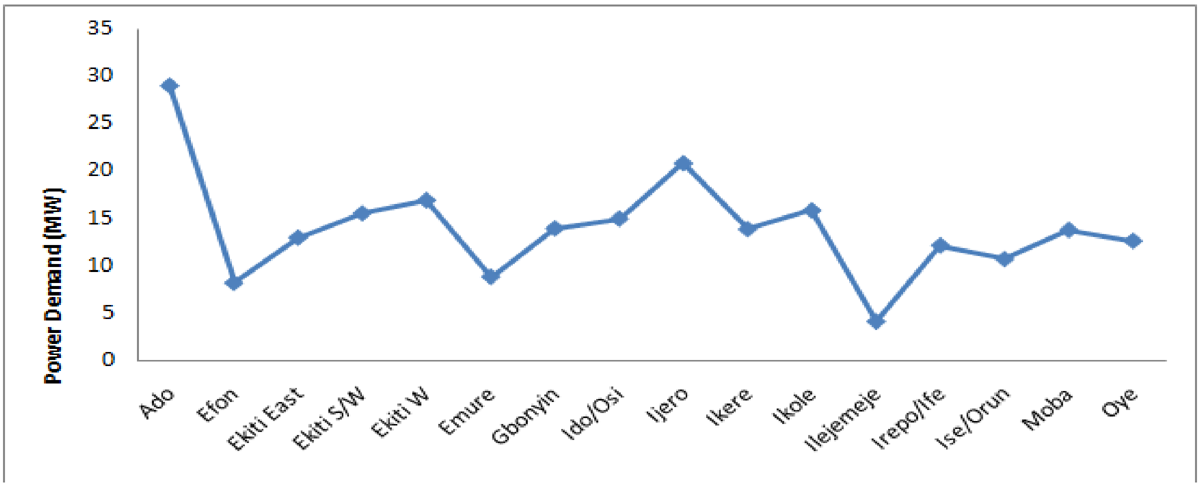

Figure 3: Estimated Maximum Demand (optimistic) at Ekiti 33kV Load centers

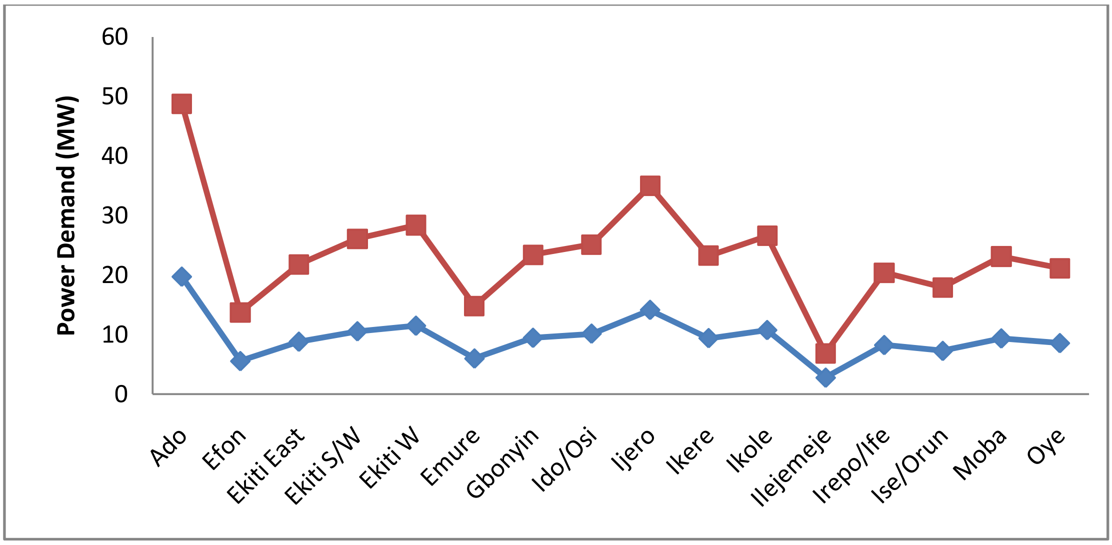

Figure 4: Interception of optimistic and pessimistic Maximum Demand of Ekiti 33kV Load centers

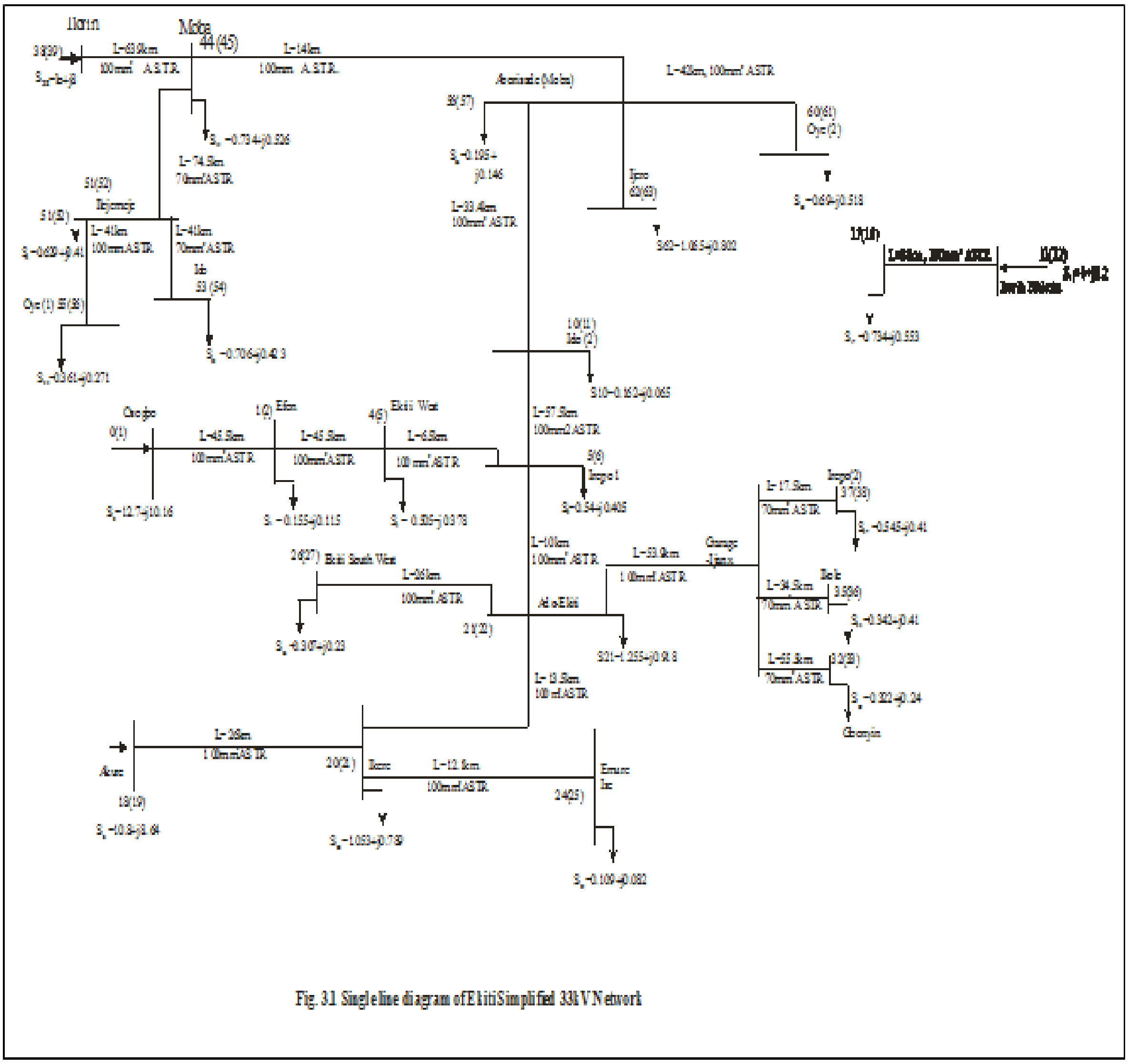

Figure 5: One line diagram of Ekiti 33kV network

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Gubi Water Treatment Plant as A Source Of Water Supply In Bauchi Township

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Abstract: - In Bauchi Township the main source of water supply is coming from Gubi dam. It is among the overall state-wide programmes for water to be supplied to the state capital. The scheme involves the use of surface water by constructing dams and treatment works. Erecting these two major facilities will require pumping station reservoirs, pumping main and major overhaul of the distribution network to make the overall scheme meaningful and useful. The dam was started with temporary structures, which was constructed across one of the streams at the permanent dam site to provide water needed for the construction of the permanent dam. In this temporary dam about 500 million gallons of water which is equivalent to $2.27 \times 10^4 m^3$ be impounded, while the construction of the permanent dam was going on it was decided to make use of the temporary dam to supplement the water supply to the town. Consequently, intake arrangements were made; a treatment plant and pumping mains were provided. The dam is zoned earth fill clay core having a maximum height of 27m with embankment length of 3.86 km and bottom earth-fill is 2,315,000m^3 with a reservoir area of 590 hectares the catchment's area is 179km^2 with a total storage of 38. 4 x 10^6 m^3, the expected yield from reservoir is 90,000m^3/d. It is expected that an average of 7 x 10^6 gallon of water which is equivalent to 3.178 x 10^4 m^3 is pumped per day. The supplies of water depend on the availability of water in the reservoir. The seasonal variation of water in the reservoir level is generally due to seasonal rainfall temperature evaporation and daily demand.

I. INTRODUCTION

With world population growing rapidly the water reservoir of the world are becoming one of the most important assets. Water is essential for human consumption and sanitation, for the production of many industrial goods and for the production of food and fibre. Water is an important means of transport in many part of the world and a significant factor in recreation. Water is unequally distributed about the earth and its availability at any place varies greatly with time. The total supplies of fresh water on earth far exceed human demand. Most of mankind lives in areas, which receives an abundance of annual rainfall. The provision of water to urban areas requires major capital investment in storage, treatment, and supply networks. Furthermore the per capita consumption of water has generally tended to increase rather than decrease, although this can be expected to be largely a function of life style and population density Jasem (2002). Hydrological analysis and designs require information on flow rate at any point of interest along a stream. However, in most cases, this information may not be available in sufficient quantity due to lack of (inadequate of stream gauging or non-availability of records. Faced with these difficulties, engineers and planners resort to the use of mathematical approaches such as synthesis and simulation as tools to generate artificial flow data for use in design for water supply, structures sizes flood control measures e.t.c. (Mustafa and Yusuf 1997).

1.1 THE STUDY AREA

Bauchi township is the study area and is located at 10^0 04' N and 9^0 09' E. It lies within the tropical climatic zone with marked wet and dry season. Fig.1 is the map of Bauchi State showing the study area.

1.2 SOURCES OF WATER

Water can be collected from surface and subsurface for the purpose of water supply. The choice should be carefully done in order to ensure sufficient quantity and good quality water. Where streams are not available or not suitable for consumption, best option in exploiting ground water exploitation may be the only option available. air, etal (1971) in their findings concluded that the nature of the water source commonly determines the planning design and operation of the distribution work. Common sources of fresh water are: - Rain water, surface water and ground water. Hofkes, (1981) found out almost all surface water will require some treatment before it can be used for domestic purpose

1.3 THE GUBI DAM

The source of water in Gubi dam is mainly coming from three tributaries, namely Gubi River, Tagwaye river link with Shadawanka and Ran River. The function of the dam is to supply the state capital and its environs with potable water. A Temporary dam close to the site was constructed across one of the streams to provide water needed for the construction of the permanent dam. The embankment of the dam which has length of 3.86km and bottom earth-fill of 2,315, 000m^3 with a reservoir area of 590 hectares. The catchments area is 17,900 hectares with total storage capacity of 38.4 x 106m^3, the expected yield from the reservoir is 90,000m^3/d.(BSWB,1981) The cross sectional dimensions of the dam is shown in Fig. 2 below.

Figure 1. Map of Bauchi state

The dam was started with temporary structures, which was constructed across one of the streams at the permanent dam site to provide water needed for the construction of the permanent dam. In this temporary dam about 500 million gallons of water which is equivalent to $2.27 \times 10^4 m^3$ be impounded, while the construction of the permanent dam was going on it was decided to make use of the temporary dam to supplement the water supply to the town.

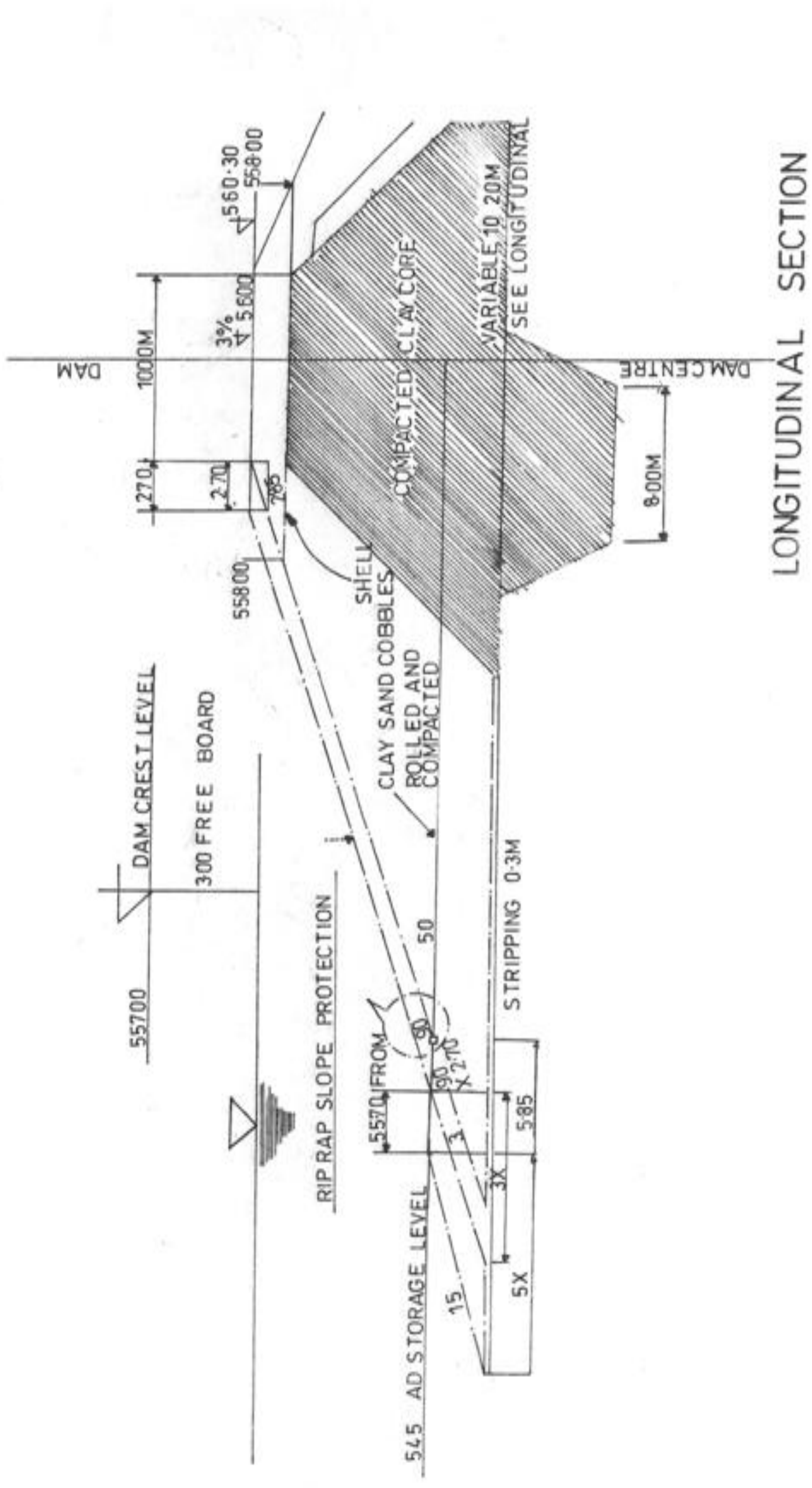

Figure 2:Cross-section of Gubi dam

Consequently in take arrangements were made, a treatment plant and pumping mains were provided. Thus the scheme with a capacity of 6,820m^3/day was put in operation on 30th may, 1980 by His Excellency the Governor of Bauchi, Late Alhaji Abubakar Tatari Ali.

The salient features of the scheme are:

(a) **The temporary dam:** this as mentioned earlier was only intended for construction purposes. The life span of the dam is only three years, but all the facilities provided can easily be removed to another dam when the main dam is ultimately commissioned.

(b) **Intake works and pumping Mains:** considering the nature of the temporary dam, the intake structure has been provided on pontoons. A total of five pumps have been installed. Four pumps working at a time discharging 340m^3/h and the fifth pump as a standby.

About three kilometer length of 300mm diameter AC raw water pumping main conveys the water to the treatment plants for purification with a 169KVA generating supplying power to the intake pumps.

(c) **Water treatment plant:** The raw water is purified in four units of the treatment plant with each unit designed to treat 85m^3/h. the raw water is mixed with chemical and then passed to a function chamber where sedimentation takes place. From this stage, the clear water is pumped for filtration. The filter media is sand of size 1.15mm thick and supported on a nozzle plate. The filtered water is disinfected with calcium hypo-chlorite solution and stored in a 1250m^3 capacity reservoir. The purified water is then pumped to the town to distribution. The power station of the treatment plant consist of two 653 KVA generator sets.

1.4 PUMPING MAIN TO TOWN

The pumps main comprise of 8.4K length of 300mm diameter DI pipeline and 200mm diameter AC pipeline one each to town centre through Ran Road and the G.R.A The treated water from Gubi dam treatment plant is conveyed to warinje hill by the help of four pumps installed in the treatment plant at pumping station. Out of four pumps, only three are now in used while the other one is kept as standby, the types of pump used in Gubi treatment plant are centrifuged pumps. Known as weir pump manufactured.

The pump has head of 152m or 15.2 bar and discharge (Q) = 1875m^3/h. the motor drive is 450 kW and 415 volt. From the pumping station the potable water is conveyed to two reservoirs at warinje hill through a steel pipe of 800 mm diameter of 12.004km length.

1.5 DISTRIBUTION SYSTEMS INTO BAUCHI ENVIRONS:

The distribution of water in Bauchi environs start from warinje reservoir. There are two reservoirs at warinje hill, each reservoir have a capacity of 11000m^3 which is equivalent to 2.million gallons of water making total of 5 million gallons. The two reservoirs at warinje hill are connected with 800mm pipe diameter. The distribution systems are classified into three zones as follows:

a) Lower north zone
b) Lower south zone
c) Upper south zone

(a) Lower north zone: this zone was connected with a 700 mm sleep pipe diameter form the reservoirs at warinje hill. This zone covers area such as Babangida square i.e Tarawa Balewa estate. Some portion of ran road down to Fadaman Mada and Maiduguri road.

(b) Lower south zone: this zone was connected with a 700 mm steel pipe diameter from the reservoirs at warinje hill which later branches into various areas at the lower south zone.
The lower zone covers area such as Bayan Ganuwa, Gombe road, Bakaro, Karolin- Madaki, Railway down to Zango area.

(c) Upper south zone: this zone was connected with 500 mm steel pipe diameter from warinje reservoirs which later spillited into different area starting from Yakubu Wanka street down to Wunti, Kobi, Gwallaga, Yan'doka road covering Wuntin Dada down to Dass road until it reach to Yelwa areas.

1.5 THE PARMANENT GUBI DAM

After the construction of the permanent Gubi dam, it was commissioned in 1981. The permanent dam consist of the following features

(1) The embankments of the dam which has length of 3.86km and bottom earth-fill of 2,315, 000m^3 with a reservoir area of 590 hectares the catchments area is 179km^2 with total storage capacity of 38.4 x 106m^3, the expected yield from the reservoir is 90,000m^2/d.
(2) The clarifier: The treatment plant consist of three clarifiers, each clarifier contains sedimentation tank and flocculation tank
(3) The chemical Building
(4) The filters: The treatment consists of six different filters. The filters are rapid sand gravity types of filter.
(5) The chlorination building
(6) Elevated tank
(7) The pumping station Details of the above feature, see figure below

Figure3: View of control well in Gubi dam treatment plant

Figure 4: View of Gubi dam water intake point

Figure 5: View of Embankment of Gubi dam

Figure 6: View of Gubi dam Treatment Plant

II. LITERATURE

2.1 RESERVOIR

The basic purpose of impounding reservoir is to hold runoff during period of high runoff, and release it during period of low runoff; the specific functions of reservoir are hydroelectric flood control, irrigation, water supply and recreation. Many large reservoirs are multipurpose.

The use of reservoir for temporarily storing stream flow often results in a net loss of total stream flow due to evaporation and seepage. While these losses may not be desired the benefits derived from regulation of water supplies from flood water storage, from hydroelectric power and from any recreational activities at the reservoir site may offset the hydrologic losses and the cost of reservoir storage capacity can be divided among three(3) major uses:-

(i) The active storage used stream flow regulation and for water supply.
(ii) The dead storage required for sediment collection, recreational development hydropower production.
(iii) The flood storage capacity reservoir to reduce potential downstream flood damage in the design of storage reservoir to serve as a water supply system for any community, it has been further recommended that judgment be based on the equalizing or operating storage which can be read from a demand curve during 12 and 24 hours respectively. The total amount storage is desirably equal to the sum of the component requirement which include domestic, industrial and commercial, public uses fire demand losses e.t.c Augustine (1997).

2.2 Consumption of water for various purposes

The total water supply of a city is usually classified according to its ultimate use or end use. The uses are:

(a) **Domestic:** These include water furnished to houses, hotels etc, for sanitary, culinary, drinking, washing, bathing and other purposes. It varies according to living condition of consumers the range usually being considered as 75 to 380L (20 to 100 gal) per capita per day, averaging 190 to 340L (50 to 90 gal) per capita. These figures include air conditioning of residences and irrigation or sprinkling of privately owned gardens and lawns, a practice that may have a considerable effect upon total consumption in some part of the country. The consumption in domestic may be expected to be about 50% of the total in the average city; but where the total consumption is small, the proportion will be much greater.

(b) **Commercial and Industrial:** Water so classified as above is that furnished to industrial and commercial plants. Its importance will depend upon local condition such as the existence of large industries and whether or not the industries patronize the public water works. proposes the quantity of water required for a commercial and industrial use to be an average of $12.2m^3/100m^2$ of floor area per day Linsley al etal (1995).

(c) **Public Use:** Public building such as city jails and schools, as well as public service flushing streets and fire protection-require much water for which usually, the city is not paid such water amount to 50-75L per capita per day. The actual amount of water used for extinguishing fires does not figure greatly in the average consumption but very large fires will cause the rate of use to be high for short periods.

(d) **Loss and Waste**: This water is sometimes classified as "un accounted for" although some of the loss of the loss and waste may be accounted for in the sense that its cause and amount are approximately known. Unaccounted for water is due to meter and pump seepage, unauthorized water connections and leaks in mains. It is apparent that the unaccounted for water and also waste by customers can be reduced by careful maintenance of the water system and by universal metering of all water services.

(e) **Agricultural Water Use:** Water is used in agriculture for irrigation, as the world population is growing high, the demand for agricultural raw materials and food is also increasing. The world is involved in agriculture to feed its teeming population and to supply raw materials for agro-industries. It has been noted that on global level 13 percent of the available lands are under irrigation, using 1.4 million cubic metres of water per annum. These indicate that irrigation is one of the largest users of water. However, from review of water quality data as well as visual inspection of many streams, rivers, and lakes, diffuse source of pollution from agriculture has not been adequately controlled and has constituted a threat to water sources Novetny and Harvey (1994).

(f) **Recreational uses:** The world is currently experiencing a period of rapid recreational development. Public and private agencies are attempting to meet a growing demand for recreation by building new facilities and modifying old ones Michael and Clerk (1977). Often, plans for new or modified recreation facilities are centred on bodies of water that are used for water supply purposes. Multipurpose reservoirs, long desired by the recreation oriented segment of the public are becoming more and more common, especially in areas where creating new lakes or using existing ones solely for recreational activities is either physically or economically impractical.

(g) **Fishing pond uses:** Several ponds are made along with the reservoir for water supply to serve or allocated for conservative purposes such as fishing purposes. Water can also be used for wild life conservation such as Yankari Game Reserve.

III. METHODOLOGY

Data collection has been carried out to observe the effect of rainfall on seasonal variation of reservoir in Gubi treatment plant for Bauchi township water supply source. These include:

(1) Discharge record of Gubi dam.
(2) Data on important design features of the dam embankment and reservoir
(3) Rainfall data of Bauchi township
(4) MINI TAB R14 Software

3.1METHOD OF ANALYSIS

The analysis begins with setting all the data's in the computer for the mean monthly draw down/rise in the reservoirs from 1997 to 2003 of the dependent variables and the independent variables as X_1 for mean monthly rainfall as shown in Appendix 1and 2 below. In the method of analysis the software used is polymath and Mini-Tab under regression analysis the total number of sample i.e. (N) is 84 samples from the period of 1997 to 2003.

The source of data was obtained as follows:

1. Gubi dam reservoir: water level changes through Gubi dam daily records of water level reservoir in Bauchi Township carried out by their staff.
2. Hydrological data of rainfall through Bauchi airport which was obtained by their staff in meteorological centre at Bauchi airport.

3.2 DISCHARGE RECORDS OF GUBI DAM

Daily water level recording from Gubi dam reservoir obtained from Bauchi state water board showed the level of water for the period of 1997 to 2003. According to the information, the dam was established and operated in 1981 and has been the main source of water supply to the people of Bauchi township but no record of daily reservoir level since then until 1997. Where records are been kept. The values of draw down and rise in the reservoir are calculated from the daily reservoir level record as shown in Appendix 1.There is a rise in reservoir from period of May-Sept

IV. ANALYSIS OF RESULTS AND DISCUSSION

The regression analysis is applied to the research work in order to observe the effect of rainfaff on the reservoir raise for the water supply in Bauchi Township. In this research, the analyses begin with the identification of all the dependent variable and independent variables.
The dependent variable is the change/rise in the reservoir for the period of 1997 to 2003 while the independent variable is the rainfall for the same period that is 1997 to 2003.
From the previous equation that is equation.
(i) $Y = ax_1 + a_0$……………………………………………15
Where Y = dependent variables, while X, is independent variable and a, is constant.
From the equation above, the change in reservoir level take the dependent variable that is Y value, while X_1= Rainfall
The value of a is constants which can be determined by the method of least square.

Regression Analysis: Y versus X2
The regression equation is
Y = 556 - 13.4 X2

Predictor	Coef	SE Coef	T	P
Constant	555.998	0.137	4059.70	0.000
X2	-13.43	10.55	-1.27	0.207

S = 0.9088 R-Sq = 1.9% R-Sq (adj) = 0.7%
Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	1.3367	1.3367	1.62	0.207
Residual Error	82	67.7198	0.8259		
Total	83	69.0566			

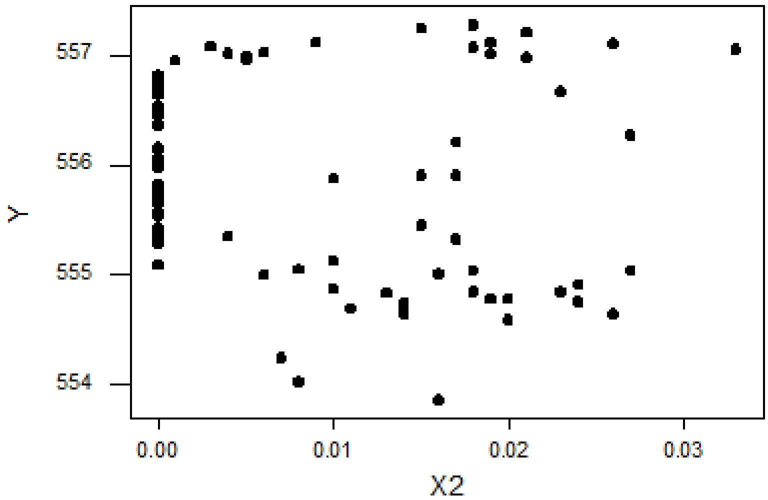

Figure 7: A line fit plot of mean monthly draw down/ rise with mean monthly rainfall

Regression Analysis: Y versus X3

The regression equation is
Y = 557 - 99.8 X3

Predictor	Coef	SE Coef	T	P
Constant	556.626	0.227	2449.79	0.000
X3	-99.82	27.64	-3.61	0.001

S = 0.8524 R-Sq = 13.7% R-Sq(adj) = 12.7%

Analysis of Variance

Source	DF	SS	MS	F	P

Regression	1	9.4766	9.4766	13.04	0.001
Residual Error	82	59.5799	0.7266		
Total	83	69.0566			

V. CONCLUSION

The Research work observed the source of water supply for Bauchi Township which was source from Gubi dam and mainly coming from three tributaries, namely Gubi River, Tagwaye river link with Shadawanka and Ran River. The embankments of the dam which has length of 3.86km and bottom earth-fill of 2,315, 000m^3 with a reservoir area of 590 hectares the catchments area is 179km^2 with total storage capacity of 38.4 x 106m^3, the expected yield from the reservoir is 90,000m^2/d. The water level in the reservoir varies seasonally due to climatic changes; the research observed the effect of rainfall on reservoir variation but the effect of rainfall is not much significant according to the result obtained.

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APENDIX 1

MONTHLY DRAW DOWN AND RISE

IN RESERVOR LEVEL (GUBI DAM)

Year /Month	**Reservoir water level (Gubi) masl**	**Monthly Draw down (m)**	**Monthly Rise up (m)**	**Mean Monthly Draw Down (m)**	**Mean Monthly rise (m)**
1997					
Jan					
Feb	555.648				
Mar	555.642				
Apr	555.359				
May	554.860				
Jun	554.702				
Jul	554.681				
Aug	554.826				
Sep	556.660		0.413	0.021	0.021
Oct	557.051	0.992		0.052	
Nov	557.015	0.201		0.007	
Dec	556.798	0.413		0.021	
	556.530				
1998					
Jan		0.247		0.021	
Feb	556.132	0.033		0.033	
Mar	555.814	0.062		0.009	
Apr	555.700	0.998		0.083	
May	555.344		0.098		0.014
Jun	554.530	0.048		0.007	
Jul	554.836		1.036		0.148
Aug	554.841		2.800		0.257
Sep	556.231	0.040		0.006	
Oct	557.259	0.370		0.046	
Nov	557.070	0.037		0.037	
Dec	556.738	0.322		0.022	
	556.445				

APPENDIX 1 (CONT)

MONTHLY DRANN DOWN AND RISE

IN RESERVOIR LEVEL (GUBI DAM)

Year/Month	Reservoir water level (Gubi) masl	Monthly Draw Down (m)	Monthly Rive up (m)	Mean month Draw Down (m)	Mean Monthly Rise up (m)
1999					
				0.035	
Jan	556.043	0.588		0.021	
Feb	555.681	0.396		0.015	
Mar	555.285	0.212		0.018	
Apr	554.014	0.274		0.012	
May	554.776	0.211		0.012	
Jun	554.587	0.243			
Jul	555.439		2.597		0.130
Aug	557.194	0.319		0.032	
Sept	557.096	0.030		0.002	
Oct	557.110	0.420		0.030	
Nov	556.814	0.286		0.014	
Dec	556.500	0.336		0.015	
2000					
Jan	556.146	0.280		0.018	
Feb	555.766	0.432		0.022	
Mar	555.414	0.496		0.025	
Apr	555.124	0.226		0.013	
May	554.780	0.333		0.017	
Jun	554.747		0.175		0.012
Jul	555.004		1.348		0.135
Aug	557.011		0.860		0.043
Sept	557.064		0.080		0.004
Oct	556.977	0.239		0.011	
Nov	556.745	0.247		0.012	
Dec	556.526	0.172		0.016	

APPENDIX 1(CONT)

Year/Month	Reservoir water level (Gubi) masl	Monthly Draw Down	Monthly Rise up (m)	Mean Monthly Draw Down (m)	Mean Monthly Rise up
2001					
Jan	555.968	0.218			
Feb	555.728	0.283		0.010	
Mar	555.383	0.372		0.018	
Apr	554.992	0.347		0.019	
May	554893			0.019	
Jun	555.038		0.004		0.002
Jul	556.204		0.870		0.046
Aug	557.277		1.286		0.061
Sept	557.243	0.250	0.145		0.006
Oct	556.938	0.210			
Nov	556.635	0.355		0.022	
Dec	556.348	0.223		0.010	
				0.017	
2002				0.014	
Jan	556003				
Feb	555.527	0.442			
Mar	555.089	0.459			
Apr	554.639	0.385		0.021	
May	554.231	0.476		0.024	
Jun	553.852	0.322		0.021	
Jul	554.742	0.319		0.024	
Aug	555.319			0.017	
Sept	556.968		0.762	0.020	0.035
Oct	556.962	0.206	1.591		0.072
Nov	556.690	0.234	0.572		0.027
Dec	556.363	0.382			
				0.009	
2003				0.012	
Jan	556.136	0.335		0.021	
Feb	555.554	0.370		0.019	
Mar	555.281	0.144		0.018	
Apr	555.048	0.121			
May	554.900		0.605		
Jun	555.026	0.162			
Jul	555.867	0.242			
Aug	555.891	0.365			
Sept	557.114		0.788	0.007	0.039
Oct	557.012		0.274	0.008	0.016
Nov	556.737		0.036	0.014	0.002
Dec	556.452		0.040	0.018	0.002

APPENDIX 2

DEPARTMENT OF METEO ROLOGICAL SERVIE

BAUCHI AIRPORT

MEAN MONTHLY RAINFALL (METRES)							
MONTH	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
JAN	0.000	0.000	0.000	0.000	0.000	0.000	0.000
FEB	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MAR	0.000	0.000	0.000	0.000	0.000	0.000	0.000
APR	0.010	0.004	0.008	0.010	0.006	0.026	0.008
MAY	0.014	0.014	0.019	0.020	0.017	0.007	0.024
JUN	0.011	0.018	0.020	0.024	0.018	0.016	0.027
JUL	0.013	0.023	0.015	0.016	0.017	0.014	0.010
AUG	0.023	0.027	0.021	0.019	0.018	0.017	0.015
SEP	0.033	0.018	0.026	0.018	0.015	0.021	0.019
OCT	0.006	0.003	0.009	0.005	0.001	0.005	0.004
NOV	0.000	0.000	0.000	0.000	0.000	0.000	0.000
DEC	0.000	0.000	0.000	0.000	0.000	0.000	0.000

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Correlation Between Entry Velocity, Pressure Drop And Collection Efficiency In A Designed Stairmands Cyclone.

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Abstract: - Three non physical parameters are of interest in an assessment of the design and performance of a cyclone. These parameters are inlet velocity, pressure drop and collection efficiency of the cyclone. An accurate prediction of cyclone pressure drop is very important as it relates directly to operating costs. Variation of entry velocities to the cyclone results in variable collection efficiencies for a given cyclone, with a decrease or increases in the pressure drop across the cyclone. An experimental rig comprising a micromill connected to a Stairmands high efficiency cyclone and toasted soyabean of moisture content 9.05% db was employed in this study. Entry velocity was varied from 9.15 to 24.08m/s with corresponding particle collections noted, and pressure drop across the cyclone investigated. Analysis of the data generated revealed that higher resulted to velocities give higher collection efficiencies to a certain level for the cyclone, though this increased the pressure drop across the cyclone. A correlation study of the entry velocities, pressure drops and collection efficiency was carried out and the results analyzed. The correlation coefficient showed that for a given pressure drop determined by entry velocity, collection efficiency can be predicted.

Keywords: *- Correlation coefficient, Cyclone, Inlet velocity, Pressure drop, Particle collection efficiency*

I. INTRODUCTION

Cyclones are devices that employ a centrifugal force generated by a spinning gas stream to separate particles from the carrier gas (Gimbun et al., 2005). Fluid mixture enters the cyclone and makes a swirl motion and, due to centrifugal force, the dense phase of the mixture gains a relative motion in the radial direction and is separated from main flow (Avci and Karagoz, 2003). Cyclone separators are the simplest and least expensive dust collection devices for industrial air pollution control. Operation and maintenance are simple because they have no moving parts. Cyclone collection efficiencies can reach 99 % for particles bigger than 5 µm, and can be operated at very high dust loading(Cooper and Alley, 2002).. Cyclones are used for the removal of large particles for both air pollution control and process use (Silva et al.,2003). Application in extreme condition includes the removing of coal dust in power plant, and the use as a spray dryer or gasification reactor (Gimbun, 2005). Engineers are generally interested in two parameters in order to carry out an assessment of the design and performance of a cyclone. These parameters are the collection efficiency of particle and pressure drop through the cyclone (Dirgo and Leith, 1985).

An accurate prediction of cyclone pressure drop is very important because it relates directly to operating costs. Higher inlet velocities give higher collection efficiencies for a given cyclone, but this also increases the pressure drop across the cyclone (Griffiths and Boysan, 1996). The vortex finder size is an especially important dimension, which significantly affects the cyclone performance as its size plays a critical role in defining the flow field inside the cyclone, including the pattern of the outer and inner spiral flows. The vortex finder affected the collection efficiency and pressure drop of cyclones, and proposed an energy-effective cyclone design (Lim et al., 2003). The efficiency of cyclone systems is a function of geometric, operating parameters as well as the particle size distribution (PSD) of entrained dust and the velocity of the air stream entering the abatement device (Wang et al., 2000). The particle size distribution of most aerosols can be described by a log-normal distribution (Hinds, 1999). A study by Ter Linden on efficiency and pressure drop characteristics of cyclone revealed that efficiency of cyclone is affected by variation of cyclone geometric parameter (diameter) up to a certain range.

With the foregoing, the geometric influence on the efficiency can be checked by choosing and fixing optimal geometric parameters of a cyclone so as to allow the study of the effect of non physical and operating parameters. However, the relationships among these variable quantities have not been fully established. This work therefore, attempts to correlate inlet velocity, pressure drop and collection efficiency. The overall aim is to establish a data template from the correlation studies which will guide designer in predicting and making sound judgment on the parameters for an optimal performance and efficient cyclone. Randomizations, trial and error often used by designers are further eliminated.

II. MATERIALS AND METHODS

The Stiarmand's high efficiency cyclone used had; diameter (D) = 300mm; entry height = gas exit diameter = vortex finder = 0.5D; body length = 1.5D; width = 0.2D; cone length = 2.5 D and dust outlet diameter = 0.375D. The experiment was carried out in normal conditions of temperature and humidity ($30^oC \pm 2\ ^oC$ and 70 -76% RH). The pitot tubes and manometers used were fabricated locally and impeller angular speeds were limited to ten (with equal increments of 250rpm) starting from 1500rpm. Toasted soya bean of moisture content 9.05% (db) was reduced to dust (flour) in a cycle time of 10 minutes using a micro-mill. The dust was delivered to the cyclone via a blower and Perspex pipe with consequent monitoring of the flow of air and dust through the different segments of the cyclone using calibrated Pitot pipes to which manometers were attached(See set up).

Fig 1: Complete assembly of experimental rig

Toasted soya bean of moisture content 9.05% (db) weighing 2kg was used for material loading for each of the specified speeds. It was fed into the micro-mill at steady state speed and the crushed powders were collected from the cyclone dust hopper. This continued until no more flour is collected at the collection point and the experiment was repeated with the various speeds and data collected. The pitot- static tubes were mounted on 11 points along the cyclone and they were each oriented to the airflow direction. The test rig was run at speeds ranging from 1500 rpm to 3750 rpm on load basis and velocity distribution across the system was recorded. The pressure drop across the cyclone at load basis was also determined by subtracting exit pressure from entry pressure**.** Graphs were plotted for varying parameters and correlation coefficients determined using MICROSOFT EXCEL 2007

III. RESULTS AND DISCUSSION

Table 1: Determination of Pressure Drop

S/No	Rpm	Inlet		Exit		Inlet pressure ($p_a + \rho g\delta h$), n/m^2	Exit pressure ($p_a + \rho g\delta h$), n/m^2	Pressure drop P_{entry}-P_{exit} (N/m^2)
		V(m/s)	**Δh(m)**	**V(m/s)**	**Δh(m)**			
1	1500	9.15	3.72	3.43	1.13	101369.32	101338.46	30.86
2	1750	10.22	4.32	6.73	2.51	101376.47	101354.90	21.57
3	2000	11.37	5.03	8.04	3.13	101384.93	101362.29	22.64
4	2250	14.26	7.04	9.72	4.03	101408.87	101373.01	35.86
5	2500	17.14	9.38	10.98	4.78	101436.75	101381.95	54.80
6	2750	19.08	11.15	12.68	5.90	101457.84	101395.29	62.55
7	3000	18.79	10.87	13.86	6.74	101454.51	101405.30	49.20
8	3250	19.30	11.36	15.74	8.20	101460.34	101422.69	37.65
9	3500	21.72	13.79	16.45	8.79	101489.29	101429.72	59.57
10	3750	24.08	16.40	16.94	9.21	101520.39	101434.73	85.66

(Source: Oriaku, 2013)

Δh (m) = Entry and Exit pressure head

Collection efficiency was obtained by dividing the mass of particles collected by the total mass of sample fed into the system and multiplying the result by 100. The values obtained are shown in Table 2.

Table 2: Collection efficiency of the cyclone

S/no	Speed (rpm)	Mass of crushed particle collected(kg)	Efficiency of collection (%)
1	1500	1.41	70.34
2	1750	1.56	78.07
3	2000	1.80	89.80
4	2250	1.85	92.70
5	2500	1.88	93.80
6	2750	1.84	91.95
7	3000	1.76	88.16
8	3250	1.68	84.22
9	3500	1.55	77.38
10	3750	1.28	64.22

(Source: Oriaku, 2013)

Table 3: Entry Velocity, Pressure Drop and collection efficieny

S/No	**RPM**	**Entry Velocity(m/s)**	**Pressure drop**(N/m^2)	**Collection efficiency** (%)
1	1500	9.15	30.86	70.34
2	1750	10.22	21.57	78.07
3	2000	11.37	22.64	89.80
4	2250	14.26	35.86	92.70
5	2500	17.14	54.80	93.80
6	2750	19.08	62.55	91.95
7	3000	18.79	49.20	88.16
8	3250	19.30	37.65	84.22
9	3500	21.72	59.57	77.38
10	3750	24.08	85.66	64.22

(Source: Oriaku, 2013)

Table 4: Velocity Index, Pressure Index and Particle collection efficiency

RPM	Entry Vel. (V_E M/S)	Terminal Vel. (V_c m/s)	Entry Velocity Index(V_{iE})	Pressure Index (Z_E)	Collection Efficiency (∫/100)
1500	9.15	3.23	10.04	0.62	0.7034
1750	10.22	6.72	23.34	0.35	0.7807
2000	11.37	8.43	32.57	0.29	0.8980
2250	14.26	10.21	49.47	0.30	0.9270
2500	17.14	11.19	65.17	0.31	0.9380
2750	19.08	13.33	86.42	0.29	0.9195
3000	18.79	15.72	100.37	0.23	0.8816

3250	19.30	17.07	111.94	0.17	0.8747
3500	21.72	18.49	136.46	0.21	0.7738
3750	24.08	19.78	161.84	0.30	0.6422

(Source: Oriaku, 2013)

Where $\mathbf{V_{iE}}$ and $\mathbf{Z_E}$ were generated using dimensional analysis as stipulated by Walton 1974 in the equation;

$$l_s = f\left(\frac{v_i\tau}{D}, Z_E\right) = f\left(\frac{v_i\tau}{D}, \frac{\Delta P}{\rho\frac{v_i^2}{2}}\right) \qquad (1)$$

Z_E is a constant for a given type of cyclone

The correlation coefficient equation given below is used to determine the correlation coefficient in Table 5`

$$\text{Correlation (r)} = \frac{N\sum XY - (\sum X)(\sum Y)}{[(N\sum X^2 - (\sum X)^2)(N\sum Y^2 - (\sum Y)^2)]^{1/2}} \qquad (2)$$

Where N = Number of values of elements (data points)

X = First data

Y = second data to be correlated

$\sum XY$ = Sum of the product of 1st and 2nd data

$\sum X$ = sum of 1st data

$\sum Y$ = Sum of second data

$\sum X^2$ = sum of squares 1st score

$\sum Y^2$ = sum of square 2nd scores.

Table 5: Correlation Coefficient

	Entry Vel. (E)	Pressure Drop (PD)	Terminal Velocity(T)	Velocity Index (VI)	Pressure Index (PI)	Collection Efficiency,ʃ
Entry Vel. (E)						
Pressure Drop (PD)	0.8842					
Teminal Velocity(T)	0.9688	0.7574				
Velocity Index (VI)	0.9786	0.8365	0.9816			
Pressure Index (PI)	-0.6527	-0.2825	-0.7703	-0.6398		
Collection Efficiency,ʃ	-0.1070	-0.2914	-0.0874	-0.2477	-0.4252	

(Source: Oriaku, 2013)

Table 6: Correlation coefficients of Entry Velocity, Velocity Index, Pressure Index and Collection Efficiency

	Entry Vel. (E)	Velocity Index (VI)	Pressure Index (PI)
Velocity Index (VI)	0.9786		
Pressure Index (PI)	-0.6527	-0.6398	
Collection Efficiency,ʃ	-0.1070	-0.2477	-0.4252

(Source: Oriaku, 2013)

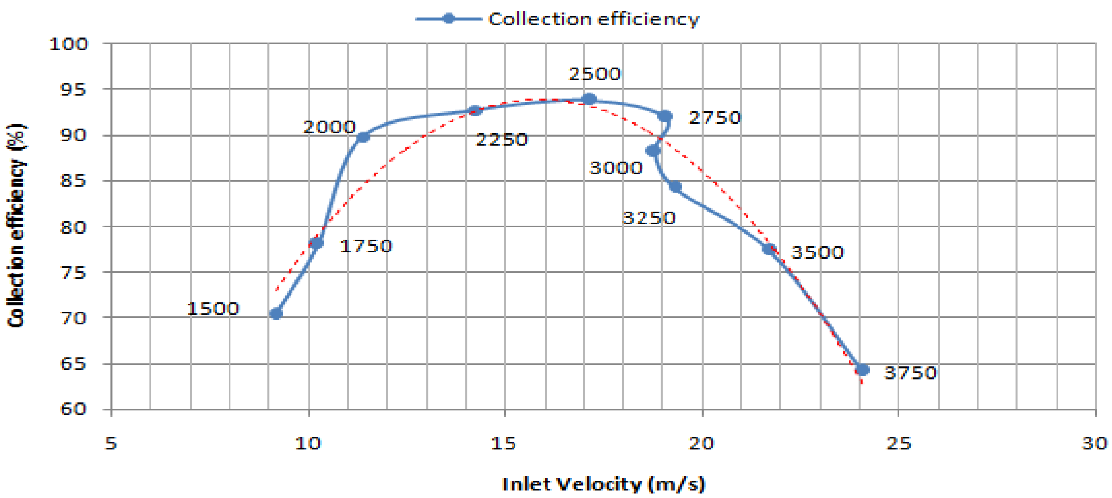

Fig 2: Collection efficiency versus Inlet velocity

$Y = -0.462x^2 + 14.67x - 22.50 \qquad (R^2 = 0.926) \qquad (3)$

The plot (Fig 2) shows the relationship between collection efficiency and inlet velocity for the various speeds employed in the cyclone. It can be seen that this relationship is best described by a quadratic function with R^2 values of 0.926 as given in equation 3. It can be deduced that as speed was increased the inlet velocity increased with attendant increase in particle collection. This trend continued until 2500rpm speed which had the highest collection percentage. From this point, further increase in speed resulted in decrease in particle collection percentage. This is similar to what was obtained by Zhao 2006 where it was reported that efficiency was found to be less significant with increase in velocity.

Fig 3 and 4 showed the relationships between inlet and exit pressure and collection efficiency and it was observed that they followed a similar trend to that obtained for inlet velocity. This can be said to show that pressure is dependent on the velocity in a high efficiency cyclone. The result is similar to what was reported by researchers such as Xiang *et al.*, 2001 and Baker and Hughs, 1999. The highest value of particle collection with respect to the inlet and exit pressure was also obtained at speed of 2500rpm.

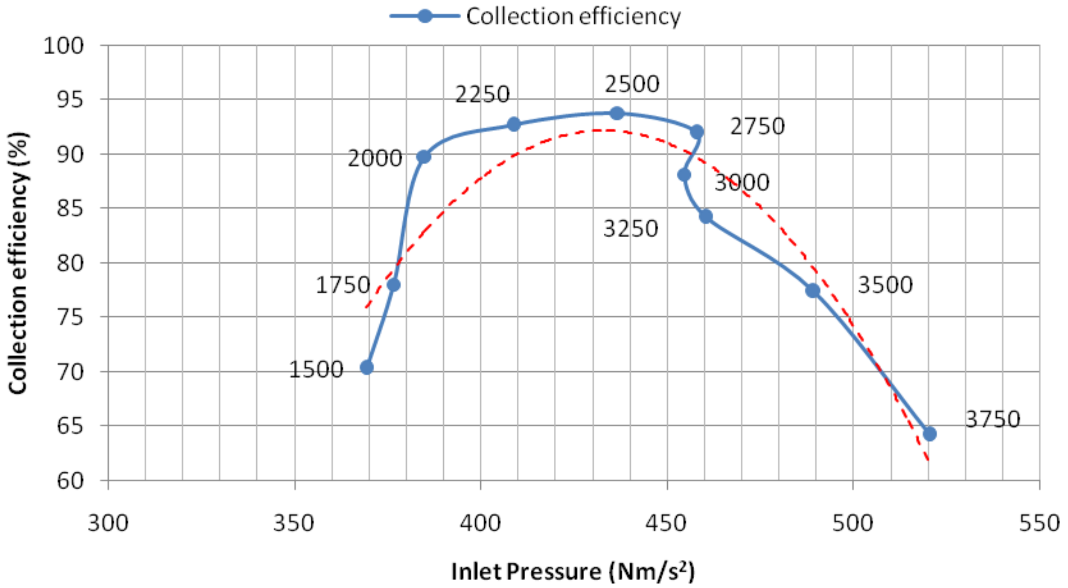

Fig 3: Collection efficiency versus Inlet Pressure

$Y = -0.004x^2 + 3.465x - 658.3$ ($R^2 = 0.853$) (4)

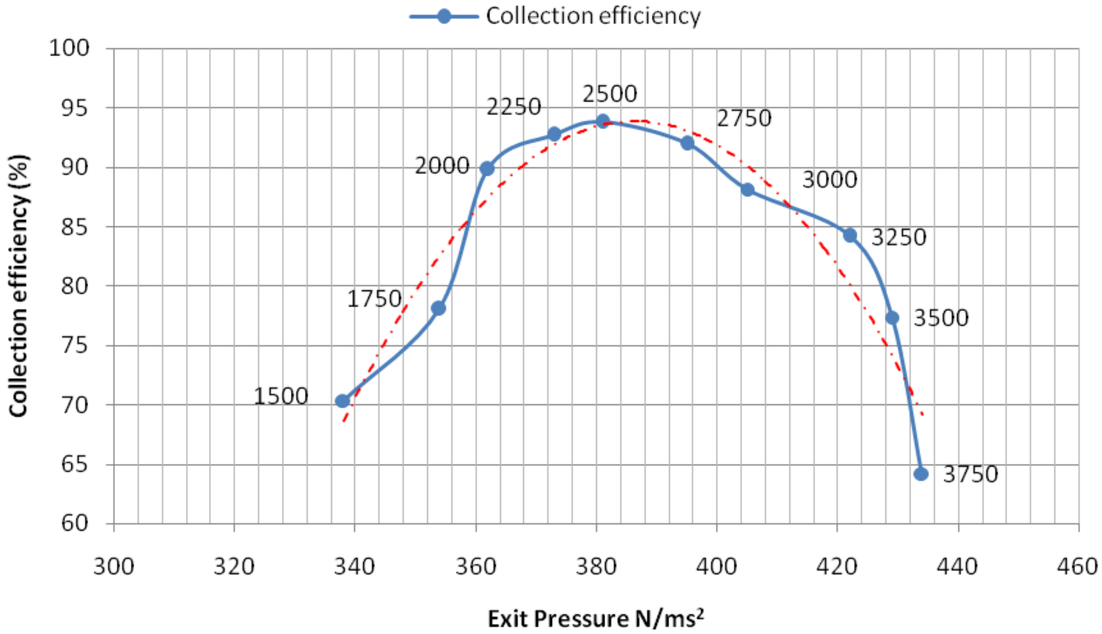

Fig 4: Collection efficiency versus Exit Pressure

$Y = -0.010x^2 + 8.362x - 1521.$ ($R^2 = 0.906$) (5)

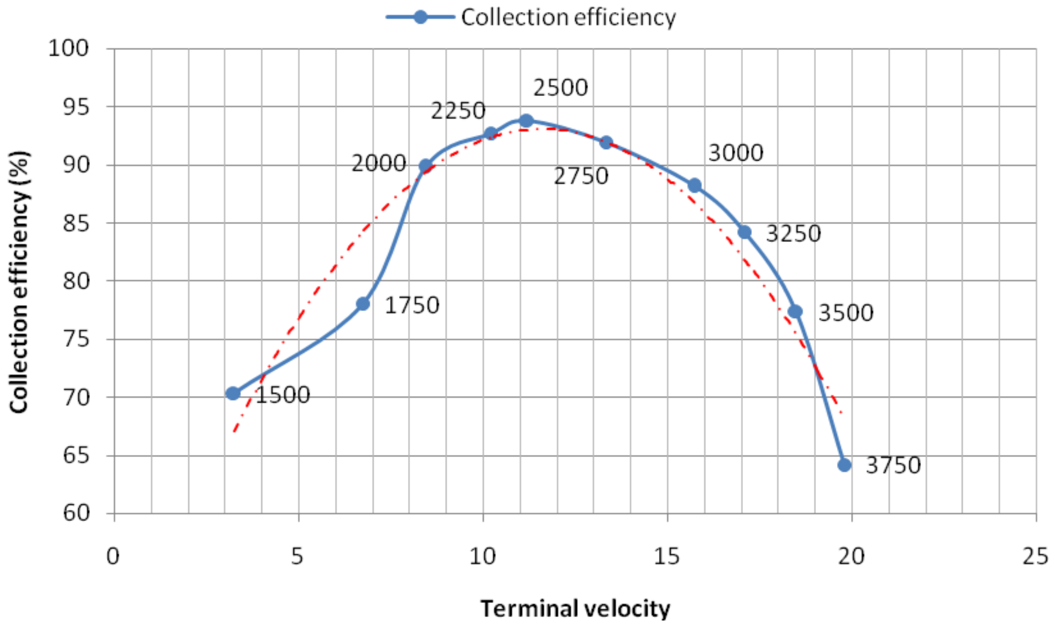

Fig 5: Collection efficiency versus terminal velocity

Y = $-0.371x^2 + 8.622x + 43.13$ ($R^2 = 0.918$) (6)

Fig 5, shows the plot of collection efficiency against particle terminal velocity. This was also best described by a quadratic function as shown in equation 6. It can be seen that the terminal velocity tended to decrease in almost equal values. This is an indication that further increase in speed beyond 2500rpm affected particle collection negatively.

From equation 1, after pressure index and velocity index have been determined dimensionally, the pressure index is held constant and values generated are plotted against collection efficiency and the graph is shown in Fig 6. The plot exhibited similar trend with previous plots and was also defined by a quadratic function.

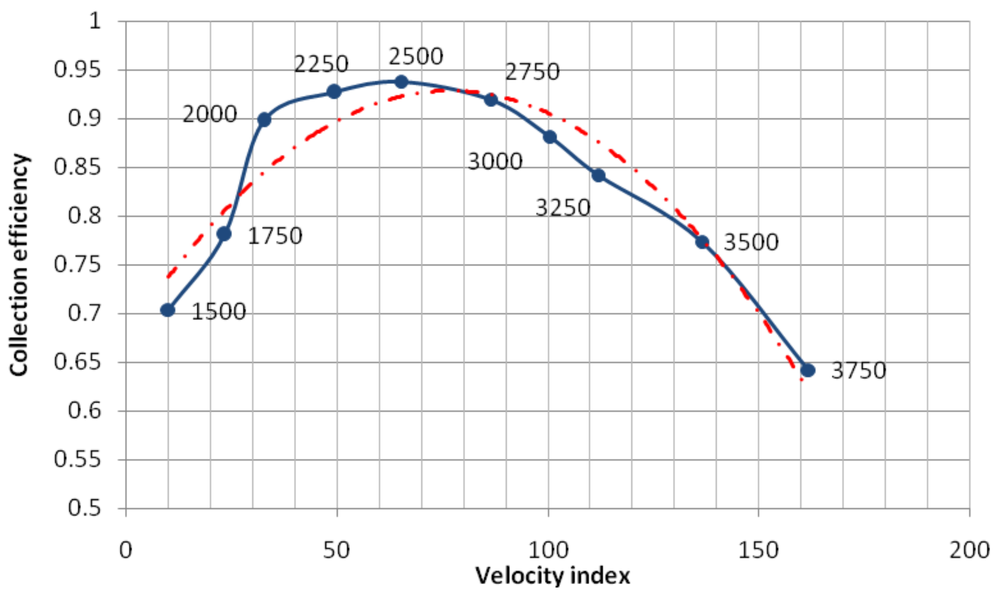

Fig 6: Collection efficiency versus Velocity Index

Y = $-4E\text{-}05x^2 + 0.006x + 0.675$ ($R^2 = 0.913$) (7)

IV. CONCLUSION

Form the results obtained it can be concluded that the relationship that exists between particle collection efficiency and the observed variables (inlet velocity, inlet and exit pressures and terminal velocity) is quadratic with R^2 values in the range of 0.853 to 0.926. This implies that for the designed high efficiency cyclone, when pressure drop is constant, the collection efficiency can be calculated for a given range of inlet velocities. The correlation was consistent in trend and showed that increase in velocity or pressure usually results in increase in particle collection up to a given point (often referred to as saltation) where further increase in these variables yields decrease in particle collection

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Design and Performance Evaluation of a Corn De-Cobbing and Separating Machine

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Abstract: - Agricultural products like maize, soya bean, millet and rice, when processed into quality forms not only prolongs the useful life of these products, but increases the net profit farmers make from mechanization technologies of such products. One of the most important processing operations done to bring out the quality of maize is de-cobbing or threshing of maize. Consequently, a de-cobbing and separation machine was designed, fabricated and its performance evaluated. Corn at moisture content of 15.14% db sourced locally was used in the experiment and the data collected were analyzed. Results showed that for a total 20kg of sample tested, the average feed and threshing time were 2.37 and 2.95 minutes respectively. The average feed and threshing rates were 2.06 and 1.65 kg/min with an average threshing efficiency of 78.93 %. The average separation efficiency was 56.06 %. These results indicate that threshing and separation can be performed out satisfactorily with the designed machine and it can be used to process about 1 tonne of maize per nine-hour shift.

Keywords: *- Maize, Separation, Efficiency, De-cobbing, Design*

I. INTRODUCTION

Maize, the American Indian word for corn, means literally that which sustains life. It is, after wheat and rice, the most important cereal grain in the world, providing nutrients for humans and animals and serving as a basic raw material for the production of starch, oil and protein, alcoholic beverages, food sweeteners and, more recently, fuel. In Africa, maize has become a staple food crop that is known to the poorest family. It is used in various forms to alleviate hunger, and such forms include pap or ogi, maize flour etc. It is because of the importance of maize that it’s processing and preservation to an optimum condition must be analyzed. The major steps involved in the processing of maize are harvesting, drying, de-husking, shelling, storing, and milling. For the rural farmers to maximize profit from their maize, appropriate technology that suites their needs must be used. The processing of agricultural products like maize into quality forms not only prolongs the useful life of these products, but increases the net profit farmers make from mechanization technologies of such products. One of the most important processing operations done to bring out the quality of maize is shelling or threshing of maize.

In Nigeria maize constitute the staple food of large chunk of the populace. It is also responsible for about 60% by weight of most of livestock feed formulations. Peasant farmers are responsible for more than 70% of the maize produced annually while large scale commercial farmers constitute the remaining 30% (Adewumi, 2004). The problems of post harvest processing and storage of agricultural produce are well documented and various approaches are being employed in tackling it. For maize one of its post harvest challenges is shelling. Kaul and Egbo, 1985 reported that maize harvested are traditionally shelled by hand or by beating sacs stuffed with maize cobs with wooden flails. These traditional methods of shelling maize are time wasting, hazardous and associated with lots of drudgery. They also described shelling as a process of repeated pounding or dragging of plant mass over a surface through an aperture. Akubuo, 2003 described the use of pestle and mortar as a process by which the dry maize is put into the mortar and pestle is used to hit the maize with impact forces. A considerable quantity of shelling is achieved per time but the amount of grain damage is high with low cleaning efficiency (Ologunagba, 2003).

There have been various means of shelling starting from the traditional pestle and mortar to the various mechanical and electro-mechanical devices. The use of ‘cone’ sheller was reported by Kaul and Egbo, (1985), the sheller consists of a cone with three to four lines of serrated ribs. The dehusked cob is rotated in the cone by one hand while the Sheller is held in the other hand rotating the cob against the internal rib of the Sheller to detach the grain from the cob. Adewale, et al (2002) and Adegbulugbe, (2000) established that shelling process is a function of moisture content. It is easier to shell maize dry than wet. Adewale et al (2002) also reported that the local techniques of shelling and winnowing of shelled maize is grossly inefficient judging by the serious bruises encountered by the crops. There are many types of maize shellers, but the motorized shellers are either imported or locally fabricated by local welders who have no knowledge of both the machine and crop parameters suitable for optimum performance of the shelling machines (Adewumi, 2004). Maize can also be dehusked and shelled but this is with a lot of kernel damage at the end of the processing operation (Adesuyi, 1983). Other types of devices used for shelling mechanism are cross flow rasp bar, axial flow rasp bar and spike tooth cylinder. A spike tooth cylinder is more positive in feeding than rasp bar cylinders with the added advantage that, it does not plug in easily. While rasp bars are easier to adjust and monitor and are relatively simple to operate and durable. The efficiency of shelling machines varies from one machine to the other as affected by some factors like the crop moisture content, feeding rate, shelling mechanism and the concave cylinder clearance (Adewale et al, 2002).

II. MATERIALS AND METHODS

Machine Description: the designed machine consists of the following components namely:

- Peforated de-cobbing barrel
- Shaft with spikes
- Bearings
- Barrel cover
- Inlet hopper
- Maize discharge spout
- Cob discharge spout
- Blower
- Blower mounting
- Structural frame work
- Electric motor
- Pulleys
- V-belts
- Keys and key sets
- Body cover
- Belt cover
- Air flow channel
- Bolts and nuts
- Hinges: locking device

The shaft carrying the spikes is suspended on two ball bearings. The spikes are arranged in spiral form (like a screw conveyor) with a uniform pitch. The bearings carrying the shaft are mounted on the structural frame work. The barrel cover carrying the inlet hopper houses the de-cobbing cylinder. The throat of the inlet hopper fits into a square hole created at one end of the de-cobbing cylinder. Both the barrel cover and de-cobbing barrel are static. The barrel is split into two halves but held at one side with hinges so that it can be opened and closed. The free end of the cover is provided with a locking device. The electric motor is mounted at one lower end of the structural frame. The assembled blower is mounted opposite to the electric motor. The air exit channel of the blower is connected against the maize exit spout. V-belts are used to connect the shaft carrying the spikes, the blower shaft to electric motor shaft via pulleys. All the components of the machine are mounted on a rigid structural frame work. The surface area of the de-cobbing barrel is perforated with a 12mm hole so that the de-cobbed maize grains and chaff can escape through them and fall to the collector that channels them to the maize exit spout. The assembled machine has the following dimensions: overall length = 1.28m; width = 0.92m; height = 1.39m; diameter of barrel cover = 0.32m; length of barrel cover = 1m; diameter and length of de-cobbing barrel = 0.21m and 0.95m respectively

2.1 Principle of operation;

The electric motor provides the primary motion required to power the machine. The motion and torque are transmitted via pulleys, v-belt and bearings to the shaft carrying the spikes and blower shaft connected to the impeller. Both the de-cobing spikes and blower impeller rotate in a clockwise direction. The whole maize (together with the cobs) are introduced into the machine through the inlet hopper. They reach the rotating spikes inside the de-cobing barrel by gravity. The spikes give continuous impact force on the whole maize, thereby removing the grains and chaff. Because the spikes are arranged in a spiral form, the whole maize moves along the length of the barrel in the forward direction until they reach the cob exit spout. Before the whole maize reaches this point, almost all the grains (seeds) are removed thereby letting the cob go out of the machine clean. Due to the impact of the spikes some of the cobs may be broken, though both broken and whole exit through the exit spout. The air generated by the blower impeller is channeled to flow against the maize grain exit spout via a wire mesh. The air blows off unwanted chaff that exit together with the maize grains thereby keeping the maize grains very clean. The clean maize then run into the receiver where they are collected for further processing operations.

Advantages:

- The machine is portable, simple to operate and requires only one operator.
- Materials of construction are locally sourced and it is inexpensive
- Power requirement is low (1.5 – 2.5 hp)
- Its output is higher than the output of several persons put together.
- It de-cobs and separates simultaneously
- Grain damage is almost eliminated

III. DESIGN PRINCIPLES

The design consideration of this machine is based on three principles namely:

- The gravitational dropping of the whole maize through the inlet hopper to the rotating spikes and exit of the grains to the receiver.
- The impact force delivered by the rotating spikes to the whole maize and motion of this whole maize along the length of the de-cobing barrel
- The air generation and supply by the blower

The dropping of the whole maize through the hopper to the rotating spikes is governed by gravitational force (f_g) which is given as; (Ryder and Bennet, 1982)

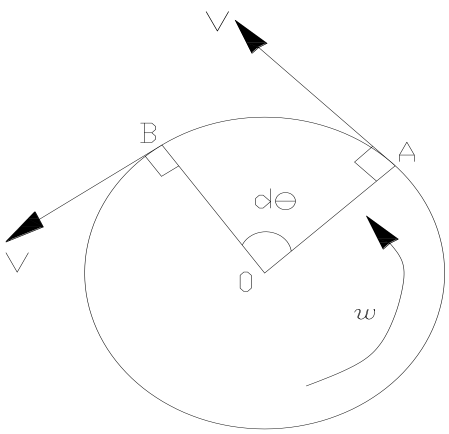
F= mg

Where: m = mass of whole maize g = acceleration due to gravity

The impact principle and air generation by the blower is achieved through the dynamics of the machine components namely: pulleys, belt, bearings and shaft. Circular motion of these components and gravitational motion of the whole maize through the inlet hopper and exit of grains through the exit spouts are employed to achieve the desired result.

3.1 Rotational motion and centrifugal force (F_C):

The rotational motion from the shaft of the prime mover (electric motor shaft) is transmitted to the driven shaft carrying the rotary spikes.



(Hannah & Stephens 1984)

Fig 1: Body experiencing circular motion

For any object of mass M moving in a circular motion, its acceleration is directed towards the centre of the body and its linear velocity is tangential to the radius of the object. The displacement which starts from point A, then to B and continues is in terms of θ. The angular velocity is designated ω. The acceleration (a) of the rotary body is given as

$$a = \omega^2 r. \qquad (1)$$

Where r = radius of the object. The acceleration is centripetal. The radially inward, or centripetal force required to produce acceleration is given as

$$F_c = Ma = M\omega^2 r = \frac{MV^2}{r} \qquad (2)$$ (Hannah and Stephens, 1984)

If a body rotates at the end of an arm, this force is provided by the tension on the arm, the reaction to this force acts at the centre of rotation and is centrifugal force. It represents the inertia of the body resisting the change in the direction of motion. A common concept of centrifugal force in engineering problems is to regard it as radially outward force which must be applied to a body to convert the dynamical condition to the equivalent static condition.

3.2 Rotational Torque (T):

The value of torque developed by a rotational body is given as the product of the force causing the motion multiplied by the radius of rotation

$\mathbf{T = F_C \times r}$ (3)

3.3 Work done by a torque:

If a constant torque T moves through an angle θ

Work done = T * θ (4)

If the torque varies linearly from zero to a maximum value T

Work done = $^1/_2$ T*θ (5)

In general case where $\mathbf{T = f(\theta)}$ (6)

Work done = $\int f(\theta)\, d\theta$ (7)

The power (P) developed by a torque T (N.M) moving at ω rad/sec is

$\mathbf{P = T\omega = 2\pi NT}$ **(watts)** (8)

Where N is the speed in rev/min and

$\omega = \frac{2\pi N}{60}$ (9)

3.4 Pulley and Belt Drive:

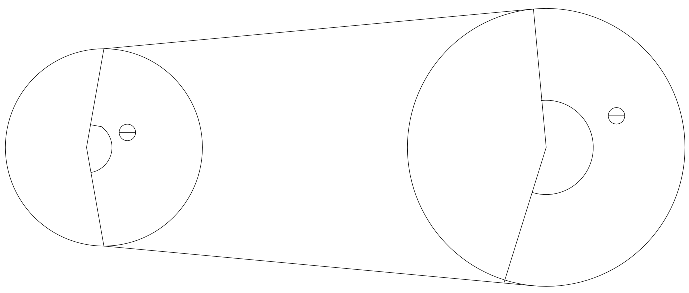


Fig 2: Diagram showing two pulleys connected by a belt.

The velocity ratio between two pulleys transmitting torque is given as (Avallone and Baumeister, 1997);

$\omega_1/\ \omega_2 = N_1/N_2 = D_2/D_1$ (10)

Where: ω_1 = angular velocity of driver pulley

ω_2 = angular velocity of driven pulley

N_1 = rpm of driver pulley

N_2 = rpm of driven pulley

D_1 = diameter of driver pulley

D_2 = diameter of driven pulley

Θ = angle of lap between belt and pulley

3.5 Tensions on Belt (T_1 and T_2):-

For belt transmission between two pulleys, the following equations by Hall et al., 1961 are used

$T_1/T_2 = e^{\mu\Theta}$ (11)

Also

$\frac{T_1 - T_c}{T_2 - T_c} = e^{\mu\Theta}$ (12)

And $T_c = mv^2$ (13)

$T_c = T_1/3$ i.e. $3T_c = T_1$ (14)

The power transmitted with the belt is given as

$P = (T_1 - T_2)\, v$ (15)

In this equation the power (P) is in watts, when T_1 and T_2 are in Newton and belt velocity is in metre per second.

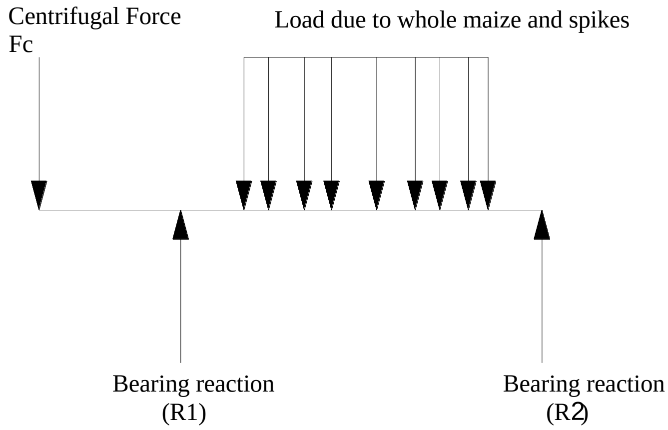
3.6 Belt Length (L):-

The belt length equation is given as (Avallone and Baumeister, 1997):

$$L = \frac{\pi}{2}\left(D_1 + D_2\right) + \frac{(D_1 - D_2)^2}{4C} + 2\,C \qquad (16)$$

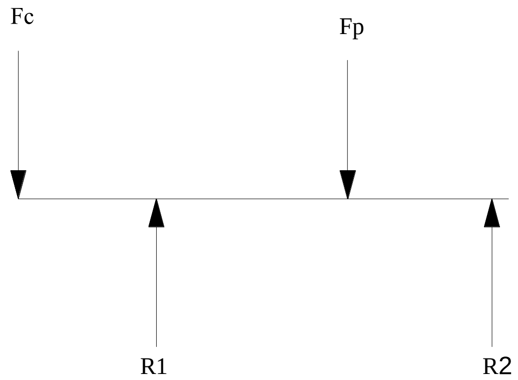
Where C = centre distance between two pulleys

3.7 Design of de-cobbing Shaft: - The shafts with the forces acting on it is represented schematically



(a)

For ease of calculations, the uniformly distributed load is made a point load as shown below



(b)

Fig 3 a & b: Schematic representation of loads on shaft

From the evaluation of the forces and determination of the bearing reactions, the maximum bending moments (Mmax) for the shaft is evaluated. The shaft diameter (D) is calculated using the ASME code standard for shafting. The ASME code equation for shafting is given as

$$D = \left\{\frac{5.1}{\tau_d}\left[(C_m \times M_{max})^2 + (C_t \times T)^2\right]^{\frac{1}{2}}\right\}^{\frac{1}{3}} \qquad (17)$$

For ASME code standard, $\tau_d = 0.3\sigma_y$ or $0.18\sigma_u$

The smaller of the two values is chosen as τ_d. The presence of key sit on the shaft reduces the value of τ_d by 75%. For rotating shafts, $C_m = 1.5$, $C_t = 1$

Definition of terms:

D = Diameter of shaft

τ_d = Allowable shear stress

C_m = Moment factor

C_t = Torque factor

M_{max} = Maximum bending moment

σ_y = Yield stress of shaft materials

σ_u = Ultimate stress of shaft material

Material used for the shafting is Stainless steel AISI 304

IV. SAMPLE PREPARATION

Already preserved corn was purchased from New market and Eke-Agbani markets in Enugu state. The samples were cleaned to remove dirt and any other foreign materials. Whole undamaged corn with cobs were selected and weighed in batches of 2kg. Some samples were collected and used to determine the moisture content of the corn. Samples of weight 2kg, 4kg, 6kg and 8kg were fed into the machine and feed time recorded. The shelled corn was collected through the exit chute and the cobs also collected through the cob exit. The collected shelled corn and the cobs were weighed and the weights recorded. The experiment was repeated twice and average values noted.

Fig 1 a) Whole Corn cob samples after cleaning b) Shelled corn collected form exit chute

c) Separated corn and cob after shelling

V. RESULTS

The results obtained from the experiment was recorded and shown in Table 1. The feed rate and threshing rate were obtained as a function of time while the separation efficiency was found by subtracting the weight of cobs collected at the exit spout form total sample collected and multiplying by 100 %. Threshing efficiency was obtained using the equation (Hamada et al, 2008). All the results obtained were analyzed to obtain their best fit mathematical models and their attendant coefficients of determination (R^2) values.

$$E_{th} = \frac{M_s - M_{ut}}{M_s} \times 100\%$$

Where; E_{th} = Efficiency of threshing (%)

M_s = Total mass of sample (kg)

M_{ut} = Mass of un-threshed seeds (kg)

Table 1: Data obtained from designed machine test

Wgt of corn	Feed time (min)	Threshing time (min)	Feed rate (kg/min)	Threshing rate (kg/min)	Threshing efficiency (%)	Separation Efficiency (%)
2kg	1.05	1.34	1.90	1.49	79.79	68.1
4kg	2.03	2.47	1.97	1.62	80.17	52.6
6kg	3.09	3.55	1.94	1.69	78.42	50.6
8kg	3.29	4.45	2.43	1.80	77.32	52.93

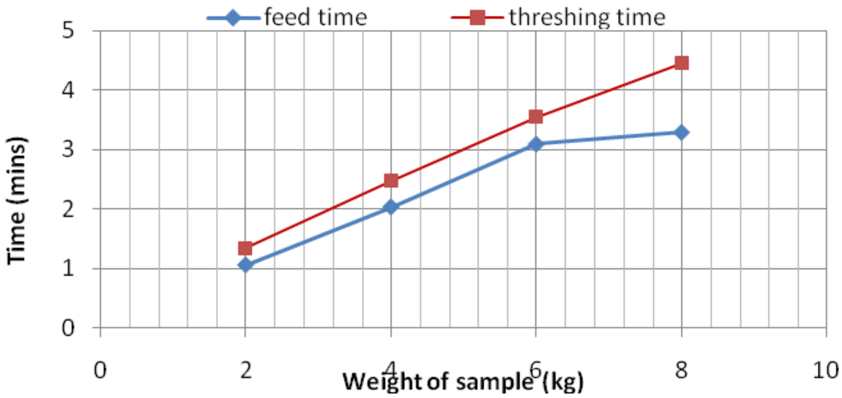


Fig 2: Feed time versus weight of sample

The plot above gives the trend observed for feed time and threshing time with respect to weight of sample. Both showed linear relationships indicating that they both increased with increase in weight of sample. Their best fit mathematical model equations are given below.

$Y_f = 0.389\,x + 0.42 \qquad (R^2 = 0.939) \qquad (18)$

$Y_T = 0.520\,x + 0.35 \qquad (R^2 = 0.997) \qquad (19)$

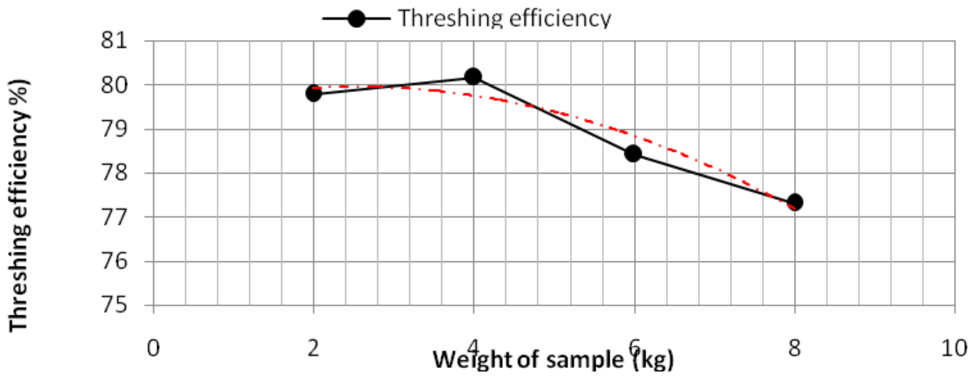


Fig 3: Threshing efficiency versus weight of sample

$Y = -0.092x^2 + 0.467x + 79.36 \qquad (R^2 = 0.924) \quad (20)$

Fig 3 shows threshing efficiency also had a quadratic relationship with weight of sample used. However, there was a slight increase before decreases started to occur. This is an indication that the more samples of materials fed into the machine the higher the probability of some not being threshed. The observed decrease was gradual as load increased.

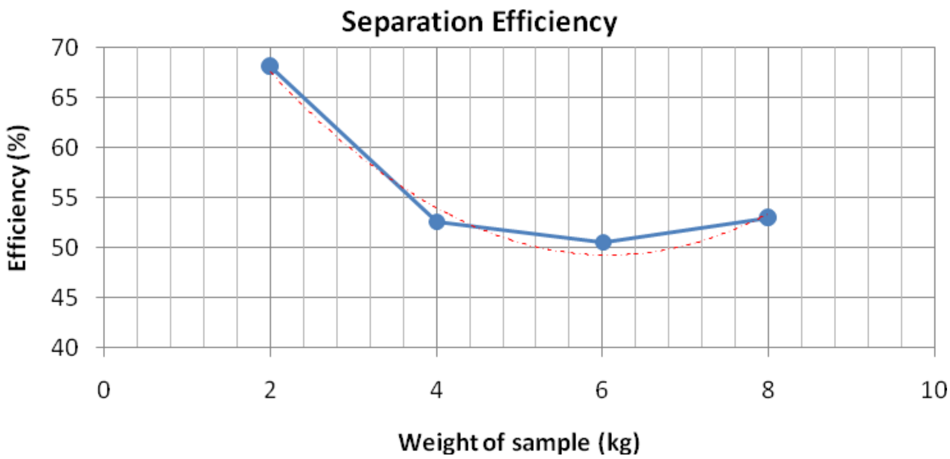


Fig 4: Separation efficiency versus weight of sample

$$Y = 1.114x^2 - 13.51x + 90.22 \quad (R^2 = 0.978) \quad (21)$$

Fig 4 showed that separation efficiency decreased as weight of samples increased. This can be attributed to the design of the machine which enabled separation to occur simultaneously with threshing. As samples increased, threshing rate increased and more materials were pushed towards the exit spout. Separation efficiency followed a quadratic trend with the model equation given in equation 21. The feed rate and threshing rate showed differing relationships to sample weight. While feed rate had a quadratic relationship, threshing rate exhibited a linear relationship. Their best fit model equations were also obtained and stated below (22 & 23). Threshing rate was on the other hand found to have a linear relationship with feed time (Fig. 6). Its best fit mathematical model is given in equation 24.

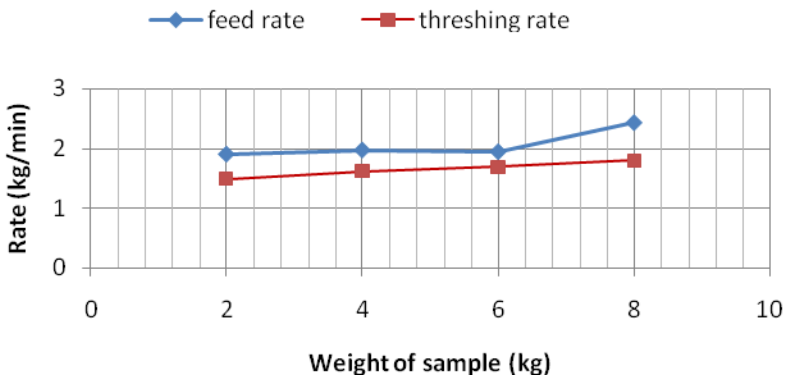


Fig 5: Separation efficiency versus weight of sample

$$Y_f = 0.026x^2 - 0.184x + 2.195 \quad (R^2 = 0.896) \quad (22)$$

$$Y_{th} = 0.05x + 1.4 \quad (R^2 = 0.988) \quad (23)$$

$$Y_{th} = 0.120x + 1.365 \quad (R^2 = 0.924) \quad (24)$$

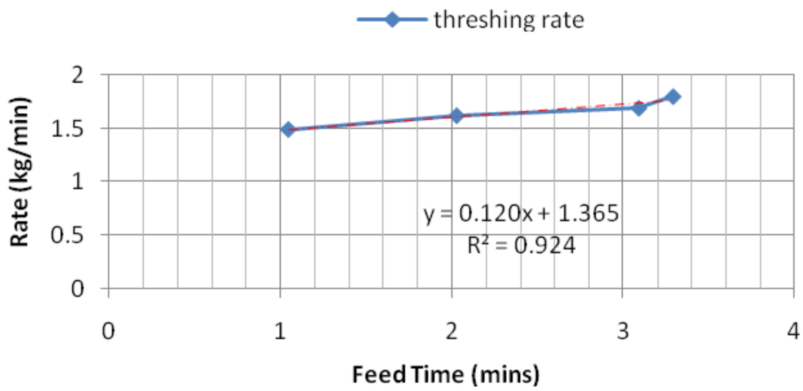


Fig 6: Threshing rate versus Feed time

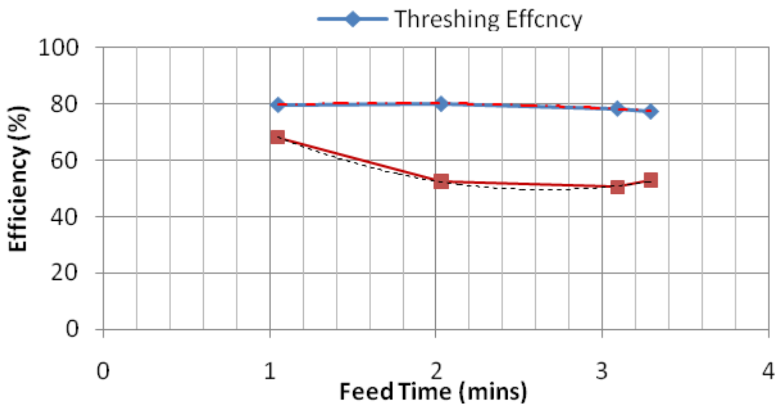


Fig 7: Threshing and Separation efficiency versus Feed time

$$Y = 7.195x^2 - 38.17x + 100.2 \qquad (R^2 = 0.998) \qquad (25)$$

$$Y = -1.192x^2 + 4.161x + 76.71 \qquad (R^2 = 0.982) \qquad (26)$$

From Fig 7, it can be observed that threshing efficiency seemed to be almost constant with respect to feed time while separation efficiency tended to decrease with increase in feed time. Both operations had quadratic functions as best mathematical models describing the relationship. However, it is important to note that the designed machine performed well in threshing but not so well in separation as more sample materials were fed. Projecting mathematically the points obtained, we see (Fig 8) that both processes diverged further. This implies that if more sample materials are fed into the machine continuously threshing efficiency will decrease slightly but separation efficiency will decrease greatly. This can result in clogging and necessitates adequate feed time regulation.

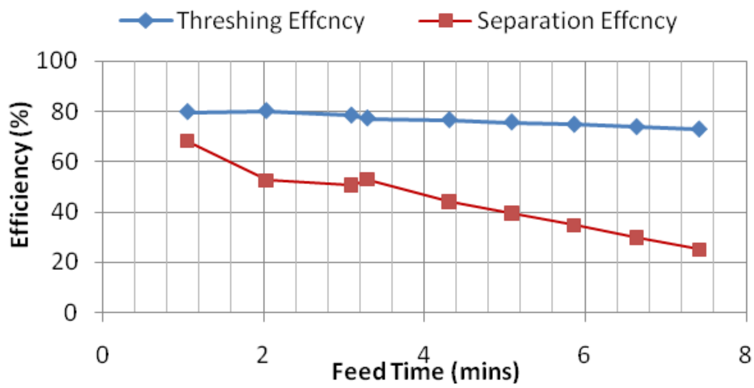


Fig 8: Projected Threshing and Separation efficiency versus Feed time

Fig 9: Photograph of designed machine

VI. CONCLUSION

From the results of the experiments carried out, the average feed rate of the designed machine was found to be 2.06 kg/min. This implies a value of 123.6 kg/hr while average threshing efficiency was obtained as 1.65 kg/min (99 kg/hr). The average threshing efficiency was found to be 78.93 % while the average separation efficiency was 56.06 %. These values were an improvement on the values obtained for human labour (as reported by Nwakire *et al*, 2011) where human mechanical efficiency was determined to be 45% at the biomaterial test weight of 20 kg with actually shelled grain weight of 15.8 kg. They also reported that human throughput capacity was 26.67 kg/hr and actual grain handling capacity of 21.1 kg/hr at a shelling time of 45 minutes or 0.75 hr. this shows clearly that the designed machine would perform satisfactorily and can process about 1 tonne of maize in 9 hrs. The design can be modified in order to find ways to improve the separation efficiency of the machine.

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The Effect of Web Corrugation in Cold-Formed Steel Beam with Trapezoidally Corrugated Web

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Abstract: **-** The corrugated steel plate is a widely used structural element in many fields of application because of its numerous favorable properties. To increase the shear capacity of web of large steel plate girders, the web with different patterns such as tapered web, haunches, corrugations of different shapes are used. This paper presents the results of the experimental study on load carrying capacity of cold-formed steel section with trapezoid web. A total of six cold-formed steel beams with plain webs and corrugated webs were tested. The load carrying capacity of cold-formed steel beam with plain web is studied and compared with the load carrying capacity of beam with trapezoidal corrugated web having 30^0 and 45^0 corrugations. The specimens were tested under two point loading for its pure flexural behaviour. From the study, it is found that the cold-formed steel beam with trapezoidally corrugated web having 30^0 corrugation has higher load carrying capacity compared to the beams having plain web and 45^0 corrugated web.

Keywords: **-** *Cold-formed steel beam, Trapezoidal corrugated web, Load carrying capacity*

I. INTRODUCTION

A corrugated web beam is a built-up beam with thin walled corrugated web. The profiling of the web avoids the failure of the beam due to loss of stability before the plastic limit loading of the web is reached. The use of corrugated webs is a potential method to achieve adequate out-of plane stiffness and shear bulking resistance without using stiffeners.

An experimental and numerical study on lateral-torsional buckling behaviour of hot-rolled steel section with trapezoidal web and found that the steel beam with trapezoidal corrugated web section have higher resistance to lateral-torsional buckling than that of section with plain web[1]. Numerical analysis on the buckling resistance of cold-formed steel beam with sinusoidally corrugated web is studied and found that the bucking failure of the web is prevented by the corrugation[2]. The lateral-torsional buckling of hot-rolled steel plate girder with corrugated webs numerically analysis using ANSYS. It was concluded that the resistance to lateral torsional buckling is more for beam with a corrugated web when compare with the models without corrugation[3]. The efficiency of plate girder with corrugated web were analyzed numerically using ANSYS software and found that the plate girder with trapezoidally corrugated web with 30^0 corrugation has a higher load-carrying capacity compared with other corrugation angle[4]. Performed lateral torsional buckling tests on beams with normal flat web and beams with trapezoid web profile. The experimental results indicated a greater resistance in lateral buckling provided for beams with trapezoid web profile[5].

Extensive research has been done on the performance of hot-rolled steel girder with corrugated web. Hence in this investigation, the load carrying capacity of cold-formed steel beam with corrugated web was carried out experimentally. A total of six cold-formed steel beams with plain webs and corrugated webs were tested. Out of the six specimens, two controlled specimens were tested with plain webs and the other four specimens were tested with corrugated webs. The degrees of corrugation were the variables among the specimens. The specimens were tested under two point loading for its pure flexural behaviour.

II. EXPERIMENTAL INVESTIGATION

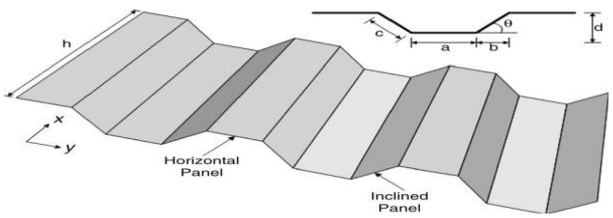
2.1 Test Specimen Details

The test specimen consist of cold-formed steel beams with plain web and trapezoidally corrugated web having 30^0 and 45^0 corrugations. The span of the beam was 2000mm and the cross section of the I-beams are 150mm x100mm x 2.5mm.The yield strength of steel used is 403 N/mm^2.The cold-formed steel beam is built up by welding the flanges and the web using intermittent welds of 4mm thick. A pair of stiffeners was provided at both the load points to minimize local effect due to concentrated loads. Table 1 shows the details of the specimens tested. A six lettered designation is given to the specimens. First 3 letters represents the nature of web whether the web is plain or corrugated, 4^{th} one indicate the degree of corrugation of the web, 5^{th} one represent the depth of the beam and the last one identify the specimen in a particular series as two specimens were tested in each series. Figure 1 shows the fabricated specimens.

Fig.1 Fabricated specimens

Table 1- Details of the specimens tested

SL.No	Beam Number
1	PWB 0^0, 150-1
2	PWB 0^0, 150-2
3	CWB 30^0, 150-1
4	CWB 30^0, 150-2
5	CWB 45^0, 150-1
6	CWB 45^0, 150-2



Trapezoidally corrugated web

2.2 Test set-up:

The testing was carried out in a loading frame of 400 kN capacity. All the specimens were tested for flexural strength under two point loading in the vertical loading frame. The specimens were arranged with simply supported conditions, centered over bearing blocks adjusted for a effective span of 1.8 m. Loads were applied at one-third distance from the supports at a uniform rate till the ultimate failure of the specimens occurred. Linear Voltage Displacement Transducers (LVDTs) were used for measuring deflections at several locations, one at mid span, two directly below the loading points and two near the end supports as shown in the Figure 2. Strain gauges and LVDTs were connected to a data logger from which the readings were captured by a computer at every load intervals until failure of the beam occurred. The beams were subjected to two-point loads under a load control mode. The experimental set-up for the test specimens are shown in Figure 3.

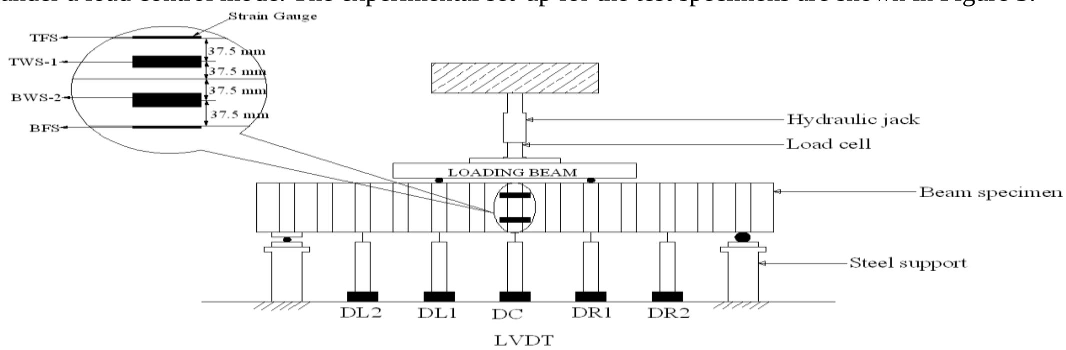


Fig. 2 Position of LVDTs and Strain gauges

Fig. 3 Experimental set-up for the test specimens

III. RESULTS AND DISCUSSION

3.1 Observed Failure Mode

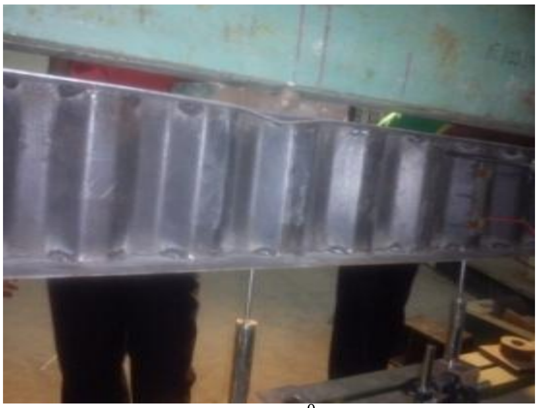
The failure pattern of the test specimens is shown in Figure 4. Beams with plain web failed by shear buckling of web. In the specimens with 45^0 trapezoidally corrugated web, failure occurred by local flange buckling and further loading caused local shear buckling of corrugated web, but the specimens with 30^0 trapezoidally corrugated web failed by local flange buckling.

(a) PWB 0^0, 150-1

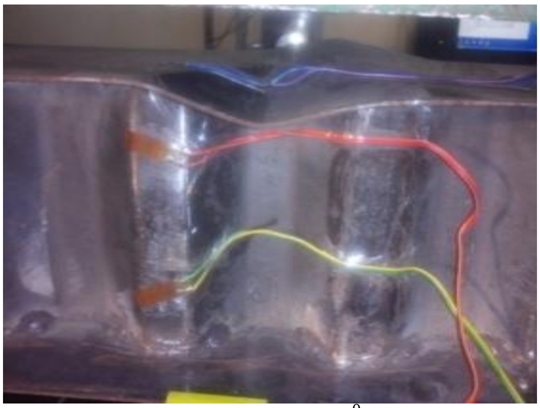
(b) PWB 0^0, 150-2

(c) CWB 30^0, 150-1

(d) CWB 30^0, 150-2



(e) CWB45^0, 150-1

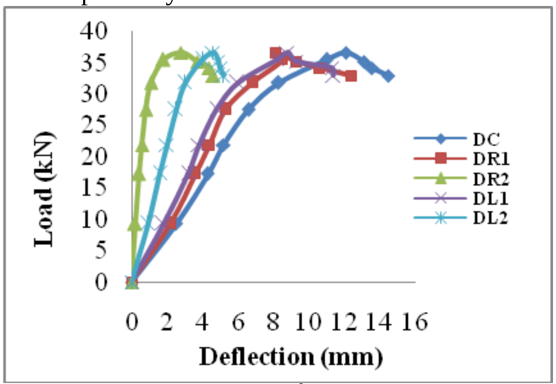


(f) CWB 45^0, 150-2

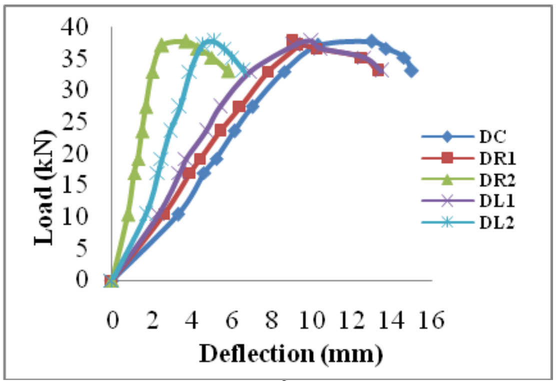
Fig. 4 Failure pattern of the test specimens

3.2. Load Versus Deflection Curves

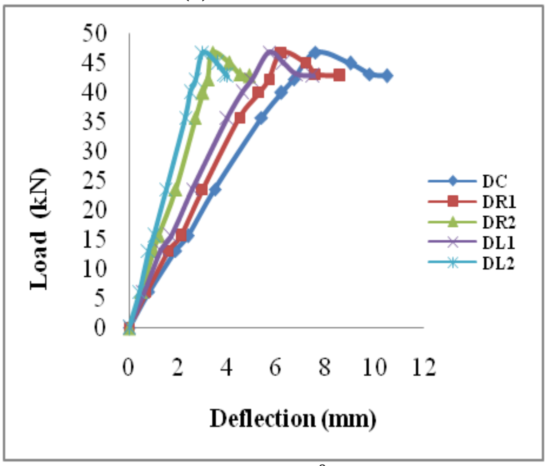
The experimental load-deflection curves of the cold-formed steel beams with plain webs and corrugated webs are shown in Figure 5. The specimens with plain web PWB 0^0, 150-1&2 failed at an average load of 37.15 kN with a central deflection of 12.5 mm and the other specimens CWB 30^0,150-1 &2 and CWB45^0,150-1&2 failed at an average loads of 46.55 kN and 45.55 kN with the corresponding average deflections of 7.85 mm and 8.55 mm respectively.



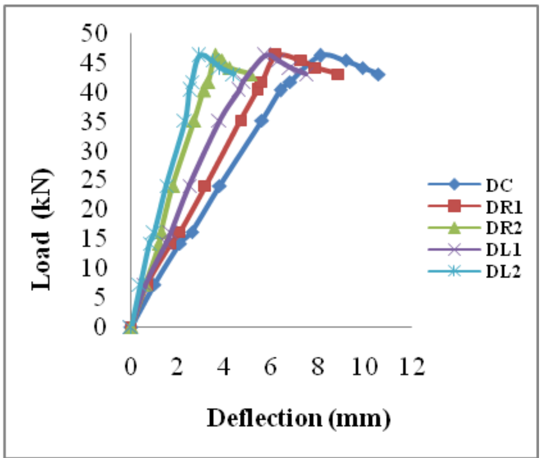
(a) PWB 0^0, 150-1



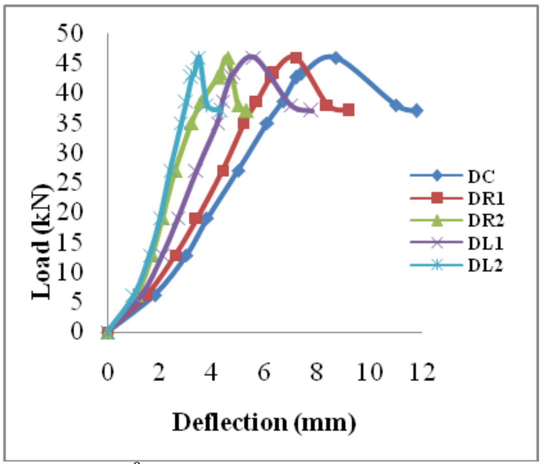
(b) PWB 0^0, 150-2



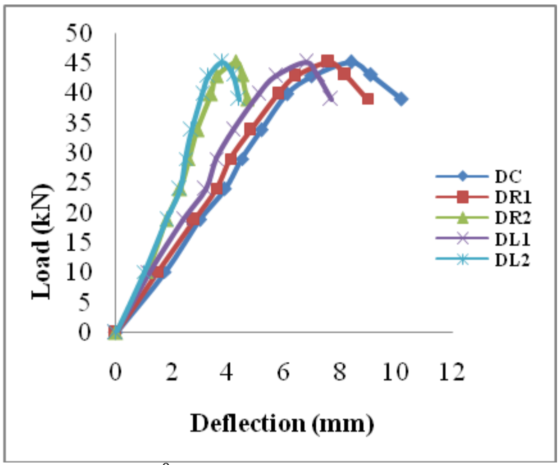
(c) CWB 30^0, 150-1



(d) CWB 30^0, 150-2



(e) CWB 45^0, 150-1

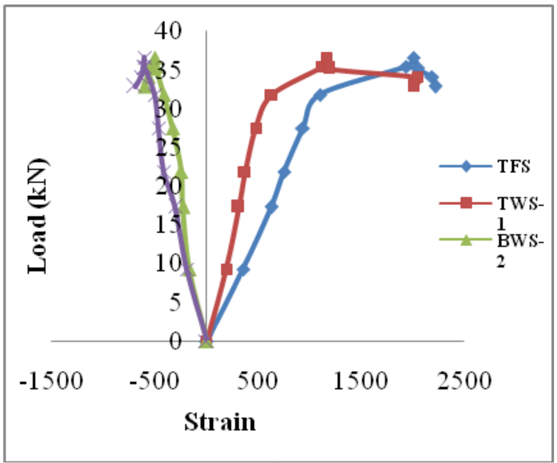


(f) CWB 45^0, 150-2

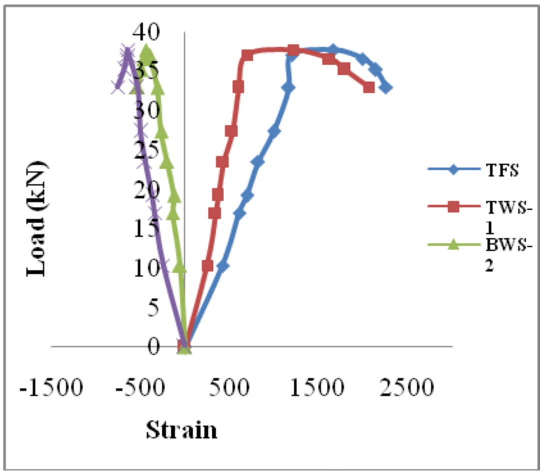
Fig. 5 Load versus deflection curves for the test specimens

3.3 Loads versus Strain Curves

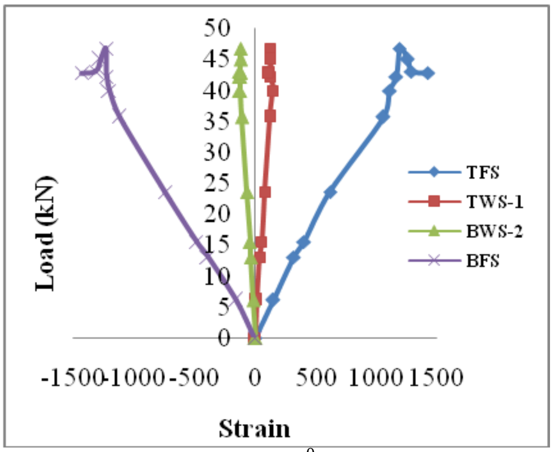
The strains were measured at the top flange, bottom flange and in the web portion . The load versus strain curves of the test specimens are shown in Figure 6. The measured steel strain at the top and bottom surface (TFS to BFS) at ultimate load varied from 1668 to 2010 & 603 to 643 respectively for plain web beams where as for a beam with 30^0 corrugated web varies from 1190 to 1320 & 1230 to 1376 and for a beam with 45^0 corrugated web varies from 1173 to 1330 & 1252 to 1703 respectively. From the results it is observed that the strain in the beams with corrugated web is more than that of the beams with plain web.



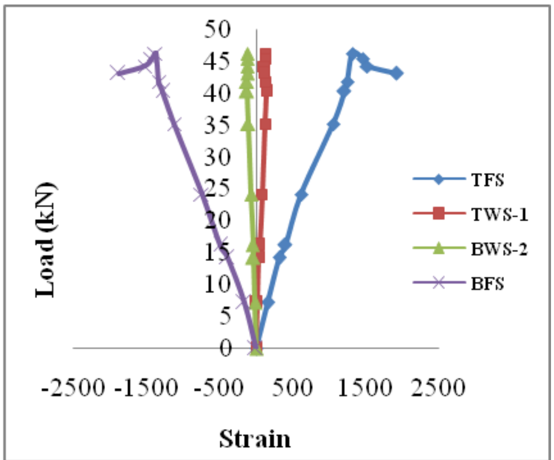
(a) PWB 0^0, 150-1



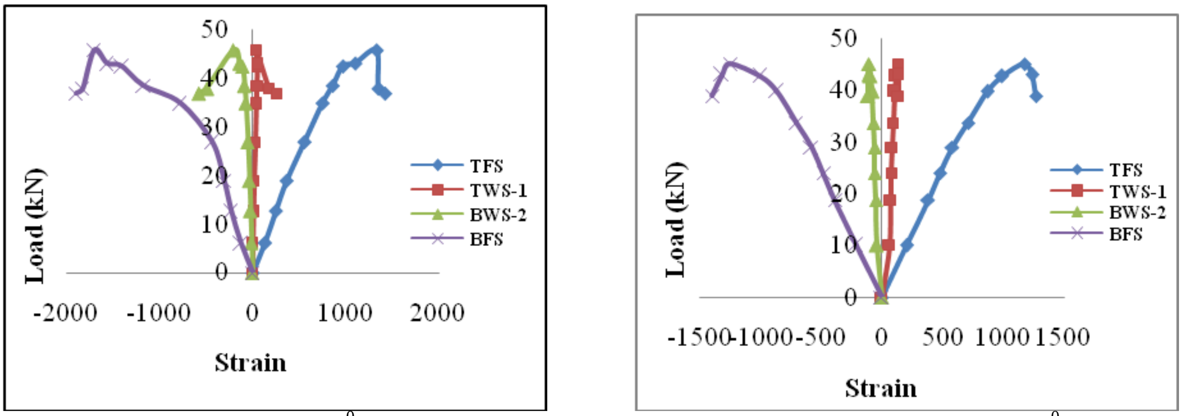
(b) PWB 0^0, 150-2



(c) CWB30^0, 150-1



(d) CWB30^0, 150-2



(e) CWB 45^0, 150-1 (f) CWB 45^0, 150-2

Fig. 6 Load versus strain curves for the test specimens

3.4. Strength Capacity of the Specimens

The trajectory of strength capacity of the specimens is shown in Figure 7. For the specimens with 150mm depth, the load carrying capacity of the beam having 30^0 corrugated web is 2.2% and 25.3% more than the specimens having 45^0 corrugation and plain web respectively.

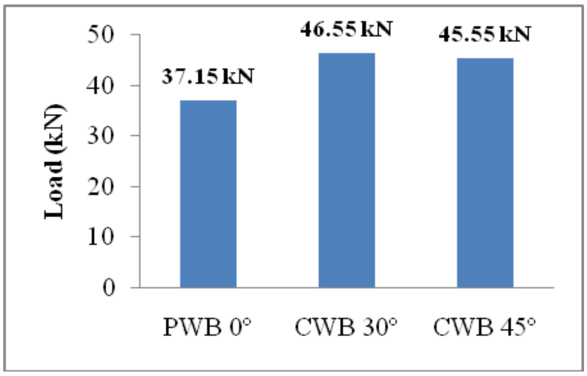


Fig. 7 Comparison of strength capacity of a specimens

IV. CONCLUSION

The following observations and conclusions can be made on the basis of the experiments conducted on the six cold-formed steel beams with plain and trapezoidally corrugated web.

1. The average load carrying capacity of cold-formed steel beams with 30^0 corrugated webs increases by 25% than the beam with plain web. But there is only a marginal increase in load carrying capacity of beam with 30^0 corrugated web than that of beam with 45^0corrugated web.
2. Beams with plain web showed shear buckling of web, but the failure due to shear in web could be eliminated by using corrugated web.
3. The strain in the beams with corrugated web is more than that of the beams with plain web.

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A Genetic Algorithm Optimization Model for the Gravity Dam Section under Seismic Excitation with Reservoir- Dam- Foundation Interactions

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Abstract: - A Genetic Algorithm optimization model was developed to find the optimum gravity dam section for dynamic loadings developed due to earthquakes excitations for a reservoir-dam-foundation system. The ANN model developed by Al-Suhaili et al. (2014), was used for estimating the developed stresses in the dam body and the developed hydrodynamic pressures, for a three groups of non-dimensional input variables concerning the dam section geometry, material properties and earthquake excitation properties. Some of these variables are inputs (non-decision) , while those concerning the dam section geometry are the decision variables. A MATLAB code was written for the developed model. Results show that the minimum size of population that should be generated randomly at the beginning in order to obtain a stable optimum solution is 30000. The effect of each of the non-decision variable on the optimum dimensions of the dam section was investigated. Different variables were found have different effects on the optimum solution.

I. INTRODUCTION

The dynamic behavior of a reservoir-dam-foundation system under dynamic earthquake loadings with consideration of interactions, between these three media, is of crucial importance to the dam safety analysis. An optimum dam section that satisfies the safety constraints with minimum area is the aim of the dam designer to ensure safety with minimum cost.

Simoes and Lapa (1994) used the maximum entropy formalism to obtain a Pareto solution indirectly by the unconstrained optimization of a scalar function. They posed the shape optimization of a concrete gravity dam as a multi objective optimization with goals of minimum volume of concrete, stresses and maximum safety against overturning and sliding. The earthquake response of gravity dam included dam reservoir and dam foundation interactions.They showed that the response to the vertical component of ground motion was especially significant for low height dams; it could even exceed the response to horizontal component.

A new hydraulic structure optimization method with a unified, easy operation and good optimizes effectiveness was developed by *Wu et al. (2008)*. For static loading conditions they solved the interface problem between exterior Particle Swarm Optimization (PSO) program of C language and ANSYS software and combined them to apply them to the shape optimization of concrete gravity dam. The results show that the PSO method can solve the difficulty to get differential coefficient and the weak ability to seek global optimization of traditional optimization methods. It improves the efficiency of optimization and can solve the optimization problem with discrete variables.

Lin et al. (2010) combined the genetic algorithms (GA) technique with the ANSYS Parametric Design Language in an effort to apply them to the shape optimization of the concrete gravity dam under static loading conditions. The results show that the new algorithm inherited the advantage of genetic algorithm in that it can search randomly instead of relying on the gradient information, and was also marked by a precision common in ANSYS. Also it was proved that the algorithm can not only improve computing speed, but also improve the accuracy of the algorithm by introducing the finite element method.

Khosravi and HeydariIn (2013) developed a procedure for modeling the geometry shape of concrete gravity dams considering dam-reservoir-foundation rock interaction with employing real values of the geometry variables. They established a 2D finite element model for the modal analysis of Concrete gravity dam-reservoir-foundation rock system with APDL language programming. The foundation rock was assumed to be mass less in which only the effects of foundation flexibility are considered and the inertia and damping effects of the foundation rock were neglected. They assumed that the foundation rock is extended to one and a half times the dam height in upstream, downstream and downward directions. The dam body was assumed to be homogeneous, isotropic and elastic properties for mass concrete. The foundation rock is idealized as a homogenous, isotropic media. The foundation model was constructed using solid elements arranged on semicircles having a radius one and a half times base of the dam. The impounded water was taken as in viscid and compressible fluid.

Investigating the previous researches, indicate the absence of a general optimization model for an optimum dam section, that minimize the massive dam concrete volume, while satisfying the constraints that do not violate the conditions of stresses developed in the dam body and factors of safety against overturning and sliding due to dynamic excitation with dam-reservoir-foundation interaction to be within the accepted limits. Hence, it is essential to develop a model that perform this task, in forms of non-dimensional input and output variables. The needed model is to be general, easy to apply for any concrete gravity dam, assigned an elevation given as input and decided according to the hydrological study.

II. THEORY OF GENETIC ALGORITHMS

Genetic Algorithms (GA) are direct, parallel, stochastic method for global search and optimization, which imitates the evolution of the living beings, described by Charles Darwin. GA is part of the group of Evolutionary Algorithms (EA). The evolutionary algorithms use the three main principles of the natural evolution: reproduction, natural selection and diversity of the species, maintained by the differences of each generation with the previous.

Genetic Algorithms work with a set of individuals, representing possible solutions of the task. The selection principle is applied by using a criterion, giving an evaluation for the individual with respect to the desired solution. The best-suited individuals create the next generation, *Popov (2005)*.

The main components of GA are:

1-***Chromosomes:*** For the genetic algorithms, the chromosomes represent set of genes, which code the independent variables. Every chromosome represents a solution of the given problem. Individual and vector of variables will be used as other words for chromosomes. The genes could be boolean, integers, floating point or string variables, as well as any combination of the above. A set of different chromosomes (individuals) forms a generation. By means of evolutionary operators, like selection, recombination and mutation an offspring population is created.

2-***Selection:***In the nature, the selection of individuals is performed by survival of the fittest. The more one individual is adapted to the environment - the bigger are its chances to survive and create an offspring and thus transfer its genes to the next population. In EA the selection of the best individuals is based on an evaluation of fitness function or fitness functions. Examples for such fitness function are the sum of the square error between the wanted system response and the real one; the distance of the poles of the closed-loop system to the desired poles, etc. If the optimization problem is a minimization one, than individuals with small value of the fitness function will have bigger chances for recombination and respectively for generating offspring.

3-***Recombination:***The first step in the reproduction process is the recombination (cross-over). In it the genes of the parents are used to form an entirely new group of chromosomes. The typical recombination for the GA is an operation requiring two parents, but schemes with more parent area also possible. Two of the most widely used algorithms are Conventional (Scattered) Cross-over and Blending (Intermediate) Cross-over.

4- ***Mutation:***The newly created chromosomes by means of selection and cross-over population can be further subject to mutation. Mutation means, that some elements of the DNA are changed. Those changes are caused mainly by mistakes during the copy process of the parent's genes. In the terms of GA, mutation means random change of the value of a gene in the population. The chromosome, which gene will be changed and the gene itself are chosen by random as well.

III. OPTIMIZATION MODEL FORMULATION

The general schematic section geometry of a gravity dam is shown in Figure (1) below:
Where,
H: total dam height.
h_w: water height in the reservoir.
h_u: upstream dam face slope height.
h_d: downstream dam back slope height.
B: total dam base width.
b_u: upstream dam face slope width.
b_c: dam crest width.
b_d: downstream dam back slope width.

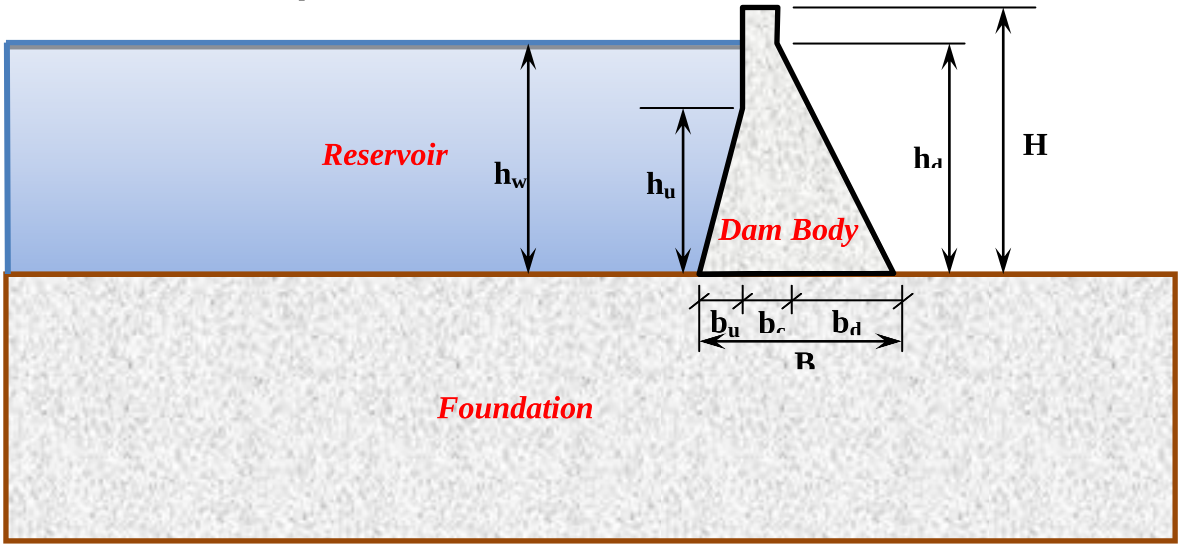

Figure 1: Schematic presentation of the dam-reservoir-foundation system analyzed dynamically using ANSYS.

The adopted objective function is to minimize the volume of dam,this implies the minimization of the dam section area, as given in Equation (1).

$$\text{Min } A\{[(b_u*h_u)/2] + (b_c*H) + [(b_d*h_d)/2]\} \quad (1)$$

This objective function given by Equation (1) is subject to a number of constraints. These constraints can be subdivided into input variables constraints, output variables constraints and overall stability constraints.

a) *Input Variables Constraints*:These constraints are set according to practical aspects and standards given by engineer manual of dam design, *Novak et.al.(2007), EM 1110-2-2200(1995), Chahar(2013)and USGS (2013)*:

$0.75 \leq B/H \leq 0.85$ (2)
$0.85 \leq h_w/H \leq 0.95$ (3)
$0.50 \leq h_u/H \leq 0.70$ (4)
$0.80 \leq h_d/H \leq 0.90$ (5)
$0.063 \leq b_u/B \leq 0.088$ (6)
$0.093 \leq b_c/B \leq 0.15$ (7)
$0.788 \leq b_d/B \leq 0.84$ (8)
$0.00 \leq a_x/g \leq 0.30$ (9)
$0.00 \leq a_y/g \leq 0.25$ (10)
$0.50 \leq w/w_n \leq 1.10$ (11)
$0.50 \leq E_s/E_c \leq 2.00$ (12)
$0.875 \leq \rho_s/\rho_c \leq 1.125$ (13)
$FOS_{ot} > 1.5$ (14)
$FOS_s > 1.5$ (15)

b) *Output Constraints*: The output constraints adopted are related to the criteria that the maximum developed shear, compressive and tensile stresses do not exceeds their respective allowable stresses, *ACI Code (2011)*:

$T/T_a < 1$ (16)
$S_{1t}/S_{ta} < 1$ (17)
$S_{1c}/S_{ca} < 1$ (18)
$S_{2t}/S_{ta} < 1$ (19)
$S_{2c}/S_{ca} < 1$ (20)
$S_{3t}/S_{ta} < 1$ (21)
$S_{3c}/S_{ca} < 1$ (22)
$Str/Str_u < 1$ (23)

c) *Overall Stability Constraints*: The overall stability of the dam section includes factors of safety against overturning and that against sliding.The overturning of the dam section takes place when the resultant force at any section cuts the base of the dam downstream of the toe. In this case the resultant moment at the toe becomes clockwise (or -ve). On the other hand, if the resultant cuts the base within the body of the dam, there will be no overturning. For stability requirements, the dam must be safe against overturning. The factor of safety against overturning is defined as the ratio of the righting moment (+ ve M_R) to the overturning moments (-ve M_0) about the toe.The factor of safety against overturning should not be less than 1.5 (FOS_{ot}> 1.5), *Punmia&Lal (2005)*. Equations (24) gives the factor of safety against overturning.

$$FOS_{ot} = \frac{Resistance\ Moment}{Overturning\ Moment} = \frac{\sum M_R}{\sum M_O} \tag{24}$$

Factor of safety against sliding is generally calculated by one of the following three methods; sliding resistance method, shear friction method and limit equilibrium method. The sliding resistance method calculates a coefficient of friction, (μ), by dividing the sum of horizontal forces parallel to the sliding plane by the sum of effective vertical forces normal to the sliding plane. The coefficient calculated in this way should be smaller than an allowable coefficient of friction (μ_{all}), *USACE (1981)*. As described in the US corps of engineering "Experience of the early dam designers had shown that shearing resistance of very competent foundation material need not to be investigated if the ratio of horizontal forces to vertical forces ($\Sigma H/\Sigma V$) is such that a reasonable safety factor against sliding results". The maximum ratio of ($\Sigma H/\Sigma V$) is set at 0.65 for static loading conditions and 0.85 for seismic conditions, *Iqbal (2012)*. Equations (25) gives the equation for the factor of safety against sliding which should not be less than 1.5 (FOS_s> 1.5).

$$FOS_s = \frac{\sum F_v}{\sum F_h} \tag{25}$$

IV. THE GENETIC ALGORITHM APPLICATION

The optimization model formulated above is used to obtain the optimum solution. The MATLAB programming language was used to write a program to apply the Genetic Algorithm technique to find the optimum section of the gravity dam for any set of non-decision input variables. Figure (2) shows the schematic of the Genetic Algorithm model flowchart. This model is solved using the genetic algorithm procedure explained in steps in section below.

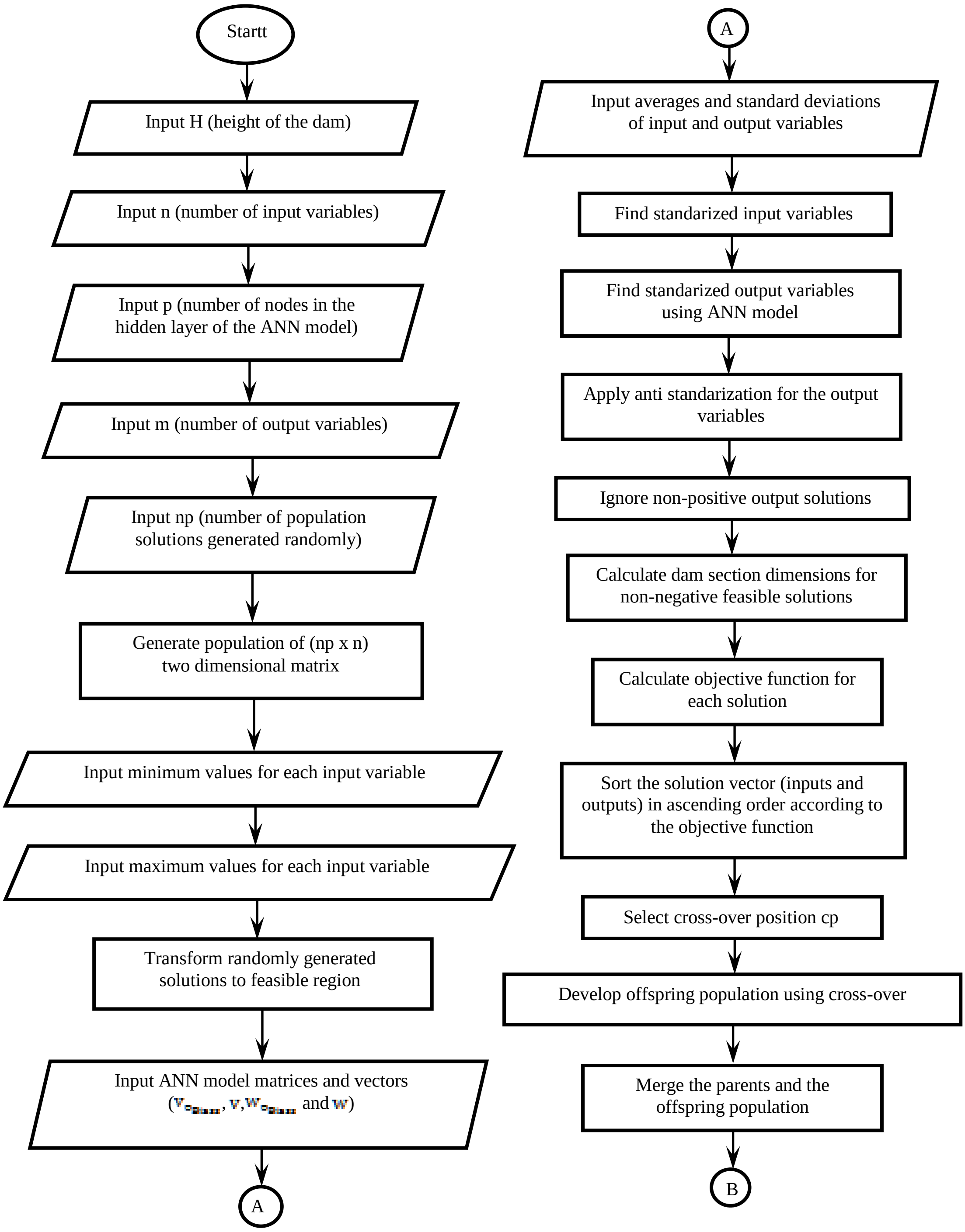

Figure 2: Schematic Genetic Algorithm model flowchart.

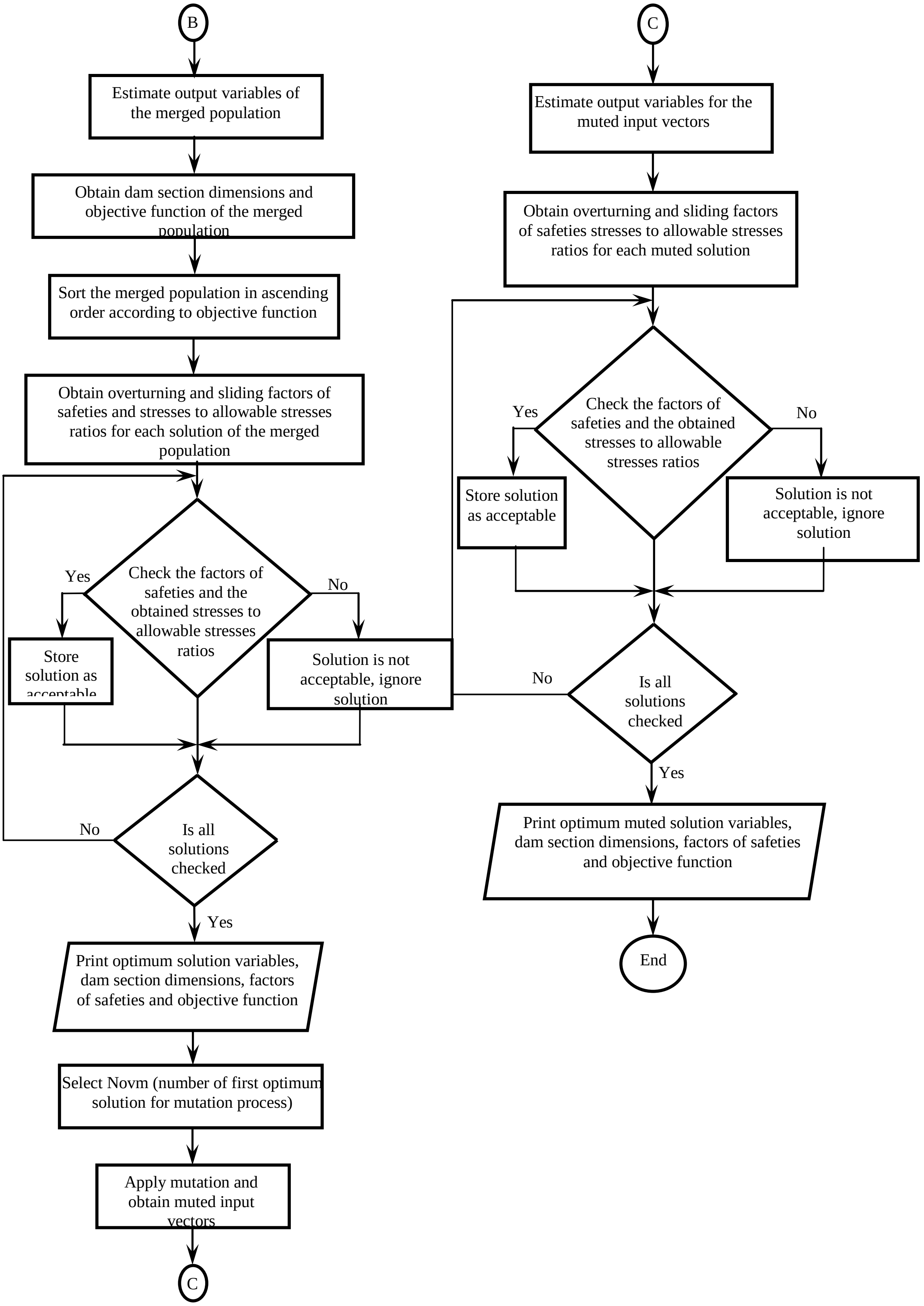

Figure 2: continued

V. OBTAINING STABLE OPTIMUM SOLUTION

Since the genetic optimization process includes the generation of a population of random solutions, the optimum solution obtained for a given input values will change for each run if the size of the population is relatively low. Hence, it is important to obtain the minimum required size of population that should be generated randomly at the first step to obtain a stable optimum solution, i.e., getting the same solution even though the run is repeated, for the same set of input data. This minimum size is depended on the phenomena for which the genetic algorithm model is applied, and the number of variables involved. Hence, this size is to be found by a trial and error procedure.

The Genetic Algorithm procedure used herein is explained in the following steps. Knowing that in this procedure the estimation of the output variables for a given set of input variables is required for a large number of randomly generated feasible solutions (chromosomes), or those resulted from the cross-over and mutation processes. For this purpose, the developed and verified ANN model by Al-Suhaili et al.(2014) is used as a direct method of estimation instead of the long process of modeling each case using the ANSYS software. The steps of the Genetic Algorithm procedure are those usually adopted in such models and as listed below and shown in a flowchart in the appendix:

1- Generate randomly an *np* (number of population) of feasible solutions with respect to the input variables constraints.

2- Estimation of the fitness function (objective function) of each set of input variables for feasible solutions with respect to output variables using the following steps:

a) Apply standardization process for the generated input variables.

b) Apply the developed ANN model to estimate the standardized output variables using the feed-forward process and model parameters.

c) Apply anti-standardization process to the output variables and check the feasibility of the output variables, ignoring the infeasible solution that violates Equations (14) to (23), (the output variables constraints).

d) Check the solution left in step (b) for feasibility of the overall stability, ignoring these solutions that violate the overall stability constraints, Equations (24) and (25).

3- Creation of mating pool with frequencies of each feasible solution obtained in step (2) above according to its fitness function.

4- Apply the cross-over process. The cross-over process adopted here in is the serial method that making cross-over with each two solution, serial (1 and 2, 3 and 4, and so on) which are considered as the parents that each couple produce a couple of offsprings. The cross over position (*cp*) can be change from (2 to 6) since the number of input variables containing the dam section geometry are (7). The probability of cross over (*pc*) can have different values, (*pc* = 100%, 90%,…..).

5- The output variables for the produced offspring population solutions was estimated using the procedure of step (2) and only those feasible solutions will be kept.

6- The population produced from the feasible solutions of offspring and those of parents will be mixed to generate a new feasible population.

7- The objective function (fitness function) will be obtained for each solution of the two mixed populations and sorted into ascending order, and only the first (*np*) solution will be kept for a next iteration of steps (2) to (7).

8- After completing the iterations for any number of iteration selected, the optimum solution will be the first one.

9- A further process of the Genetic Algorithm can be performed which is the mutation process. This can be done after the completion of the iterations by selecting for example the first (10) solutions. That means we have (90) variables to be muted. The usual mutation probability is (*pm* = 0.05), that means (4) numbers will be muted. The mutation process is to change their values by an amount called mutation level (*ml*), for example ±0.01. This level is set according to the order of magnitude of the variables. The (4) numbers selected for mutation is a random process that is to generate a four random number range from (1) to (90).

VI. ILLUSTRATION OF RESULTS

Since the genetic algorithm optimization method needs first the generation of (*np*) random solutions, it is needed to find the minimum required (*np*) value that gives a stable optimum solution, i.e., ignored differences in the objective function values for different runs with the same data input. This (*np*) value is dependent on the physical phenomenon that is under optimization, hence will be found by trial and error. A dam example is used for illustration of the model application, is of (100m) height subject to horizontal and vertical excitation equal to ($a_x/g = 0.25$) and ($a_y/g = 0.2$) respectively, with earthquake frequency to the natural frequency ratio equal ($w/w_n = 1.0$). The modulus of elasticity and density ratios are ($E_s/E_c = 0.8$) and ($\rho_s/\rho_c = 0.9$) respectively. Table (1) gives the objective function for the optimum solution for three different runs, and different values of the generated (*np*). The cross-over position was held constant at (*cp*) equal to four. It is obvious that as the (*np*) value increases the differences in the objective functions for the runs was decreased and the final (*np*) value that gives the stable solution is 30000. Hence, this value will be adopted in the further analysis.

Table 1: Effects of the number of the population (*np*) on the objective function.

np	***Objective Function, (Area -m^2-)***		
	Run 1	***Run 2***	***Run 3***
500	3900.048	4012.433	4056.273
1000	3816.635	3730.952	3899.299
3000	3826.213	3814.389	3720.883
5000	3757.099	3629.661	3725.686
8000	3728.983	3593.522	3650.425
10000	3596.001	3704.253	3662.584
15000	3529.465	3679.242	3607.222
20000	3529.760	3655.887	3487.915
25000	3559.387	3495.583	3633.377
30000	3591.269	3593.197	3590.797

As the decision variables for the optimization model are seven, hence the cross-over position effect on the optimum solution should be investigated. This value can be set as (2, 3, 4, 5 and 6). Table (2) shows the variation of the optimum objective function for these values of (*cp*), for the same example shown in Table (1), with (*np*) equal to 30000. As shown in this table the cross-over position equal to four gives minimum objective function, so it will be used in the optimization model to obtain the optimum dimensions.

Table 2: Effect of the cross over position (*cp*) of the G. A. on the objective function.

np	***cp***	***Objective Function Area (m^2)***
30000	2	3593.865
	3	3605.988
	4	3593.197
	5	3652.562
	6	3685.605

Table (3) shows the results of the optimum dimensions obtained from the optimization model for three different heights dams with various non-decision inputs.

Table 3: Optimum dimensions for three different dams using G.A. model.

Variable Type	***Variable Name***	***Case 1***	***Case 2***	***Case 3***
Non-Decision Inputs	H	50	100	150
	a_x/g	0.15	0.25	0.30
	a_y/g	0.10	0.20	0.15
	w/w_n	0.70	1.00	0.50
	E_s/E_c	0.50	0.80	1.50
	ρ_s/ρ_c	0.80	0.90	1.00
Optimum Outputs*	h_w	42.552	88.963	127.676
	B	38.420	76.180	113.555
	h_u	29.075	67.652	101.640
	h_d	40.897	85.287	130.946

Variable Type	Variable Name	Case 1	Case 2	Case 3
	b_u	2.511	4.939	7.519
	b_c	3.884	9.369	10.801
	b_d	32.025	61.871	95.234
	FOS_O	1.640	1.616	1.629
	FOS_S	1.533	1.521	1.541
	Obj. Fun.	885.554	3742.374	8237.590

*****All dimensions in meter.

Tables (4) to (9) shows the investigation of the effect of each non-decision variable on the optimum dimensions of the dam section, by using the same dam section with various decision variables at each time.

As shown in those tables the objective function (cross-section area) always is directly proportional to each non-decision variable. The dam base width to height ratio (B/H), the water height to dam height ratio (h_w/H) and the upstream slope height to dam height ratio (h_u/H) are inversely proportional to dam height only and directly proportional to other non-decision variables. The downstream slope height to dam height ratio (h_d/H) is wobbling with the increase of horizontal and vertical accelerations and foundation modulus of elasticity and inversely proportional to other non-decision variables. Also the upstream slope width to dam base width ratio (b_u/B) is inversely proportional to dam height only and directly proportional to other non-decision variables, while the downstream slope width to dam base width ratio (b_d/B) is directly proportional to dam height only and inversely proportional to other non-decision variables. Finally the crest width to dam base width ratio (b_c/B) is always directly proportional to each non-decision variable.

Table 4: Effect of dam heights.

Variable Type	Variable Name	Case 1	Case 2	Case 3
Non-Decision Inputs	H	50	100	150
	a_x/g	0.10	0.10	0.10
	a_y/g	0.05	0.05	0.05
	w/w_n	0.50	0.50	0.50
	E_s/E_c	0.50	0.50	0.50
	ρ_s/ρ_c	0.88	0.88	0.88
Optimum Outputs*	h_w	42.686	85.064	127.672
	B	37.778	75.245	113.161
	h_u	33.832	55.770	101.131
	h_d	42.201	82.488	122.539
	b_u	2.712	4.775	7.382
	b_c	3.514	7.042	10.753
	b_d	31.551	63.427	95.026
	FOS_O	1.610	1.628	1.634
	FOS_S	1.508	1.520	1.523
	Obj. Fun.	887.343	3453.390	7808.357
Dimensionless Optimum Outputs	B/H	0.756	0.752	0.754
	h_w/H	0.854	0.851	0.851
	h_u/H	0.677	0.558	0.674
	h_d/H	0.844	0.825	0.817
	b_u/B	0.072	0.063	0.065
	b_c/B	0.093	0.094	0.095
	b_d/B	0.835	0.843	0.840

*All dimensions in meter.

Table 5: Effect of horizontal acceleration.

Variable Type	Variable Name	Case 1	Case 2	Case 3
Non-Decision Inputs	H	100	100	100
	a_x/g	0.10	0.20	0.30
	a_y/g	0.05	0.05	0.05
	w/w_n	0.50	0.50	0.50
	E_s/E_c	0.50	0.50	0.50
	ρ_s/ρ_c	0.88	0.88	0.88
Optimum Outputs*	h_w	85.064	85.918	86.783
	B	75.245	79.063	76.228
	h_u	55.770	68.740	61.580
	h_d	82.488	80.505	84.927
	b_u	4.775	5.140	4.929
	b_c	7.042	7.630	7.314
	b_d	63.427	66.293	63.985
	FOS_O	1.628	1.658	1.618
	FOS_S	1.520	1.542	1.515
	Obj. Fun.	3453.390	3608.163	3600.152
Dimensionless Optimum Outputs	B/H	0.752	0.791	0.762
	h_w/H	0.851	0.859	0.868
	h_u/H	0.558	0.687	0.616
	h_d/H	0.825	0.805	0.849
	b_u/B	0.063	0.065	0.065
	b_c/B	0.094	0.097	0.096
	b_d/B	0.843	0.838	0.840

*All dimensions in meter.

Table 6: Effect of vertical acceleration.

Variable Type	Variable Name	Case 1	Case 2	Case 3
Non-Decision Inputs	H	100	100	100
	a_x/g	0.10	0.10	0.10
	a_y/g	0.05	0.15	0.22
	w/w_n	0.50	0.50	0.50
	E_s/E_c	0.50	0.50	0.50
	ρ_s/ρ_c	0.88	0.88	0.88
Optimum Outputs*	h_w	85.064	86.033	87.809
	B	75.245	75.928	83.978
	h_u	55.770	68.115	69.524
	h_d	82.488	83.412	82.197
	b_u	4.775	5.228	5.331
	b_c	7.042	7.098	8.503
	b_d	63.427	63.602	70.145
	FOS_O	1.628	1.626	1.666
	FOS_S	1.520	1.521	1.549
	Obj. Fun.	3453.390	3540.417	3918.455
Dimensionless Optimum Outputs	B/H	0.752	0.759	0.840
	h_w/H	0.851	0.860	0.878
	h_u/H	0.558	0.681	0.695
	h_d/H	0.825	0.834	0.822
	b_u/B	0.063	0.069	0.064
	b_c/B	0.094	0.094	0.101
	b_d/B	0.843	0.838	0.835

*All dimensions in meter.

Table 7: Effect of acceleration frequency.

Variable Type	Variable Name	Case 1	Case 2	Case 3
Non-Decision Inputs	H	100	100	100
	a_x/g	0.10	0.10	0.10
	a_y/g	0.05	0.05	0.05
	w/w_n	0.50	0.80	1.10
	E_s/E_c	0.50	0.50	0.50
	ρ_s/ρ_c	0.88	0.88	0.88
Optimum Outputs*	h_w	85.064	85.611	85.050
	B	75.245	76.039	75.246
	h_u	55.770	67.328	65.465
	h_d	82.488	81.608	80.099
	b_u	4.775	5.715	5.220
	b_c	7.042	7.368	8.935
	b_d	63.427	62.955	61.090
	FOS_O	1.628	1.628	1.649
	FOS_S	1.520	1.523	1.549
	Obj. Fun.	3453.390	3498.046	3511.066
Dimensionless Optimum Outputs	B/H	0.752	0.760	0.752
	h_w/H	0.851	0.856	0.851
	h_u/H	0.558	0.673	0.655
	h_d/H	0.825	0.816	0.801
	b_u/B	0.063	0.075	0.069
	b_c/B	0.094	0.097	0.119
	b_d/B	0.843	0.828	0.812

*All dimensions in meter.

Table 8: Effect of foundation elasticity.

Variable Type	Variable Name	Case 1	Case 2	Case 3
Non-Decision Inputs	H	100	100	100
	a_x/g	0.10	0.10	0.10
	a_y/g	0.05	0.05	0.05
	w/w_n	0.50	0.50	0.50
	E_s/E_c	0.50	1.00	2.00
	ρ_s/ρ_c	0.88	0.88	0.88
Optimum Outputs*	h_w	85.064	85.339	85.541
	B	75.245	77.046	76.359
	h_u	55.770	68.034	58.302
	h_d	82.488	80.563	83.077
	b_u	4.775	5.198	6.070
	b_c	7.042	7.233	7.235
	b_d	63.427	64.616	63.053
	FOS_O	1.628	1.625	1.610
	FOS_S	1.520	1.503	1.512
	Obj. Fun	3453.390	3502.910	3519.614
Dimensionless Optimum Outputs	B/H	0.752	0.770	0.764
	h_w/H	0.851	0.853	0.855
	h_u/H	0.558	0.680	0.583
	h_d/H	0.825	0.806	0.831
	b_u/B	0.063	0.067	0.079
	b_c/B	0.094	0.094	0.095
	b_d/B	0.843	0.839	0.826

*All dimensions in meter.

Table 9: Effect of foundation mass density.

Variable Type	Variable Name	Case 1	Case 2	Case 3
Non-Decision Inputs	H	100	100	100
	a_x/g	0.10	0.10	0.10
	a_y/g	0.05	0.05	0.05
	w/w_n	0.50	0.50	0.50
	E_s/E_c	0.50	0.50	0.50
	ρ_s/ρ_c	0.88	1.00	1.13
Optimum Outputs*	h_w	85.064	85.058	86.295
	B	75.245	76.031	78.484
	h_u	55.770	67.972	59.829
	h_d	82.488	82.045	80.828
	b_u	4.775	5.085	5.409
	b_c	7.042	7.552	7.439
	b_d	63.427	63.394	65.636
	FOS_O	1.628	1.637	1.623
	FOS_S	1.520	1.529	1.502
	Obj. Fun.	3453.390	3528.633	3558.302
Dimensionless Optimum Outputs	B/H	0.752	0.760	0.785
	h_w/H	0.851	0.851	0.863
	h_u/H	0.558	0.680	0.600
	h_d/H	0.825	0.821	0.808
	b_u/B	0.063	0.067	0.069
	b_c/B	0.094	0.099	0.095
	b_d/B	0.843	0.834	0.836

*All dimensions in meter.

VII. CONCLUSIONS

From the research conducted herein, the following conclusion can be deduced:

1- The Genetic Algorithm optimization model cannot give stable optimum solution for the dam-reservoir-foundation system subject to dynamic loading ,unless a minimum number of initial populations generated are (30000).

2- A sensitivity analysis of the position of the cross-over process was performed to select the best cross-over position for the Genetic Algorithm optimum solution. The position of cross-over which gives the most optimum solution is (4), i.e. cross-over of (b_u/B, b_c/B and b_d/B).

3- It was found that the cross-over probability and mutation probability values have little effect on the optimization process.

4- The results show that the optimum solution (optimum dimensions) for the dam cross-section is to be highly affected by any change in the non-decision variables, direct or inverse proportionality were obtained with varying rates.

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A Multi-Variables Multi -Sites Hydrological Forecasting Model Using Relative Correlations

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Abstract: - A multi-variables multi-sites hydrological data forecasting model was derived and checked using a case study. The philosophy of this model is to use the cross-variables correlations, cross-sites correlations and the time lag correlations simultaneously. The case study is of four variables and three sites. The variables are the monthly air temperature, humidity, precipitation, and evaporation; the sites are Sulaimania, Chwarta, and Penjwin, which are located north Iraq. This model represents a modification of the model proposed by Al-Suhili and Mustafa(2013). The model performance was compared with four well known forecasting models developed for the same data. These models are the single-site single-variable first order auto regressive, the multi-variables single-site Matalas(1967), the single-variable multi-sites Matalas(1967), and Al-Suhili and Mustafa models. In addition to that another multi-variables multi-sites model was developed herein similar in its concept to the Matalas(1967) model considering the variables as an additional sites. The results of the six models for three forecasted series for each variable, were compared using the Akaike test which indicates that the developed model is more successful, since it gave the minimum (AIC) values for (83.33 %) of the forecasted series. This indicates that the developed model had improved the forecasting performance. Moreover the t-test for monthly means comparison between the models indicates that the developed model has the highest percentage of succeed (94.44%).

Keywords: - *Forecasting, Multi-sites, Multi-variables, Cross sites correlation, Serial correlation, Cross variables correlations, Hydrology,*

I. INTRODUCTION

Weather generation models have been used successfully for a wide array of applications. They became increasingly used in various research topics, including more recently, climate changes studies. They can generate series of climatic data with the same statistical properties as the observed ones. Furthermore, weather generators are able to produce series for any length in time. This allows developing various applications linked to extreme events, such as flood analyses, and draught analysis, hence allowing proper long term water resources management to face the expected draught or flood events. There exist in the literature many types of stochastic models that simulate weather data required for various water resources applications in hydrology, agriculture, ecosystem, climate change studies and long term water resource management.

Single site models of weather generators are used for forecasting a hydrological variable at a single site independent of the same variable at the near sites, and thus ignoring the spatial dependence exhibited by the observed data. On the other hand single variable forecasting models are used for forecasting a hydrological variable in a site independent of the other related variables at the same site, thus ignoring the cross variables relations that may physically exist between these variables. Tobler (1970) mentioned in the first law of geography that “everything is related to everything else, but near things are more related than distant things". Matals(1967), had developed the most well known multi-sites model using cross site correlations between one variable at different sites. This model can be applied as a multi-variable model that uses multi variables cross correlation in a given site. Richardson (1981) had proposed a multi-variables stochastic weather models for daily precipitation, maximum temperature, minimum temperature, and solar radiation, as cited in Wilks (1999). This model forecast a hydrological variable at multiple sites, hence simulate the cross sites dependency between these sites. The Multi-variables models are similar to the multi-sites model but simulate the cross variables dependency that exists between some variables at a certain site. The two models forms are similar but using cross sites correlations in the first one , while the second one uses the cross variables correlations. Much progress had been made principally in the last 20 years to come up with theoretical frameworks for spatial analysis Khalili(2007).Some models, such as space–time models have been developed to regionalize the weather generators. In these models, the precipitation is linked to the atmospheric circulation patterns using conditional distributions and conditional spatial covariance functions Lee et al (2010). The multi-site weather generators presented above are designed using relevant statistic information. Most of these models are either complicated or some are applicable with a certain conditions. There exist in the literature some relatively recent trials to account for the spatial variation in multi-sites. Calder(2007) had proposed a Bayesian dynamic factor process convolution model for multivariate spatial temporal processes and illustrated the utility of the approach in modeling large air quality monitoring data. The underlying latent components are constructed by convolving temporally-evolving processes defined on a grid covering the spatial domain and include both trend and cyclical components. As a result, by summarizing the factors on a regular spatial grid, the variation in information about the pollutant levels over space can be explored.

In real situation both cross variables and cross sites correlation may exist between different hydrological variables at different sites. Al-Suhili et al(2010) had presented a multisite multivariate model for forecasting different water demand types at different areas in the city of Karkouk, north Iraq. This model first relate each demand type with explanatory variables that affect its type, using regression models, then obtaining the residual series of each variable at each site. These residual are then modeled using a multisite Matalas(1967) models for each type of demand. These models were then coupled with the regression equation to simulate the mult-isites multi-variables variation. The last two cited research are those among the little work done on forecasting models of multi-sites multi-variables types. However these model are rather complicated, and/or do not model the process of cross site and cross variables correlation simultaneously, which as mentioned above is the real physical case that exist. Hence researches are further required to develop a simplified multi-sites multi-variables model. Al-Suhili and Mustafa(2013) had proposed a multi-variables multi-sites model that uses relative correlation matrix and a residual matrix as the model parameters to relate the dependent and independent stochastic components of the data. This model represents the dependent stochastic of each variable at a time step as a weighted sum of the dependent stochastic component at the preceding time step and the present independent stochastic components. However these weights are not summed to one, while logically they should be. Moreover the model was applied for only eight months of the year (October to May) excluding these months of zero precipitation values.

In this research a modified multi-sites multi-variables approach is proposed to develop a model that describe the cross variables, cross sites correlation and lag-time correlation structure in the forecasting of multi variables at multi sites simultaneously. This model represents a modification of Al-Suhili and Mustafa model(2013). The modification is done such that the total weights of the weighted components summed to 1, i.e. each variable is resulted from the weighted sum of the other variables in the same site and those in the other sites in addition to the same variable at the preceding time step. This was done by adopting a different method for estimating the parameters of the model. Moreover the model was applied for all the months of the year that includes zero values for the precipitation. The problem was overcome by adding a constant value of 0.1 to the whole precipitation data series, to investigate whether this modification can solve this problem of zero values. This model was applied to a case study of monthly data of four hydrological variables, air temperature, humidity, precipitation and evaporation at three sites located north Iraq, Sulaimania, Chwarta, and Penjwin.

II. THE MODEL DEVELOPMENT

The multivariate multisite model developed herein, utilizes single variable time lag one correlations, cross variables lag-one correlations, and cross sites lag-one correlations. In order to illustrate the model derivation consider figure 1a where the concept of the model is shown. This figure illustrates the concept for two variables, two sites and first order lag-time model. This simple form is used to simplify the derivation of the model. However, the model could be easily generalized using the same concept. For instant, figure 1b is a schematic diagram for the multi-variables multi-sites model of two variables, three sites and first order lag-time. The concept is that if there will be two-variables, two sites, and one time step (first order), then there will exist (8) nodal points. Four of these represent the known variable, i.e. values at time (t-1); the other four are the dependent variables, i.e. the values at time (t). As mentioned before, figure 1 shows a schematic representation of the developed model and will be abbreviated hereafter as MVMS (V, S ,O),where V: stands for number of variables in each site , S: number of sites , and O : time order, hence the model representation in figure (1a and b) can be designated as MVMS (2,2,1), and MVMS (2,3,1), respectively.

This model can be extended further to (V-variables) and / or (S-sites) and / or (O- time) order. The model concept assume that each variable dependent stochastic component at time t can be expressed as a function of the independent stochastic component for all other variables at time (t), and those dependent component for all variables at time (t-1) at all sites. The expression is weighted by the serial correlation coefficients, cross-site correlation coefficients, cross-variable coefficients and cross-site, cross-variable correlation coefficients. In addition to that; the independent stochastic components are weighted by the residuals of all types of these correlations. These residual correlations are expressed using the same concept of autoregressive first order model (Markov chain). Further modification of this model is to use relative correlation matrix parameters by using correlation values relative to the total sum of correlation for each variable, and the total sum of residuals as a mathematical filter ,as will be shown later.

A model matrix equation for first order time lag, O=1, number of variables=V, and number of sites=S, could be put in the following form:

$$[\epsilon_t]_{v*s,1} = [\rho]_{v*s,v*s} * [\epsilon_{t-1}]_{v*s,1} + [\sigma]_{v*s,v*s} * [\xi_t]_{v*s,1} \quad (1)$$

Which for V=2,S=3,and O=1, can be represented by the following equation:

$$[\epsilon_t]_{6,1} = [\rho]_{6,6} * [\epsilon_{t-1}]_{6,1} + [\sigma]_{6,6} * [\xi_t]_{6,1} \quad (2)$$

Where :

$$\begin{pmatrix} \epsilon_{(v1,s1)} \\ \epsilon_{(v2,s1)} \\ --- \\ \epsilon_{(v1,s2)} \\ \epsilon_{(v2,s2)} \\ --- \\ \epsilon_{(v1,s3)} \\ \epsilon_{(v2,s3)} \end{pmatrix}_{\mathbf{t}} = [\epsilon_t]_{6,1} \quad (3)$$

$$\begin{pmatrix} \epsilon_{(v1,s1)} \\ \epsilon_{(v2,s1)} \\ --- \\ \epsilon_{(v1,s2)} \\ \epsilon_{(v2,s2)} \\ --- \\ \epsilon_{(v1,s3)} \\ \epsilon_{(v2,s3)} \end{pmatrix}_{\mathbf{t-1}} = [\epsilon_{t-1}]_{6,1} \quad (4)$$

$$\begin{pmatrix} \xi_{(v1,s1)} \\ \xi\epsilon_{(v2,s1)} \\ --- \\ \xi_{(v1,s2)} \\ \xi\epsilon_{(v2,s2)} \\ --- \\ \xi_{(v1,s3)} \\ \xi\epsilon_{(v2,s3)} \end{pmatrix}_t = [\xi_t]_{6,1} \quad (5)$$

$$\begin{pmatrix} \rho_{1,1} & \rho_{1,2} & \rho_{1,3} & \rho_{1,4} & \rho_{1,5} & \rho_{1,6} \\ \rho_{2,1} & \rho_{2,2} & \rho_{2,3} & \rho_{2,4} & \rho_{2,5} & \rho_{2,6} \\ \rho_{3,1} & \rho_{3,2} & \rho_{3,3} & \rho_{3,4} & \rho_{3,5} & \rho_{3,6} \\ \rho_{4,1} & \rho_{4,2} & \rho_{4,3} & \rho_{4,4} & \rho_{4,5} & \rho_{4,6} \\ \rho_{5,1} & \rho_{5,2} & \rho_{5,3} & \rho_{5,4} & \rho_{5,5} & \rho_{5,6} \\ \rho_{6,1} & \rho_{6,2} & \rho_{6,3} & \rho_{6,4} & \rho_{6,5} & \rho_{6,6} \end{pmatrix} = [\rho]_{6,6} \quad (6)$$

$$\begin{pmatrix} \sigma_{1,1} & \sigma_{1,2} & \sigma_{1,3} & \sigma_{1,4} & \sigma_{1,5} & \sigma_{1,6} \\ \sigma_{2,1} & \sigma_{2,2} & \sigma_{2,3} & \sigma_{2,4} & \sigma_{2,5} & \sigma_{2,6} \\ \sigma_{3,1} & \sigma_{3,2} & \sigma_{3,3} & \sigma_{3,4} & \sigma_{3,5} & \sigma_{3,6} \\ \sigma_{4,1} & \sigma_{4,2} & \sigma_{4,3} & \sigma_{4,4} & \sigma_{4,5} & \sigma_{4,6} \\ \sigma_{5,1} & \sigma_{5,2} & \sigma_{5,3} & \sigma_{5,4} & \sigma_{5,5} & \sigma_{5,6} \\ \sigma_{6,1} & \sigma_{6,2} & \sigma_{6,3} & \sigma_{6,4} & \sigma_{6,5} & \sigma_{6,6} \end{pmatrix} = [\sigma]_{6,6} \quad (7)$$

where:
$\rho_{1,1} = \rho$ [(x1, x1), (s1, s1), (t, t-1)]= population serial correlation coefficient of variable 1 with itself at site 1 for time lagged 1

$\rho_{1,2} = \rho$ [(x1, x2), (s1, s1), (t, t-1)]= population cross correlation coefficient of variable 1 at site 1 with variable 2 at site 1, for time lagged 1

$\rho_{1,3} = \rho$ [(x1, x1), (s1, s2), (t, t-1)]= population cross correlation coefficient of variable 1 at site 1 with variable 1 at site 2, for time lagged 1

$\rho_{1,4} = \rho$ [(x1, x2), (s1, s2), (t, t-1)]= population cross correlation coefficient of variable 1 at site 1 with variable 2 at site 2, for time lagged 1

$\rho_{1,5} = \rho$ [(x1, x1), (s1, s3), (t, t-1)]= population cross correlation coefficient of variable 1 at site 1 with variable 1 at site 3, for time lagged 1

$\rho_{1,6} = \rho$ [(x1, x2), (s1, s3),(t,t-1)]= population cross correlation coefficient of variable 1 at site 1 with variable 2 at site 3, for time lagged 1,the definition continues… , finally

$\rho_{6,6} = \rho$ [(x2, x2), (s3, s3), (t, t-1)]= population serial correlation coefficient of variable 2 at site 3 with variable 2 at site 3, for time lagged 1.

The designation ($\rho_{i,j}$) is used for simplification .

ϵ: is the stochastic dependent component.

ξ: is the stochastic independent component.

$\sigma_{i,j}$: is the residual of the correlation coefficient $\rho_{i,j}$.

The matrix equation (2) can be written for each term, for example for the first term:

$$\epsilon_{(1,s1,t)} = \rho_{1,1} * \epsilon_{(1,s1,t-1)} + \rho_{1,2} * \epsilon_{(2,s1,t-1)} + \rho_{1,3} * \epsilon_{(1,s2,t-1)} + \rho_{1,4} * \epsilon_{(2,s2,t-1)} +$$

$$\rho_{1,5} * \epsilon_{(1,s3,t-1)} + \rho_{1,6} * \epsilon_{(2,s3,t-1)} + \sigma_{1,1} * \xi_{(1,s1,t)} + \sigma_{1,2} * \xi_{(2,s1,t)} + \sigma_{1,3} * \xi_{(1,s2,t)} + \sigma_{1,4} *$$

$$\xi_{(2,s2,t)} + \sigma_{1,5} * \xi_{(1,s3,t)} + \sigma_{1,6} * \xi_{(2,s3,t)} \qquad (8)$$

Similar equations could be written for the other variables. The correlation coefficient in each equation is filtered by a division summation filter, as in the following equation:

$$\rho r_{i,j} = \frac{\rho_{i,j}}{\sum_{j=1}^{n=v*s} abs\,(\rho_{i,j}+\sigma_{i,j})}. \qquad (9)$$

Where $\rho r_{i,j}$ is the relative correlation coefficient of row i and column j of the matrix given in eq.(6). σ values are estimated using the following equation:

$$\sigma_{i,j} = (1 - \rho_{i,j}^2\ )^{0.5} \qquad (10)$$

Then these $\sigma_{i,j}$ are also filtered using an equation similar to eq.(9) as follows:

$$\sigma r_{i,j} = \frac{\sigma_{i,j}}{\sum_{j=1}^{n=v*s} abs(\rho_{i,j}+\sigma_{i,j})} \qquad (11)$$

Then the model matrix equation is the same as that appear in eq.(2), replacing $\rho_{i,j}$ values by the corresponding relative values $\rho r_{i,j}$ in equation (6), and $\sigma_{i,j}$ with the corresponding relative values $\sigma r_{i,j}$ in equation (7) . The differences of this model than that proposed by Al-Suhili and Mustafa(2013), are in eqs(9) and (11), where for the first equation the denominator is the sum of $\rho_{i,j}$, only , while for the second equation it is the sum of $\sigma_{i,j}$, only. The model can be generalized to any number of variables and number of sites.

III. THE CASE STUDY AND APPLICATION OF THE MODEL:

In order to apply the developed (MVMS) model explained above the Sulaimania Governorate was selected as a case study. Sulaimania Governorate is located north of Iraq with total area of (17,023 km2) and population (2009) 1,350,000. The city of Sulaimania is located (198) km north east from Kurdistan regional capital (Erbil) and (385) km north from the federal Iraqi capital (Baghdad). It is located between (33/43- 20/46) longitudinal parallels, eastwards and 31/36-32/44 latitudinal parallels, westwards. Sulaimania is surrounded by the Azmar range, Goizja range and the Qaiwan range from the north east, Baranan mountain from the south and the Tasluje hills from the west. The area has a semi-arid climate with very hot and dry summers and very cold winters, Barzanji, (2003) .The variables used in the model are the monthly air temperature, humidity, precipitation and evaporation .These variables that are expected to be useful for catchment management and runoff calculation. Data were taken from three meteorological stations (sites) inside and around Sulaimania city, which are Sulimania, Chwarta and Penjwin. These stations are part of the metrological stations network of Sulaimania governorate north Iraq. This network has eight weather stations distributed over an approximate area of (17023 km^2). Table 1 shows the names, latitudes, longitudes and elevations of these stations. Figure 2 shows a Google map of the locations of these stations. Table 2 shows the approximate distances between these stations.

The model was applied to the data of the case study described above. The length of the records for the four variables and the three stations is (8) years of monthly values, (2004-2011). The data for the first (5) years, (2004-2008) were used for model building, while the left last 3 years data, (2009-2011) were used for verification. The data includes the precipitation as a variable which has zero values for June, July, August and September, in the selected area of the case study. These months are included in the analysis, by adding a constant value to the precipitation series of 0.1 to avoid the problems that may be created by these zeros. Hence the model was built for the all of the months from January to December, rather than for October to May as proposed by Al-Suhili and Mustafa(2013).

The first step of the modeling process is to check the homogeneity of the data series. The split sample test suggested by Yevjevich(1972)was applied for this purpose for each data series to test the homogeneity both in mean and standard deviation values . The data sample was divided into two subsamples with sizes (n1=5,and n2=3) as number of years for subsample one and subsample two respectively. The split sample test estimated t-values were compared with the critical t-value. If the t-value estimated is greater than the critical t-value then the data series is considered as non-homogeneous, and thus this non-homogeneity should be removed. The results of this test had showed that there are some variables exhibits non- homogeneity. Tables 3 and 4 show these results, which indicates that non-homogeneity is exist in each of Sulaimania air temperature, Penjwin humidity, Penjwin air temperature, and Penjwin evaporation series, while the series of the other variables are homogeneous. To remove this non-homogeneity the method suggested by Yevjevich (1972), was used by applying the following data transformation to the series of the non-homogeneous variables for the n1 years:

$$H_{i,j} = Mean2 + \frac{X_{i,j}-(A1-B1*i)}{A2-B2*i} * Sd2 \tag{12}$$

Where,

$H_{i,j}$: is the homogenized series at year i, month j of the first sub-sample (old n1 series).

$X_{i,j}$: is the original series at year i, month j, of the first sub-sample .

A1, B1: are the linear regression coefficients of the annual means.

A2,B2 : are the linear regression coefficients of the annual standard deviations.

Mean2,Sd2 : are the overall mean and standard deviation of the second sub-sample(recent n2 series). This implies that the data is homogenized according to the second sub-sample, i.e., the most recent one which is the correct way for forecasting. Table 5 shows the values of Mean2, Sd2, A1, B1, A2, and B2, for the non-homogeneous series. Tables 6 and 7 show the results of the split sample test after the application of equation (12), which ensures that the data series are all now homogeneous.

The second step in the modeling process is to check and remove the trend component in the data if it is exist. This was done by finding the linear correlation coefficient (r) of the annual means of the homogenized series, and the T-value related to it. If the t-value estimated is larger than the critical t-value then trend exists, otherwise it is not. The following equation was used to estimate the t-values.

$$T = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}} \tag{13}$$

Where

n: is the total size of the sample.

Table 8 shows the trend test results, which indicate the absence of the trend component in all of the data series of the twelve variables.

The third step of the modeling process is the data normalization of the data to reduce the skewness coefficient to zero. The well known Box-Cox transformation Box and Jenkin (1976), was used for this purpose as presented in the following equation:

$$XN = \frac{(H+\alpha)^{\mu}-1}{\mu} \tag{14}$$

Where:

μ : is the power of the transformation.

α : is the shifting parameter.

XN : is the normalized series.

Table 9 shows the coefficients of the normalization transformation of all of the twelve series. A shifting parameter of constant value 5 is selected to ensure avoiding any mathematical problem that may occur due to the fraction value of the power µ. The power value is found by trial and error so as to select the one that reduce the skewness to almost zero value. However it was found that for the precipitation series in the three locations the required normalization transformation is of high negative value of order less than -4. If these values were selected the series is transformed to values that numerically differ after the 6 digits beyond the point, which means a very high accuracy is needed to perform the analysis which is not assured even if the long format of the Matlab software is used. Hence, for the precipitation series the minimum power value obtained among the other variables was used (-0.55). This transformation power will not let the skewness of the precipitation reduces to nearly zero as required, but at least reduce this skewness to values that are much smaller than the skewness of the homogenized series. Table 11 shows that the skewness coefficients are reduced to almost zeros for the data series, with an exception of the precipitation , which have skewness values less than 1.

The fourth step in the modeling process is to remove the periodic component if it exist to obtain the stochastic dependent component of the series, which is done by using eq.(15), as follows:

$$\epsilon_{i,j} = \frac{XN_{i,j} - Xb_j}{Sd_j} \tag{15}$$

Where:
$\epsilon_{i,j}$: is the obtained dependent stochastic component for year i, month j.
Xb_j : is the monthly mean of month j of the normalized series XN.
Sd_j : is the monthly standard deviation of month j of the normalized series XN.

The existence of the periodic components is detected by drawing the corrlogram up to at least 25 lags, if the curve exhibits periodicity then the periodic components are exist, otherwise it is not. Figure 3 shows the correlograms of the normalized data, where the periodic component is clear. Figure 4 shows the correlograms of the dependent stochastic component, which indicates the removal of the periodic components.

The fifth step in the modeling process is to estimate the parameters of the model. The $\epsilon_{i,j}$ obtained series are used to estimate the Lag-1 serial and cross correlation coefficients $\rho_{i,j}$, and $\sigma_{i,j}$ of matrix eqs. (6) and (7) respectively, which then used to estimate the model parameters $\rho r_{i,j}$ and $\sigma r_{i,j}$ using eqs.(9), and (11), respectively.

For the sake of comparison between the developed model and the known forecasting models in the literature, five types of forecasting models were developed for the same data of the case study. For each variable a single variable single site first order autoregressive model (8 models), for each site multi-variables single site first order Matalas model(3 models), for each variable a single variable multi-sites first order Matalas model (4 models) ,Al-Suhili and Mustafa multi-variables multi-sites model(1 model), and a multi-variables multi-sites Matalas model(1 model).

IV. FORECASTING RESULTS AND DISCUSSION

The developed models mentioned above are used for data forecasting, recalling that the estimated parameters above are obtained using the 5 years data series (2004-2008). The forecasted data are for the next 3-years (2009-2011), that could be compared with the observed series available for these years, for the purpose of model validation. The forecasting process was conducted using the following steps:

1. Generation of an independent stochastic component (ξ) using normally distributed generator, for 3 years, i.e., (3*12) values.
2. Calculating the dependent stochastic component ($\epsilon_{i,j}$) using equation (2) and the matrices of $\rho r_{i,j}$ and $\sigma r_{i,j}$ as shown in eqs.(9), and (11),respectively.
3. Reversing the standardization process by using the same monthly means and monthly standard deviations which were used for each variable to remove periodicity using eq. (15) after rearranging.
4. Applying the inverse power normalization transformation (Box and Cox) for calculating un-normalized variables using normalization parameters for each variable and eq.(14).

In most forecasting situation, accuracy is treated as the overriding criterion for selecting a model. In many instance the word “accuracy” refers to “goodness of fit,” which in turn refers to how well the forecasting model is able to reproduce the data that are already known. The model validation is done by using the following steps:

1. Checking if the developed monthly model resembles the general overall statistical characteristics of the observed series.
2. Checking if the developed monthly model resembles monthly means using the t-test .

3. Checking the performance of the model of the hole forecasted series using Akaike test.

The Akaike test can be used also for the purpose of comparison of the forecasting performance between the new multi-variables multi-sites model developed herein and the other models. This performance comparison was made to investigate whether the new model can produce better forecasted data series. For this purpose the Akaike (AIC), test given by the following equation was used:

$$AIC = 2K + n \, Ln \frac{Rss}{n} \tag{16}$$

Where:
n: is the number of the total forecasted values .
K: number of parameters of the model plus 1.
Rss: is the sum of square error between the forecasted value and the corresponding observed value.

For each site and variable three sets of data are generated, using the six different models mentioned above. The overall statistical characteristics are compared with those observed, for each of the generated series. It is observed that the six models can all give good resemblances for these general statistical properties. For all variables and sites the generated sets resemble the statistical characteristics not exactly with the same values of the observed series but sometimes larger or smaller but within an acceptable range. No distinguishable performance of any of the model can be identified in this comparison of the general statistical properties. Tables 10,11 and 12 show the t-test percent of succeed comparison summary for all of the variables and sites, for the three generated series. As it is obvious from the results of these tables, the generated series for the first four model succeed in (t-test) with high percentages except for the Penjwin station where sometimes low percentage is observed. It is also clear that the developed model had increased the percent of succeed. The developed model had the highest overall percent of succeed among the other models. However the overall succeed percent given by the Al-suhili and Mustafa model is almost similar to that given by the developed model.

As mentioned above for purpose of the comparison between the developed model performance and that of the available forecasting models and developed for the data as mentioned above, the Akaike(1974) test was used. Table 13, shows the Akaike test results for all of the forecasted variables, in each site, obtained using the developed five models and those obtained by the developed model. It is obvious that the developed model had produced for most of the cases the lowest test value, i.e, the better performance. These cases represent (83.33%). Al-Suhili and Mustafa model had gave the lowest test value for the remaining cases (16.66%). However for these cases the developed model had gave the next lowest AIC values. Moreover for these cases it is observed that very small differences are exist between these test values of the new model and the minimum obtained one.

Figure 5 shows comparisons between the observed and the generated series using the developed model for the whole three years and between the monthly means of these two series. This figure indicates the capability of the model for forecasting the future variation of all of the variables.

V. CONCLUSIONS

From the analysis done in this research, the following conclusion could be deduced:
The model parameters can be easily estimated and do not require any extensive mathematical manipulation.
The model can preserve the overall statistical properties of the observed series with high accuracy. However this is also observed for the other five models developed for the same variables.
The model can preserve the monthly means of the observed series with excellent accuracy, evaluated using the t-test with overall success (94.4%). This percent is almost the highest among the those obtained by the other model, except that the Al-Suhili and Mustafa model(2013), had presented a very close values.
The comparison of the model performance with the other models performances using the Akaike test had proved that the developed model had a better performance for the most cases(83.33%). Moreover for those remaining cases where Al-suhaili and Mustafa(2013) model had the better performance(minimum AIC value); the test value of the developed model is slightly higher than this minimum value.

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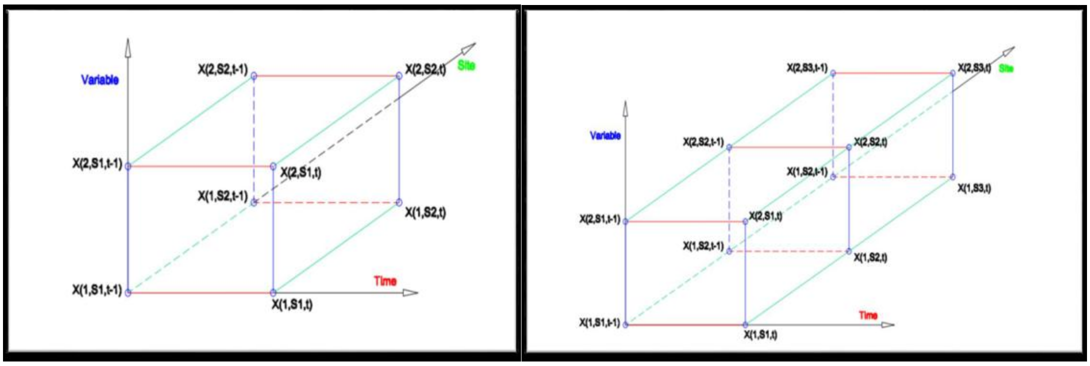


(a) **(b)**

Fig. 1 Schematic representation of the developed multi-variables multi-sites model, a)MVMS(2,2,1), b) MVMS(2,3,1).

Table 1 North and east coordinates of the metrological stations selected for analysis.

Metrological station	N	E
Sulaimania	35° 33' 18"	45° 27' 06"
Dokan	35° 57’ 15”	44° 57' 10"
Derbenikhan	35° 06' 46"	45° 42' 23"

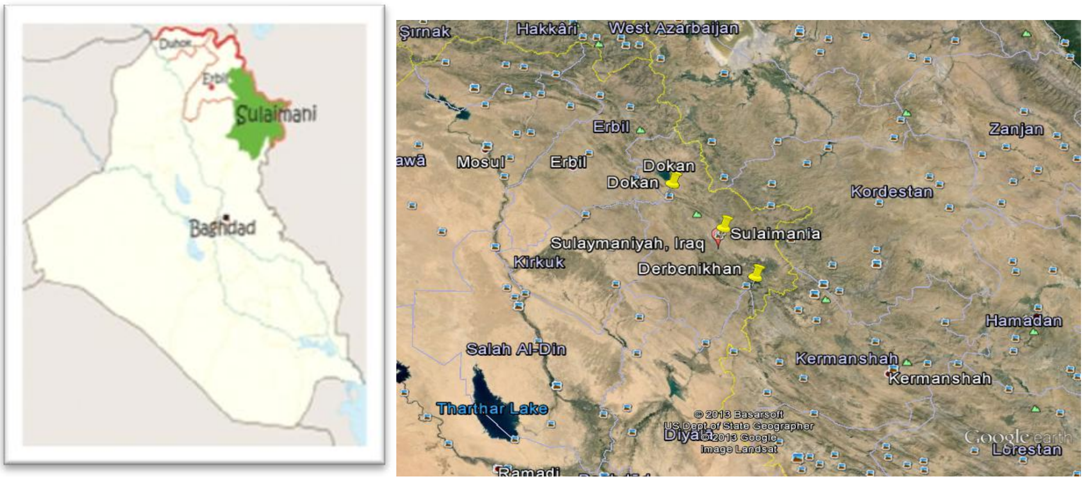


Fig. 2 Locations of the metrological stations selected for analysis.

Table 2 Approximate distances between the Sulaimania weather stations network (Km.).

Name of Weather Station	Sulaimani	Dukan	Darbandikhan	Penjwin	Chwarta	Halabjah	Bazian	Chamchamal
Sulaimani	0	62.76	54.00	45.88	20.85	63.36	29.17	56.10
Dukan	62.76	0	114.73	97.10	61.20	125.85	42.00	47.90
Darbandikhan	54.00	114.73	0	61.40	68.68	28.36	73.98	90.57
Penjwin	45.88	97.10	61.40	0	36.53	48.22	74.15	102.12
Chwarta	20.85	61.20	68.68	36.53	0	69.73	41.30	69.90
Halabjah	63.36	125.85	28.36	48.22	69.73	0	89.50	111.05
Bazian	29.17	42.00	73.98	74.15	41.30	89.50	0	28.41
Chamchamal	56.10	47.90	90.57	102.12	69.90	111.05	28.41	0

Table 3 Test of homogeneity of the original data in mean, n1=5,n2=3.

	Mean1	Mean2	s1	s2	s	t-test	Case
SulAT	19.9008	20.1485	0.4507	1.18751	0.778	-0.436	Hom.
SulHu	46.9446	45.8553	2.4575	1.46515	2.178	0.68499	Hom.
SulPr	1.69637	1.66298	0.4676	0.13639	0.39	0.11729	Hom.
SulEv	5.52551	5.23813	0.1015	0.45864	0.277	1.41827	Hom.
ChwAT	16.4929	17.1897	0.5596	1.29252	0.875	-1.0904	Hom.
ChwHu	49.6663	46.9338	3.4431	1.90116	3.018	1.23977	Hom.
ChwPr	1.9079	1.89837	0.6068	0.07698	0.497	0.02625	Hom.
ChwEv	5.60861	5.28657	0.4906	0.3626	0.452	0.97565	Hom.
PenAT	13.9755	13.5897	0.7737	1.14588	0.915	0.57744	Hom.
PenHu	63.3525	52.6272	6.9884	4.69652	6.318	2.32467	NonHom.
PenPr	2.75305	2.66979	0.9516	0.0907	0.779	0.1464	Hom.
PenEv	5.46681	4.62648	0.4845	0.25017	0.421	2.7322	NonHom.

Table 4 Test of homogeneity of the original data in standard deviation, n1=5,n2=3.

	Mean1	Mean2	s1	s2	s	t-test	case
SulAT	10.1889	9.52285	0.2866	0.47757	0.362	2.52179	NonHom.
SulHu	18.7659	17.4115	2.5053	0.99604	2.125	0.8728	Hom.
SulPr	2.18701	1.86037	0.6365	0.28427	0.545	0.82064	Hom.
SulEv	3.69204	3.52068	0.21	0.36782	0.273	0.85961	Hom.
ChwAT	10.5129	9.65657	0.5551	0.6469	0.587	1.99648	Hom.
ChwHu	16.0407	15.7313	2.1606	1.65751	2.007	0.21105	Hom.
ChwPr	2.43547	2.12283	0.8342	0.23539	0.695	0.61639	Hom.
ChwEv	3.8826	3.59904	0.2506	0.02954	0.205	1.89074	Hom.
PenAT	11.3524	9.38528	1.094	0.84784	1.019	2.64447	NonHom.
PenHu	13.033	14.0986	1.492	3.44251	2.331	-0.6259	Hom.
PenPr	3.50955	2.82328	1.3632	0.34376	1.131	0.83116	Hom.
PenEv	4.10278	3.75387	0.5069	0.2391	0.436	1.09505	Hom.

Table 5 Linear fitting equations for removal of non-homogeneity.

	A1	B1	R1	A2	B2	R2
SulAT	19.534	0.102	0.342	10.22	-0.062	0.318
SulHu	48.102	-0.348	0.407	20.859	-0.578	0.678
SulPr	1.904	-0.049	0.333	2.481	-0.092	0.425
SulEv	5.601	-0.041	0.336	3.817	-0.042	0.385
ChwAT	15.886	0.193	0.533	10.522	-0.073	0.256
ChwHu	51.877	-0.719	0.562	17.164	-0.275	0.362
ChwPr	2.178	-0.061	0.325	2.834	-0.114	0.422
ChwEv	5.529	-0.009	0.05	3.843	-0.015	0.151
PenAT	14.562	-0.162	0.457	12.504	-0.42	0.741
PenHu	72.717	-2.975	0.904	13.267	0.037	0.04
PenPr	3.213	-0.109	0.371	4.238	-0.219	0.485
PenEv	5.63	-0.106	0.446	3.993	-0.005	0.026

Table 6 Test of homogeneity of the homogenized data in mean, n1=5,n2=3.

	Mean1	Mean2	s1	s2	s	t-test	Case
SulAT	20.207998	20.1485	0.2963	1.18751	0.727	0.112	Hom.
SulHu	46.944628	45.8553	2.4575	1.46515	2.1775	0.68499	Hom.
SulPr	1.6963688	1.66298	0.4676	0.13639	0.3899	0.11729	Hom.
SulEv	5.5255085	5.23813	0.1015	0.45864	0.2775	1.41827	Hom.
ChwAT	16.492926	17.1897	0.5596	1.29252	0.875	-1.0904	Hom.
ChwHu	49.666252	46.9338	3.4431	1.90116	3.018	1.23977	Hom.
ChwPr	1.9079033	1.89837	0.6068	0.07698	0.4974	0.02625	Hom.
ChwEv	5.6086085	5.28657	0.4906	0.3626	0.452	0.97565	Hom.
PenAT	13.492285	13.5897	0.5189	1.14588	0.7856	-0.1698	Hom.
PenHu	52.170046	52.6272	3.5289	4.69652	3.9566	-0.1582	Hom.
PenPr	2.7530521	2.66979	0.9516	0.0907	0.7787	0.1464	Hom.
PenEv	4.7733789	4.62648	0.584	0.25017	0.4982	0.40373	Hom.

Table 7 Test of homogeneity of the homogenized data in standard deviation, n1=5,n2=3.

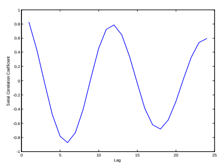
	Mean1	Mean2	s1	s2	s	t-test	case
SulAT	9.6723865	9.52285	0.3562	0.47757	0.4008	0.51093	Hom.
SulHu	18.76593	17.4115	2.5053	0.99604	2.1249	0.8728	Hom.
SulPr	2.1870135	1.86037	0.6365	0.28427	0.545	0.82064	Hom.
SulEv	3.6920379	3.52068	0.21	0.36782	0.273	0.85961	Hom.
ChwAT	10.512893	9.65657	0.5551	0.6469	0.5873	1.99648	Hom.
ChwHu	16.040672	15.7313	2.1606	1.65751	2.007	0.21105	Hom.
ChwPr	2.4354703	2.12283	0.8342	0.23539	0.6945	0.61639	Hom.
ChwEv	3.882598	3.59904	0.2506	0.02954	0.2054	1.89074	Hom.
PenAT	9.4755896	9.38528	0.7297	0.84784	0.7711	0.16037	Hom.
PenHu	13.737973	14.0986	1.6012	3.44251	2.379	-0.2075	Hom.
PenPr	3.5095495	2.82328	1.3632	0.34376	1.1306	0.83116	Hom.
PenEv	3.8723131	3.75387	0.4844	0.2391	0.4189	0.38718	Hom.

Table 8 Trend detection test after removing non-homogeneity.

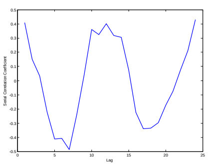
	r	t
SulAT	0.0766045	0.1882
SulHu	-0.407047	-1.0916
SulPr	-0.333184	-0.8656
SulEv	-0.336426	-0.8751
ChwAT	0.5332421	1.54401
ChwHu	-0.562345	-1.6658
ChwPr	-0.325523	-0.8433
ChwEv	-0.049619	-0.1217
PenAT	-0.109125	-0.2689
PenHu	-0.187953	-0.4687
PenPr	-0.370671	-0.9776
PenEv	0.2005191	0.50135

Table 9 Normalization transformation power, and skewness for data (2004-2008).

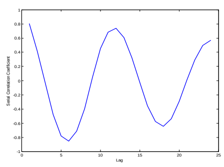
	Power	Skewness
SulAt	1.1	0.007658458
SulHu	0.9	0.008000455
SulPr	-0.55	0.756794614
SulEv	-0.55	0.001047691
ChwAt	1	0.000888238
ChwHu	1	0.001705557
ChwPr	-0.55	0.749611239
ChwEv	-0.35	-0.005834051
PenAT	1.05	-0.003692929
PenHu	1.1	-6.97121E-05
PenPr	-0.55	0.62709928



a1



a2



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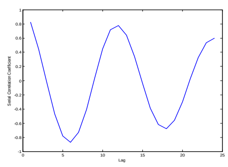

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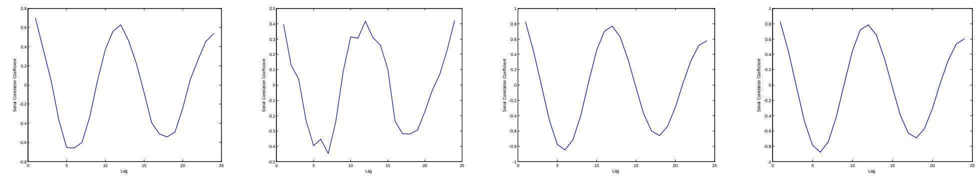
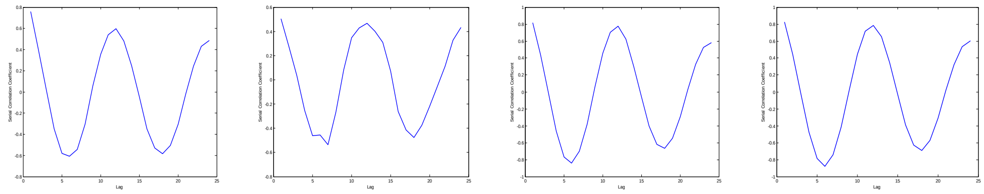
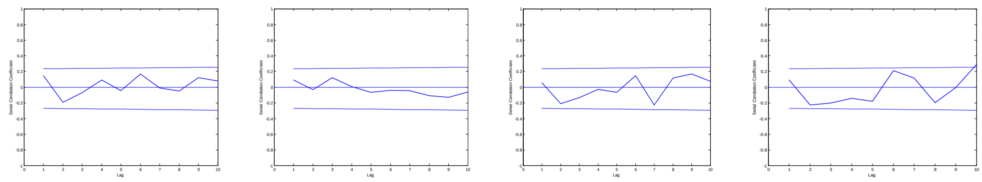


b1 b2 b3 b4

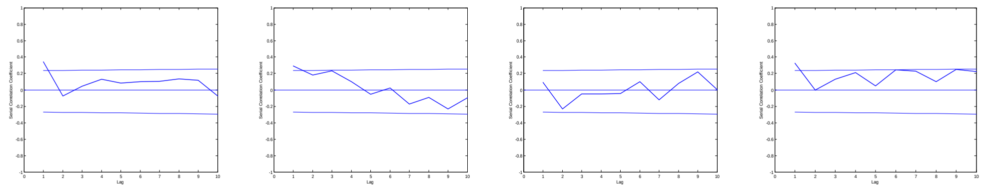


c1 c2 c3 c4

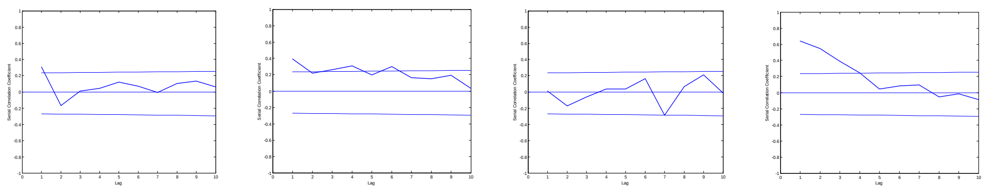
Fig. 3 Correlograms of the normalized data series,a) Sulaimania, b) Chwarta, c) Penjwin, 1) Air temperature,2) Humidity,3) Precipitation,4) Evaporation.



a1 a2 a3 a4



b1 b2 b3 b4



c1 c2 c3 c4

Fig. 4 Correlograms of the dependent stochastic series, a) Sulaimania, b) Chwarta, c) Penjwin, 1) Air temperature,2) Humidity,3) Precipitation,4) Evaporation.

Table 10 Comparison between the percent of succeed in t-test for differences in monthly means of the generated and observed data for set 1 generated series, by each model.

	SS	MSSV	MVSS	Al-Suhili and Mustafa	Matalas MVMS	MVMS
SulAT	100	91.667	100	100	91.66666667	100
SulHu	100	100	100	83.3333333	91.66666667	100
SulPr	83.33	100	100	91.6666667	100	91.667
SulEv	100	100	100	100	100	100
ChwAT	100	91.667	91.667	91.6666667	91.66666667	91.667
ChwHu	100	100	91.667	100	91.66666667	100

ChwPr	91.67	91.667	83.333	91.6666667	100	91.667
ChwEv	91.67	91.667	91.667	91.6666667	91.66666667	91.667
PenAT	83.33	100	91.667	100	91.66666667	91.667
PenHu	66.67	66.667	83.333	83.3333333	75	83.333
PenPr	100	91.667	91.667	100	91.66666667	100
PenEv	66.67	83.333	100	100	91.66666667	91.667
Overall	90.28	92.361	93.75	94.4444444	92.36111111	94.444

Table 11 Comparison between the percent of succeed in t-test for differences in monthly means of the generated and observed data for set 2 generated series, by each model.

	SS	MSSV	MVSS	Al-Suhili and Mustafa	Matalas MVMS	MVMS
SulAT	100	100	100	100	100	100
SulHu	91.67	91.667	100	91.6666667	100	91.667
SulPr	100	100	100	100	100	91.667
SulEv	100	100	100	100	100	100
ChwAT	83.33	100	91.667	91.7	75	91.7
ChwHu	100	91.667	91.67	100	100	100
ChwPr	91.67	91.667	91.667	91.6666667	91.66666667	91.667
ChwEv	91.67	91.667	91.667	91.6666667	83.33333333	91.667
PenAT	100	100	100	100	91.66666667	91.667
PenHu	66.67	66.667	75	75	91.66666667	83.3
PenPr	100	100	100	91.6666667	91.66666667	100
PenEv	100	91.667	91.667	100	91.66666667	100
Overall	93.75	93.75	94.445	94.4472222	93.05555556	94.444

Table 12 Comparison between the percent of succeed in t-test for differences in monthly means of the generated and observed data for set 3 generated series, by each model.

	SS	MSSV	MVSS	Al-Suhili and Mustafa	Matalas MVMS	MVMS
SulAT	83.33	91.667	100	100	100	100
SulHu	100	91.667	83.333	83.3333333	100	91.667
SulPr	100	100	91.667	91.6666667	100	100
SulEv	100	100	100	100	100	100
ChwAT	100	100	91.667	91.6666667	91.66666667	100
ChwHu	91.67	100	100	91.6666667	91.66666667	91.667
ChwPr	91.67	100	91.667	100	91.66666667	100
ChwEv	100	83.333	91.667	91.6666667	91.66666667	91.667
PenAT	91.67	100	91.667	100	100	91.667
PenHu	75	66.667	66.667	75	75	75
PenPr	91.67	91.667	91.667	91.6666667	91.66666667	91.667
PenEv	100	100	83.333	100	83.33333333	100
Overall	93.75	93.75	90.278	93.0555556	93.05555556	94.444

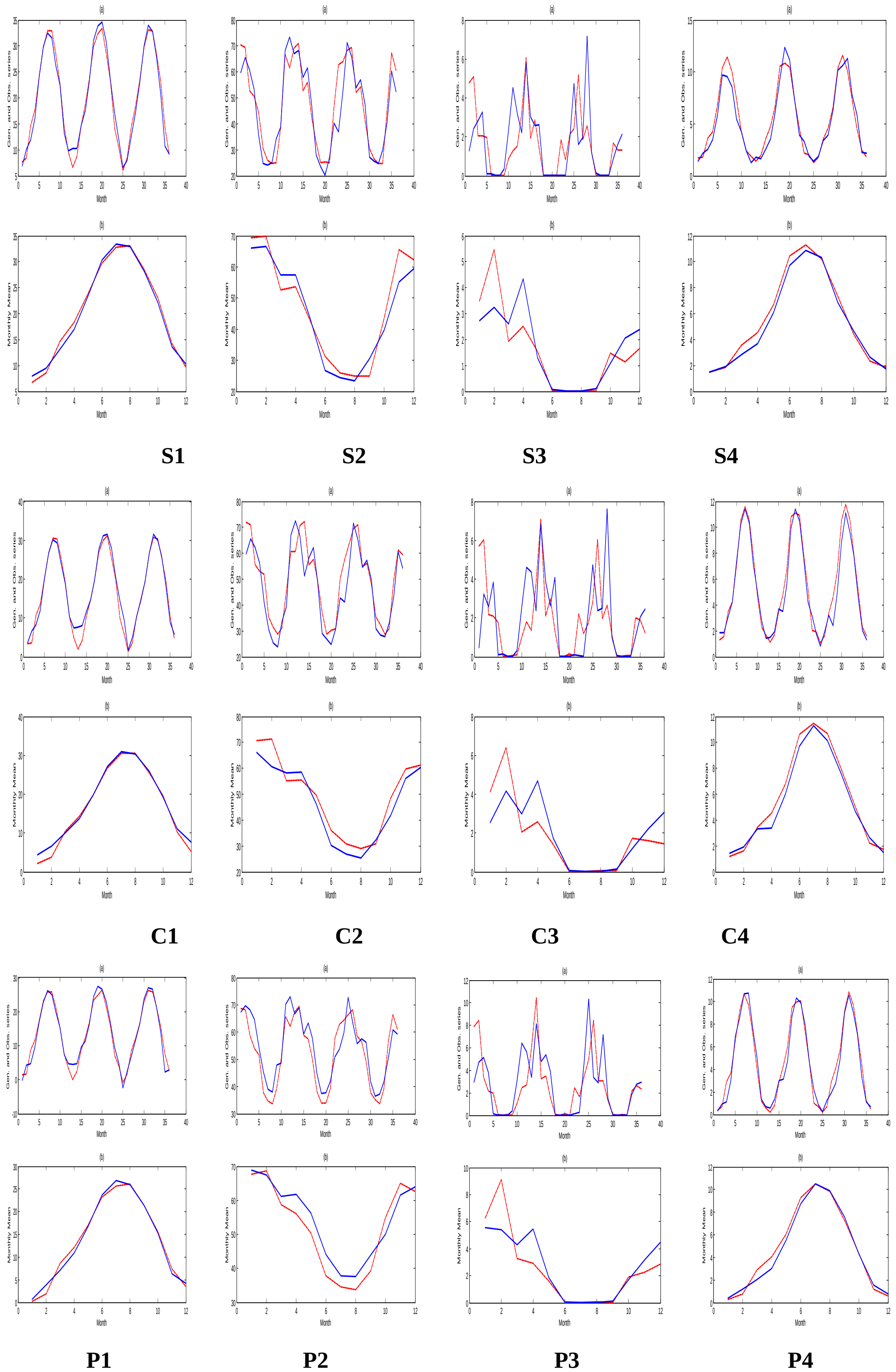


Fig. 5 Comparison between observed and forecasted series(2009-2011), S:Sulaimania,C:Chwarta,P:Penjwin,1:Airtemperature, 2:Humidity, 3:Pecipitatio-n Evaporation, a:Three years series, b:Monthly means.

Table 13. Comparison between the AIC test for the three generated series by each model.

		SulAT	SulHu	SulPr	SulEv	ChwAT	ChwHu	ChwPr	ChwEv	PenAT	PenHu	PenPr	PenEv
Set 1	SS	60.04	183	54.89	2.104	58.31	165.55	65.53	14.39	63.32	143.64	95.86	6.103
	MSSV	42.13	185	57.73	14.42	70.01	186.98	99.93	4.1	57.76	152.49	91.31	13.22
	MVSS	66.97	158	58.37	7.095	71.31	169.69	51.35	-1.246	60.95	157.9	130.7	-8.323
	Al-Suhili and Mustafa	45.02	158	39.68	-1.38	55.91	153.2	47.48	-13.86	53.88	143.23	62.2	-11.74
	MVMS	36.43	144	36.58	-5.35	48.84	144.92	48.62	-15.76	46.57	126.39	61.89	-20.55
Set 2	SS	54.38	163	50.84	10.68	79.51	187.49	55.09	-19.04	61.29	153.73	91.79	19.75
	MSSV	73.38	168	72.78	13.97	62.9	173.26	63.21	6.373	67.8	173.56	101.3	15.52
	MVSS	48.31	190	62.51	6.358	81.06	169.01	66.25	-3.124	61.9	142.18	95.18	29.9
	Al-Suhili and Mustafa	40.6	153	33.71	-3.7	53.7	148.72	46.15	-12.47	50.31	137.7	59.68	-19.29
	MVMS	35.09	150	36.09	-3.21	51.71	146.4	46.3	-9.43	45.59	127.45	63.46	-14.18
Set 3	SS	46.43	145	63.35	17.81	64.45	171.17	110.7	22.29	56.22	164.29	107.7	-5.484
	MSSV	48.88	165	67.72	11.97	69.84	177.03	86.33	29.87	70.4	149.45	63.05	20.53
	MVSS	48.96	167	45.03	25.9	81.77	160.22	87.54	-1.396	69.7	153.59	98.92	28.11
	Al-Suhili and Mustafa	43.53	150	42.85	-6.46	57.58	147.49	55.41	-16.01	55.76	132.87	67.45	-14.84
	MVMS	41.61	144	35.67	-2.82	57.4	142.15	45.95	-11.54	51.3	117.14	62.19	-15.31

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An Expression for Obtaining Total Heads for Lift Pump Selection

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Abstract: - By making reasonable assumptions of flow parameters which should result in fairly high pressure losses in simple water lifting systems such as those utilized in building and estate development projects (as distinct from the elaborate water works that serve entire localities), an expression was derived for calculating the total system head which a selected pump would be required to overcome in duty. Such flow parameters include the Hazen–Williams coefficient, pipe sizes and number of each type of pipe fitting and valve. A computer program was subsequently written to obtain total system heads for various pump discharge rates, and varying static heads and horizontal pipe length. A system head curve was then drawn using the output and utilized to illustrate how the pump selection process can be facilitated by such sets of curves.

Keywords: - *System head equations, lift pump selection*

I. INTRODUCTION

The selection of lift pumps for water supply systems is a frequent exercise in building services design in developing environments. This is due to the erratic nature of the pressure of the city mains supply. Private borehole water supplies also require lifting to high elevations from which distribution is effected by virtue of gravity.

A common lifting arrangement is shown in Fig 1. Water flows from the city mains into a low level tank. A pump then raises the water into a high level tank. The procedure for selecting the lift pump utilizes two important parameters: the discharge rate and the total pressure head. The discharge rate is determined by the desired rate of filling the high level tank, while the total head is determined by the total pressure loss of the system which the pump should overcome in duty. The total system head is an addition of the height of the high level storage above the pump (called the static discharge head), the frictional head loss, the head loss due to pipe fittings and valves, and height of the pump above the low level storage (called the suction lift.)

The pump selection procedure involves calculating total heads (utilizing the chosen height of the high level storage) for varying discharge rates (in the region of the chosen filling rate). A graph of system head against flow rate is thereby generated and superimposed onto the characteristic head versus flow rate curves of a particular set of pumps. A pump having a characteristic curve which cuts the system head near the point of peak efficiency of the set of pumps is then selected for the duty. The pump selection procedure is well illustrated in the literature [1, 2]

This procedure, involving series of calculations and plotting of graphs, is usually time-consuming. Also considering that, apart from pump selection, there are several other requirements needed to be accomplished in realizing a complete water supply and distribution system design, there is the need to seek means of facilitating the pump selection procedure.

In this regard, an expression for obtaining sets of system head curves useful in pump selection is derived in this paper (as an illustration) by assuming commonly utilized values of system parameters. Such parameters include the Hazen – Williams coefficient C, pipe sizes, and numbers and types of pipe fittings and valves. The assumed values are such that they result in not-too-favourable pressure losses in the lifting arrangement; and therefore, fairly higher pump heads than would be required in real situations. These assumed values thus provide some margin of safety in pump selection.

II. FORMULATION OF SYSTEM HEAD EQUATIONS

The pressure losses to be overcome in the pumping arrangement of Fig. 1 are analyzed here. This arrangement, with the incorporation of a few more elbows, serves to represent the generality of simple water lifting configurations that abound; as it consists of a larger number of flow-resisting fittings than most others.

In order to illustrate the formulation of a representative expression of total system heads for various water lifting schemes, some values of flow parameters are standardized as follows. However, for systems which differ widely from the one being considered in Fig. 1, different representative sets of parameters should be assumed.

(a) Table 1 shows typical values of C for various piping materials after about 20 years in service [2]. As most of these piping materials have C values greater than 100, this value is chosen as a standard in the analysis
(b) As most pumps used for water lifting in building projects of moderate complexity come with suction and discharge connections which are not less than 25 mm (1″), this size is taken as standard for pipes, fittings and valves, in order to reckon with a flow condition that is not too favorable: a larger size would result in a smaller head loss.
(c) The number and type of each fitting and valve shown in the scheme of Fig. 1 are used to present those normally utilized in simple water lifting schemes and are listed in Table 2. However, to allow for unforeseen changes in direction during actual pipe installation the number of elbows (of 90^0 and 135^0 types) appearing in Fig. 1 have been doubled as listed in Table 2.
(d) The size of the orifice of the water discharge ball valve located at the high level storage tank is taken as 6 mm (¼″) for this illustration analysis, as ball valves having smaller orifice sizes are seldom utilized in water lifting. Also, this size produces a fairly high pressure loss in the range of flow rates normally encountered in simple water lifting arrangements. A comparison with the next larger size of orifice, i.e. the 9.5 mm ($^3/_8$″) size, shows this in Appendix 1 [3]. For instance, for a flow rate of 0.3 l/s (1.08m^3/h), the 6 mm orifice produces a loss of 4.7 m while the 9.5 mm orifice produces a loss of only 1.4 m.

It is also observed that, generally, the head h_o through the ball valve orifice is a major contribution to the total system head and wide variations in total head would result from varying orifice sizes. It is therefore suggested that different expressions of total system head be derived for different sizes of ball valve orifice.

2.1 Frictional Head Loss, H_f

This loss H_f is analyzed by using the Hazen-Williams formula in the form [4]

$$H_f = \frac{133.4d^{-0.017}}{C^{1.85}} \left[\frac{1}{vd}\right]^{0.15} \left[\frac{l}{d}\right] \frac{v^2}{2g} \quad (1)$$

where d = pipe diameter (in m)
l = pipe length (in m)
v = flow velocity (in m/s)
g = acceleration due to gravity (9.81m/s^2)

Also, $$V = \frac{4Q}{\pi d^2} \quad (2)$$

where Q = pump discharge (in m^3/s)
Substituting for v in Eqn. 1 and simplifying the resulting expression, we have

$$H_f = \frac{10.6226 l\, d^{-4.867}}{C^{1.85}} Q^{1.85} \quad (3)$$

The total length l is the sum of the vertical and horizontal lengths, H_s and H_h respectively

$$\therefore \quad l = H_s + H_h \quad (4)$$

Also, d = 0.025 m and C = 100.

Substituting these values in Eqn. 3 and simplifying the resulting expression we have

$$H_f = 132879.14\,(H_s + H_h)\,Q^{1.85} \quad (5)$$

2.2 Loss through Fittings and Valves H_p

This loss is given as

$$H_p = \frac{1}{2g}\sum_{i=1}^{i=n} k_i v_i^2 \qquad (6)$$

Again substituting for V_i using Eqn. 2 and noting that the flow rate Q is the same through every fitting and valve in the pumping system, we obtain

$$H_p = 0.08256\,Q^2 \sum_{i=1}^{i=n} k_i d_i^{-4} \qquad (7)$$

The values of head loss coefficient K_i to be applied in Eqn. 7 are obtained from Table 2. [4]. However the head loss h_o through the 6 mm (¼") ball valve orifice is taken from the graph of head loss versus flow rate shown in Appendix 1.

By substituting the values in Table 2 and the size of 25 mm (0.025 m) for pipes, fittings and valves we have

$$H_p = 0.025^{-4} \times 0.08256\,Q^2\,[(1 \times 1.00) + (12 \times 0.75) + (2 \times 0.45) + (2 \times 2.00) + (2 \times 0.25) + (1 \times 3.00)] + h_0$$

$$\therefore\; H_p = 3888906.24\,Q^2 + h_0 \qquad (8)$$

The graph of h_o against flow rate may be translated into a mathematical expression in order to make the calculation of H_p more straightforward. This derivation is done in Appendix 2 resulting in the expression

$$h_o = 10^{1.7197 \log Q + 6.7353} \qquad (9)$$

2.3 Total Static Head H_s

$$H_s = \text{static discharge head} + \text{suction lift} \qquad (10)$$

$$= \text{total vertical pipe length}$$

2.4 Total System Head H_t

H_t is then given as
$$H_t = H_f + H_p + H_o + H_s \qquad (11)$$

The right hand side of this equation is given by Eqns. 5, 8, 9 and 10, respectively. Eqn. 11 can therefore be expressed as

$$H_t = 132879.14\,(H_s + H_h)\,Q^{1.85} + 3888906.24\,Q^2 + 10^{1.7197\log Q + 6.7353} + H_s \qquad (12)$$

The static head H_s depends on the required height of the high level storage which is usually determined by the pressure requirements of the final water distribution network. The horizontal pipe run H_h is usually minimized as the high level storage tank is usually sited as close as possible to the low level tank in simple water supply schemes.

Eqn. 12 can be used to plot a system head curve by varying the pump discharge rate Q, once H_s and H_h have been chosen. Several system head curves can thereby be obtained for various values of H_s and H_h. Such standard head curves can be used to select pumps for different simple water lifting schemes.

III. RESULTS AND DISCUSSIONS

A computer run, shown in Appendix 3, has been done utilizing Eqn. 12 to obtain total system heads for values of static discharge head H_s ranging from 0 m to 50m in steps of 5m for a total horizontal pipe run H_h of 10 m. The variables appearing in the program listing of Appendix 3 are defined in Appendix 4. The computer-generated values are shown in Table 3.

A typical set of manual calculations for testing the computer output for a static head of 15 m, a total horizontal pipe run of 10 m and a pump discharge rate of 5m^3/h using Eqn. 12 gives H_t as 105.9987m.

Here, H_s = 15m, H_h = 10m, and Q = $\frac{5}{3600}$ m^3/s

$$\therefore H_t = 132879.14(15+10)\left(\frac{5}{3600}\right)^{1.85} + 3888906.24\left(\frac{5}{3600}\right)^2 + 10^{1.7197\log\left(\frac{5}{3600}\right)+6.7353} + 15$$

$$= 17.1992 + 7.5017 + 66.3048 + 15$$

$$= 105.9987\text{m}$$

This value agrees with that in Table 3 (106.00m) as obtained using the computer. It is observed from this computation that the head loss of 66.3048 m through the ball valve orifice constitutes a major contributor to the total system head of 105.9987 m. As suggested earlier, different expressions similar to Eqn. 12 should therefore be derived and utilized for different sizes of ball valve orifice.

The discharge rates Q utilized in generating the heads are chosen to fall within the range of flows normally utilized in simple private water lifting schemes (i.e. up to about 10 m^3/h).

Taking an example of pump selection for a scheme of water lifting to a static head H_s of 20 m and a total horizontal pipe length H_h of 10m, the system head curve of Fig. 2 is drawn and superimposed onto the characteristic curve of a particular make and range of pumps. The pump efficiency versus discharge curve of the particular range of pumps is also shown in Fig. 2.

The peak efficiency of 70% occurs at a flow of 7.0 m^3/h; and as the nearest flow rate at which a characteristic curve cuts the system head curve is 7.4 m^3/h, the pump which has this characteristic curve (i.e. pump no. 3) is selected for the duty; the total pump head at this point of duty being 210m.

Thus, ready – made sets of system head curves obtained for different static heads, total horizontal pipe lengths, and other standardized system parameters would facilitate lift pump selection, since they can be used repeatedly for different projects.

IV. CONCLUSIONS

By making assumptions of flow parameters which would bring about reasonably high pressure losses in the pumping system, an expression has been derived for calculating the total head to be overcome in duty by lift pumps utilized in simple water supply schemes. The envisaged high pressure losses would ensure that pumps having safely high heads are selected for each duty. For those lifting configurations whose flow parameters can be safely and economically approximated to those discussed in this paper the set of curves obtainable from the computer-generated values can be used repeatedly with different pump characteristic curves to select pumps that satisfy different discharge rates.

For lifting configurations which differ appreciably from this, different analyses should be done, in the same manner, to evolve applicable pressure head equations, computer output data, and sets of system head curves.

Table 1: Some Values of C in Hazen – Williams Formula [2]

Extremely smooth and straight pipes (such as plastics)	140
Asbestors – Cement	140
Copper or brass	130
Lead, tin, or glass	130
Cast iron or wrought iron	100
Welded or seamless steel	100
Concrete	100
Corrugated steel	60

Table 2: Head Loss Coefficients for Fittings and Valves [4].

Fitting or Valve Type	Number in System	Average Lost Head Coefficient
Tank-to-pipe entrance fitting	1	1.00
90^0 elbow	12	0.75
135^0 elbow	2	0.45
Tee	2	2.00

Gate valve	2	0.25
Check valve	1	3.00
Ball valve with 6mm orifice	1	Values obtained from Appendix 1

Table 3: Computed Total System Heads Using Equation 12 for a Total Horizontal Pipe Run H_h of 10 m

Static Head H_s (m)	**Pump Discharge Rate Q (m^3/h)**									
	1	2	3	4	5	6	7	8	9	10
0	4.81	16.18	32.92	54.53	80.68	111.16	145.78	184.40	226.90	273.19
5	9.99	21.81	39.25	61.80	89.12	120.98	157.19	197.60	242.10	290.58
10	15.16	27.44	45.49	69.08	97.56	130.80	168.60	210.81	257.30	307.98
15	20.34	33.07	51.93	76.35	106.61	140.61	180.00	224.01	272.50	325.37
20	25.51	38.70	58.26	83.63	144.44	150.43	191.41	237.21	287.70	342.76
25	30.69	44.33	64.60	90.90	122.88	160.25	202.82	250.42	302.90	360.16
30	35.87	49.97	70.94	98.18	131.31	170.07	214.23	263.62	318.10	377.56
35	41.04	55.60	77.27	105.45	139.75	179.88	225.63	276.82	333.30	394.95
40	46.22	61.23	83.61	112.73	148.19	189.70	237.04	290.03	348.50	412.35
45	51.39	66.86	89.95	120.01	156.63	199.52	248.45	303.23	363.71	429.75
50	56.57	72.49	96.28	127.28	165.07	209.34	259.86	316.43	378.91	447.14

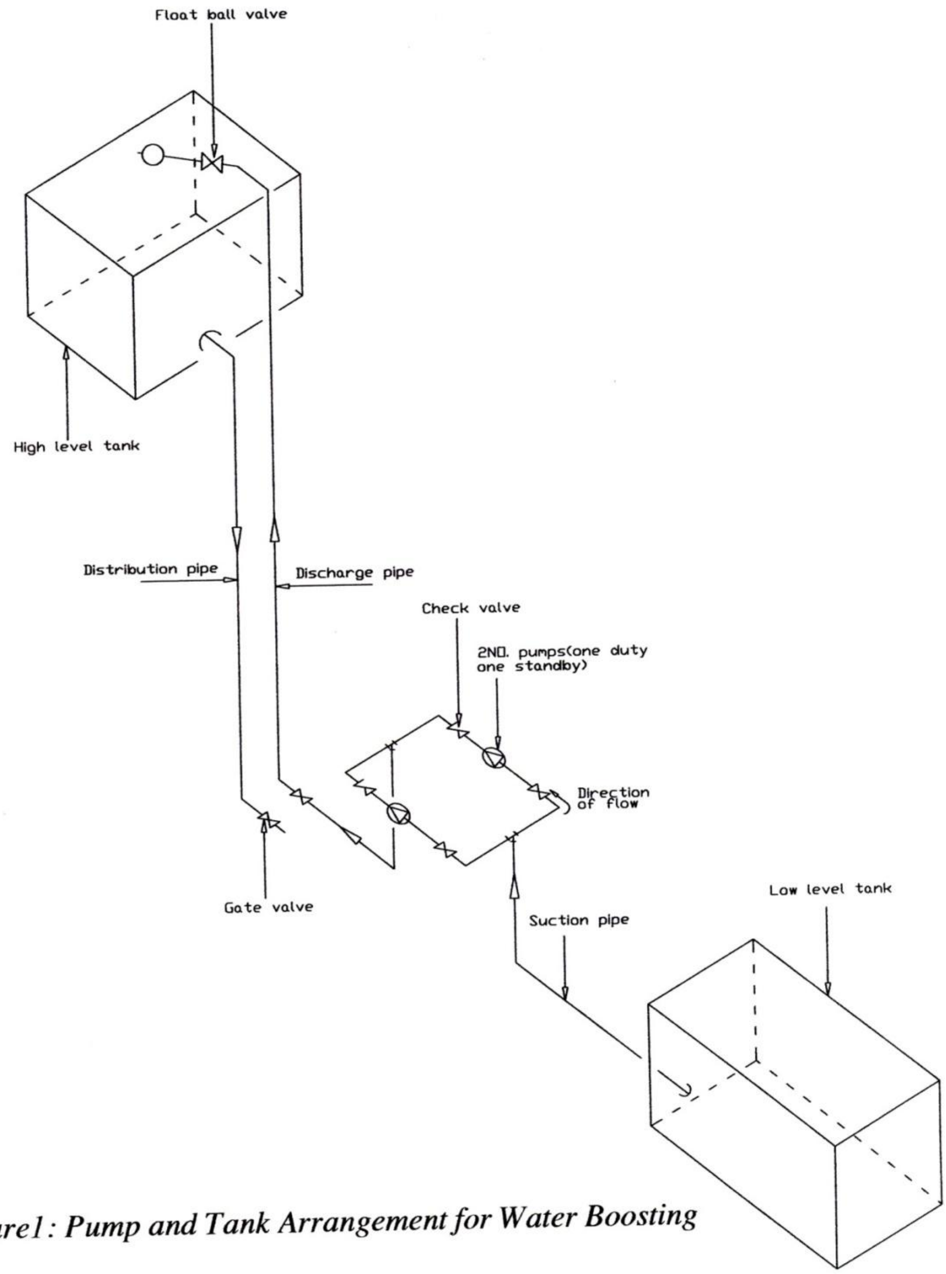

Figure1: Pump and Tank Arrangement for Water Boosting

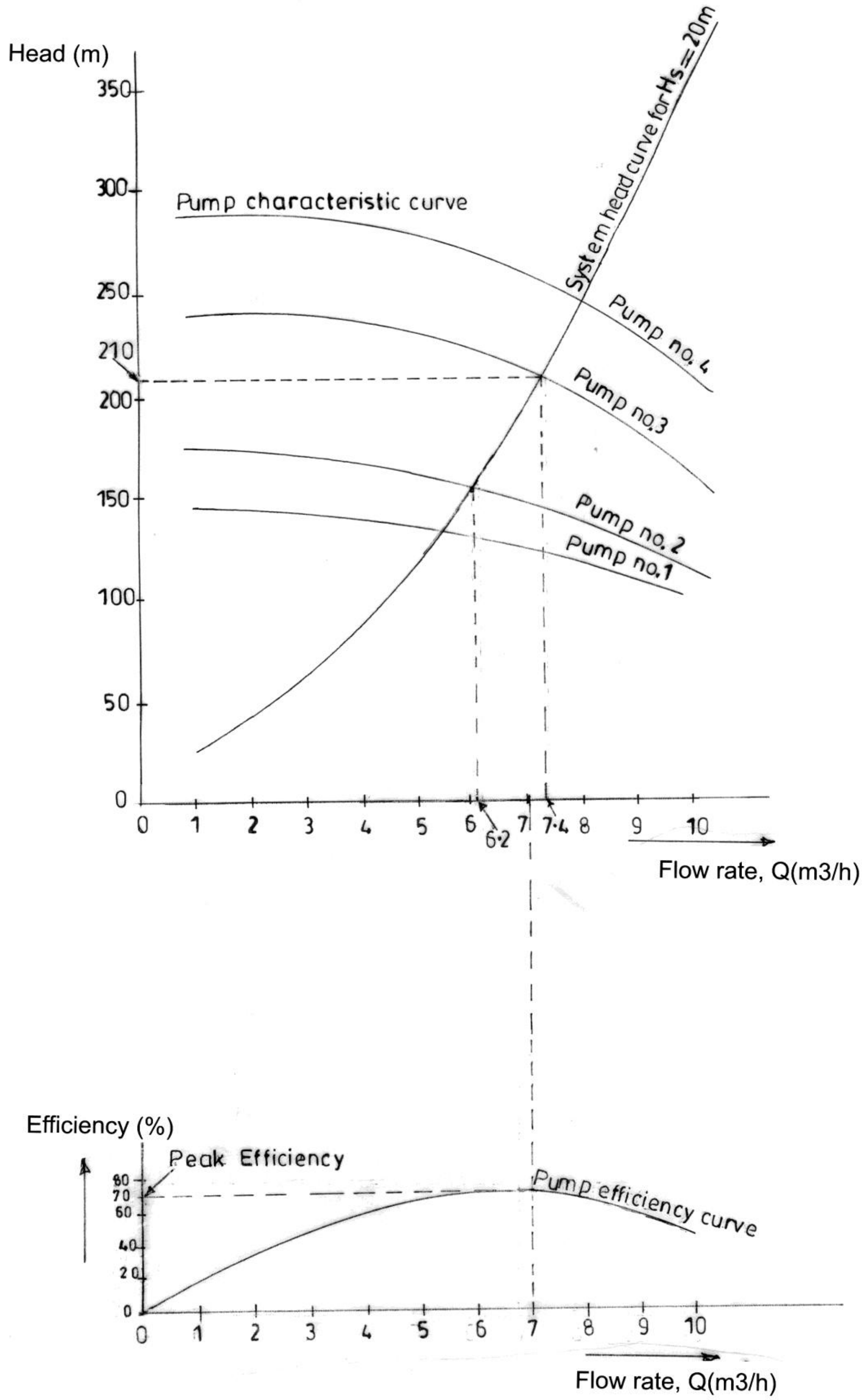

Figure 2: System head, pump characteristic, and efficiency curves

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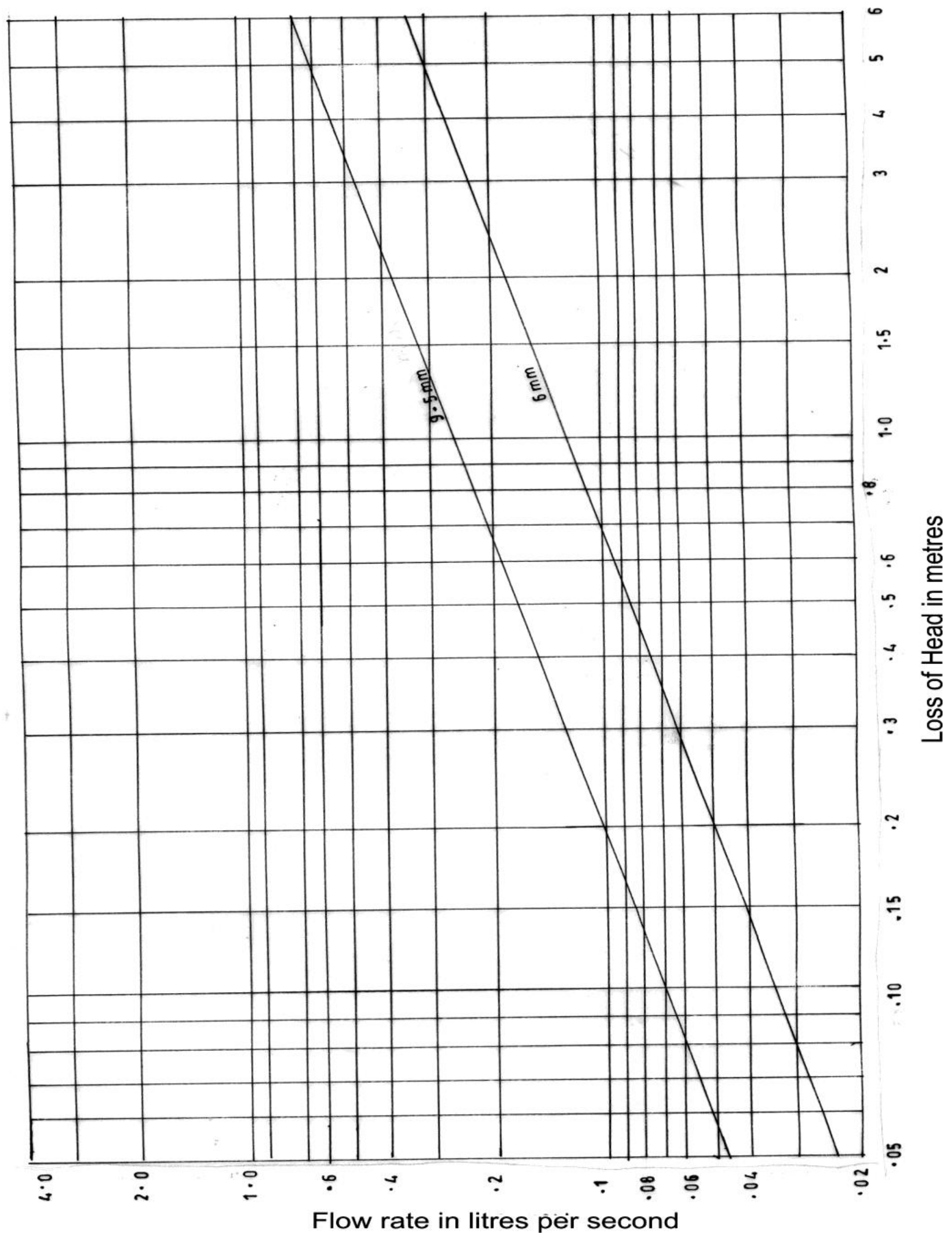
Appendix 1: Head Loss through 6mm (1/4") and 9.5mm (3/8") Ball Valve Orifices



Appendix 2: Estimation of h_0 from Graph of Head Loss Versus Flow Rate For 6 mm (¼″) Orifice

The graph of head loss h_0 versus Q for the 6 mm (¼″) orifice ball valve is a log – log plot which can be expressed mathematically as

$$h_0^x = k\ Q^y \tag{A1}$$

where k, x and y are constants

Then x log h_0 = log k + y log Q (A2)

In order to determine k, x and y three sets of values of h_0 and Q obtained from the graph are substituted into Eqn. A2 and the resulting equations are solved simultaneously.

Thus, from the graph, at Q = 0.34 l/s (3.4 x 10^{-4} m^3/s), h_0 = 6m

at Q = 0.10 l/s (1.0 x 10^{-4} m^3/s), h_0 = 0.7 m,

and at Q = 0.04 l/s (0.4 x 10^{-4} m^3/s), h_0 = 0.15 m.

Correspondingly, the following equations are obtained:

$$x \log 6 = \log k + y \log 3.4 \times 10^{-4} \quad \text{(A3)}$$

$$x \log 0.7 = \log k + y \log 1 \times 10^{-4} \quad \text{(A4)}$$

$$x \log 0.15 = \log k + y \log 0.4 \times 10^{-4} \quad \text{(A5)}$$

Solving Eqns. A3, A4 and A5 simultaneously yields the result

$$\log k = 3.9166y \quad \text{(A6)}$$

and

$$x = 0.5815y \quad \text{(A7)}$$

Eqn. A2 can therefore be expressed as

$$0.5815\, y \log h_0 = 3.9166y + y \log Q \quad \text{(A8)}$$

$$\therefore \quad \log h_0 = 1.7197 \log Q + 6.735 \quad \text{(A9)}$$

or

$$h_o = 10^{1.7197\log Q + 6.735} \quad \text{(A10)}$$

Appendix 3: Computer Program

```
*************************************************
*    Program:      BOOSTER.prg
*    Description:  Program to Calculate System Heads for *
     Water Boosting
*    Language:     Microsoft Visual Foxpro Version 5.0
*************************************************
SET TALK ON
SET SAFETY OFF
CLOSE DATA
USE BOOSTER
ZAP
HH = 10
FOR HS = 0 TO 50 STEP 5
     FOR     QO=1TO 10 STEP 1
             QT=QO/3600
             LH=(1.719*LOG(QT))+6.7353
             HT=(132879.14*(HS+HH)*(QT**1.85))
             +(3888906.24*(QT**2))+(10**LH)+HS
             APPEND BLANK
             REPLACE   STATIC   _HD   WITH   HS,
             DISCHARGE  WITH  QO,  SYSTEM  _HD
             WITH HT
   ENDFOR
ENDFOR
LIST TO FILE BOOSTER
CLOSE ALL
RETURN
*EOFO
```

Appendix 4: Mathematical Symbols

HH Total horizontal pipe run
HS Static head
QO Pump discharge rate expressed in m^3/h
QT Pump discharge rate expressed in m^3/s
LH Logarithm of lost head through ball valve orifice (as given by Eqn. 9)
HT Total system head to be overcome by lift pump

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Improved Cellulose and Organic-Solvents based Lignocellulosic Fractionation Pre-treatment of Organic Waste for Bioethanol Production

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Abstract: **-** This study investigates the performance of the Cellulose and Organic-Solvents based Lignocellulosic Fractionation (COSLIF) method for the pretreatment of Source-Separated Organic (SSO) waste. An improvement on the standard method of COSLIF pre-treatment was developed based on lower enzyme loading and using an ethanol washing instead of acetone. It was demonstrated that a much higher glucose yield (90% after 72 hours) was possible with this improvement, as compared to the original method, which yielded 70% in the same time frame. Evaluation of the enzymatic hydrolysate obtained from the modified COSLIF pre-treatment was further examined by anaerobic fermentation with Zymomonas mobilis 8b strain. At 48 hours, ethanol concentration reached to 140 g/L, which is equivalent to 0.48 g of ethanol produced per gram of SSO biomass. This study demonstrated that the modified COSLIF pretreatment provides a substantial improvement over the standard method in terms of enzyme savings, glucose formation, and ethanol production.

Keywords: **-** *lignocellulose, organic waste, pre-treatment, ethanol, enzyme, bacteria*

I. INTRODUCTION

Pre-treatment is considered one of the most expensive processing steps in the bioconversion of lignocellulosic biomass, often accounting for up to 40% of the total processing cost [1]. In addition, it greatly affects the downstream cost of operations such as enzymatic hydrolysis and fermentation. Additional costs resulting from inefficient pre-treatment include detoxification, limited enzymatic hydrolysis rate, high enzyme loading, low product concentration, and complicated product purification. Therefore, pre-treatment can be seen as a key step in limiting the feasibility of bioconversion. Pre-treatment, together with enzymatic hydrolysis, is the central task of the entire bioethanol production process [1]. Evidently, all the lignocellulosic pre-treatment processes experience sugar degradation and inhibitor formation. The shortfalls of the current leading lignocellulosic pre-treatments can be mainly attributed to: 1) inefficiency in breaking up the orderly hydrogen bonds in crystalline cellulose, resulting in slow hydrolysis rates and low cellulose digestibility, which compromises the overall sugar yields, and 2) the presence of lignin and hemicellulose on the surface of cellulose, which is commonly thought to have the effect of restricting the accessibility of enzymes to the biomass [2].

Cellulose and Organic-Solvents based Lignocellulosic Fractionation (COSLIF) is a promising technology, recently developed to overcome these problems. The COSLIF pre-treatment is a technology that can effectively fractionate lignocelluloses into amorphous cellulose, lignin, hemicelluloses, and acetic acid [2], [3]. This technology has been applied successfully to a broad range of substrates from agricultural to industrial waste, with inclusion of organics such as: food, paper, cardboard, plastics and yard wastes [1], [2], [4], [5], [6]. The COSLIF technology has many advantages over traditional lignocellulosic pre-treatments, most notably the following: modest treatment conditions at 50°C and atmospheric pressure; minimized degradation of sugars; no inhibitor formation; co-utilization of different sugars increasing potential output; high sugar yields; fast hydrolysis rates; efficient solvent recycling; low usage of enzymes; and low energy consumption [2].

The objective of this paper is to evaluate the performance of the COSLIF pre-treatment on an innovative feedstock for ethanol production, namely, source-separated organic (SSO) household waste. Due to its potential for high energy content and environmental implications, SSO has been proposed as a suitable feedstock for bioethanol production [7]. It was demonstrated that the overall process of lignocellulose fractionation with the use of cellulose solvent (phosphoric acid) and organic solvent (acetone/ethanol) as pre-treatment reagents is effective in hydrolysing the sugar content of the waste [2]. In order to successfully deal with the causes of the SSO recalcitrance - breaking up orderly hydrogen bonds in crystalline cellulose chain and removing lignin and hemicelluloses from the surface of cellulose, a standard COSLIF process was modified by using ethanol washing solvent instead of acetone and lowering enzyme loading. It allowed to increase the concentration of glucose released after enzymatic hydrolysis and to achieve highest ethanol yield in fermentation step. The enzymatic hydrolysis behaviours of the original and modified pre-treatment methods were also investigated and compared in terms of their glucose yield. A scanning electron microscopy (SEM) was used to examine the supra-molecular structures of COSLIF-pretreated SSO samples for qualitative comparison.

II. MATERIALS AND METHODS

The SSO waste utilized in this work was initially pre-processed mechanically, under high temperature (of ~120OC) and pressure (over 50 bars) with a thermal screw press to form a dry stable mass. Samples were prepared as a heterogeneous substrate by blending with 20% of woodchips waste from construction before pre-processing [8]. Optimum Waste Recycling Systems, Toronto, Canada, supplied the biomass feedstock used in this work. The general flowchart of the experimental investigation is shown in Fig. 1.

-Fig. 1 about here –

It started with the SSO waste supplied to thermo-screw press and to make it homogenous. After this, the SSO samples underwent lignocellulosic fractionation with the use of a cellulose solvent (85% phosphoric acid) and an organic solvent (either acetone or ethanol). Next step in the flowchart above is enzymatic hydrolysis with addition of commercial available enzyme, Accellerase 1500, to mediate enzymatic hydrolysis process and release fermentable sugars as much as possible. Accellerase 1500 is Genencor's new generation of enzyme product, a significant step forward towards more cost effective, commercial scale production developed for second generation of biorefineries. It has been shown to successfully hydrolyze a wide range of lignocellulosic feedstocks [9]. Accellerase 1500 enzyme used in this research was supplied by Genencore Inc., a Denisco Division, Rochester, New York, USA, as well as the Sigma Aldrich Corp., USA.

Prior to testing, the SSO samples were oven-dried at 45-50^{o} C for 72 hours accordingly to [10]. Five grams of dry lignocelluloses was placed in a 250 mL centrifuge bottle and then mixed with 40 mL of 85% concentrated phosphoric acid using a glass rod. The solid/ liquid slurry was placed in a benchtop shaking incubator at 150 rpm and 50 ºC ± 0.2ºC for 2 hours. One hundred mL of ethanol was then added and mixed well. After centrifugation at 7000 rpm at room temperature for 15 minutes, the supernatant was decanted. The solid pellet was then re-suspended by 150 mL of ethanol and centrifuged. The supernatant again was decanted. Next, the solid pellet was re-suspended by 150 mL of distilled water and centrifuge for two times.

Enzymatic hydrolysis experiments were conducted next in sequence in the chosen SHF approach in a benchtop shaking incubator. The separate hydrolysis and fermentation (SHF) approach was used in this study to avoid interference of samplings. The procedure for enzymatic cellulose hydrolysis was adopted from a procedure developed by the National Renewable Energy Laboratory, as described in [11], [12]. After thawing, the treated solid pellet containing amorphous cellulose was neutralized to pH 4.8-5.0 by NH4OH. Upon diluting to 20 g glucan/L based on the 27% glucose content from [11], the sample was then brought to 50ºC before adding 30 FPU/ g glucan or 60 FPU/g glucan of Accellerase 1500. The incubator was set at 250 rpm to keep solids in constant suspension with the temperature of 50°C for 72 hours. Sampling was carried out at 0, 12, 24, 48 and 72 hour and glucose yield was measured.

Following enzymatic hydrolysis, batch soluble sugar fermentation was carried out to determine the ethanol yields. The Zymomonas mobilis 8b recombinant strain was chosen for its capability to ferment glucose and to produce ethanol at high yields [13] and was donated by the National Renewable Energy Laboratory, Golden, Colorado, USA. Soluble sugars batch fermentation was performed in 250-mL serum bottles with 100-mL working volume and purged with nitrogen before being autoclaved. Temperature was maintained at 30-37oC and pH was controlled at 5.0-6.0 by 1M potassium hydroxide (KOH) as suggested by previous studies [14]. Each batch sugar fermentation process was carried out in triplicates on the pre-treated biomass for both the standard and modified COSLIF methods.

Concentrations of glucose in hydrolysates from the COSLIF pre-treated biomass and ethanol from in fermentation broths were analyzed by high performance liquid chromatography (HPLC), Bio-Rad HPX-87P column quipped with the appropriate guard column. All concentrations were reported as per liter volume basis. Percent theoretical ethanol yield was calculated as in [15]:

$$\% \text{ Theoretical ethanol yield} = \frac{[EtOH]f - [EtOH]i}{0.51(f[Biomass]1.111)} \times 100$$

where: [EtOH]f - ethanol concentration at the end of fermentation, (g/L)
[EtOH]i - ethanol concentration at the beginning of fermentation, (g/L)
[Biomass] - dry biomass concentration at the beginning of fermentation, (g/L)
f - cellulose fraction of dry biomass (g/g)
0.51- conversion factor for glucose to ethanol
1.111- converts cellulose to equivalent glucose

Supra-molecular structures of the intact and pretreated SSO samples were examined by scanning electron microscope, as described elsewhere [16], [17]. A scanning electron microscope (SEM) is a type of electron microscope that produces images of a sample by scanning it with a focused beam of electrons. The electrons interact with atoms in the sample, producing various signals that can be detected and that contain information about the sample's surface topography and composition. The electron beam is generally scanned in a rectangular pattern of image, and the beam's position is combined with the detected signal to produce an image. SEM can achieve resolution better than 1 nanometer. Samples can be observed in high and low vacuum, and in wet conditions. A SEM was kindly provided by the Ryerson University Analytical Center, Toronto, Canada.

III. RESULTS AND DISCUSSION

A detailed quantitative assessment on the composition of SSO waste was carried out in [11] and adopted for further investigation in this study. The SSO samples, contained 20% woodchips, were already pretreated by the thermal screw machine. The woodchips were typically Douglas fir wood waste originated from home construction furniture, flooring, cabinet, and doors. All sharp foreign matter such as metal needles, plastic and rubber wastes, and broken glasses were collected and removed, as much as it was possible. The dried SSO biomass was sent to MBI International, the Michigan State University Foundation, for grinding and determination of polymeric sugars content. The results are summarized in Table 1.

-Table 1 about here -

It turned out that those essential polymeric sugars made up 41.3% in oven dried SSO samples, including: 27% glucan, 5.4% xylan, 5.7% mannan, 1.2% arabinan, and 1.2% of galactan, which were a good starting point for enzymatic hydrolysis followed by fermentation. It was found that the SSO samples were acidic (pH of 5.0-5.5) and had the lowest content of the food waste, just about 10% of total waste of samples. Comparison between pretreated and non-treated SSO validated the high recalcitrant nature of lignocellulosic fraction of biomass as suggested in [2], and which was in agreement with other works [1], [3], [14].

3.1. Glucose Yield

Results obtained from COSLIF washing with concentrated phosphoric acid and acetone reagent generated a significant glucose yield of about 70%, in the first few trials (Fig. 2).

-Fig 2 about here –

But, acetone is a more toxic reagent and it is less safe to use than ethanol. The cost of using acetone is higher than that of ethanol and during the recovery of the reaction’s by-products more energy is consumed when acetone is used as the reagent. In addition, pre-treatment with acetone must be performed under extremely stringent and efficient conditions due to the volatility of acetone. Ethanol, on the other hand, is less corrosive and can be easily recovered by distillation under milder conditions. Therefore, after extensive trials and investigations, some changes were made to further improve the efficiency of COSLIF pre-treatment to obtain a higher glucose yield. The major change made to the original standard method of COSLIF pre-treatment was to omit acetone altogether and use 95% (v/v) ethanol as the organic solvent instead. Another was changing enzyme loading from 60FPU to 30FPU. As a result of these changes, it was found that the glucose yield increased to approximately 90% (Fig. 2). It was also observed that only 50% of the original volume of ethanol was needed to replace the acetone.

3.2. Enzymatic Hydrolysis

Fig. 3 shows the glucose digestibility profiles over a course of 72 hours for the SSO samples treated by the standard and modified COSLIF methods as well as non-treated samples.

-Fig 3 about here -

High glucan digestibility of the pretreated SSO was accredited to drastic changes in the supramolecular structure of the biomass before and after the COSLIF pre-treatment, observed by the SEM in this study. Typical COSLIF pretreatment conditions were used, namely 50^{o}C and atmospheric pressure with a pretreatment time from 30 to 60 minutes, depending on the type of feedstock. Although diverse feedstocks showed great variations in enzymatic digestibility, suggesting that their different recalcitrant structures confer variable resistance to enzymes, the use of concentrated phosphoric acid at 50^{o}C can efficiently dissolve them so to erase their inherent structure difference and result in an amorphous biomass with similar high-accessibility [3], [6]. As a result, COSLIF-pretreated biomass feedstock exhibited similar enzymatic glucan digestibility regardless of their sources [6]. When concentrated phosphoric acid was used as the cellulose solvent, it should be used at 50^{o}C or lower to avoid extensive hydrolysis of polymeric carbohydrates and sugar degradation.

The enzymatic glucose digestibility for pre-treated COSLIF samples was calculated as described in [2]. With high enzyme loading (FPU=60) and acetone washing, the glucose digestibility of the pretreated standard COSLIF sample was approximately 70% as presented in Fig. 3 above. With a lower enzyme loading (FPU=30) and ethanol washing, it reached 90% digestibility after 36 hours. This suggests that by removing hemicelluloses and lignin barriers, there was an increase in accessibility to the cellulose change by the cellulobiose, while also reducing the competitive inhibition of xylan to endo-glucanase. Data from this study on the hydrolysis rates and digestibility were comparable to the range (90%-95%) cited in other scientific papers [18], [19].

3.3. Fermentation

Fermentation is the final step in evaluating the overall process of cellulosic ethanol production. The effectiveness of the enzymatic hydrolysis was gauged by assessing the potential inhibitory factors and effects of fermentation. These results can be found in the following section. A genomic DNA-integrated glucose and xylose co-fermenting strain, Z. mobilis 8b recombinant strain was used due to its ability to ferment glucose and xylose to produce ethanol at high yields [13]. The microbe was developed and evaluated by the NREL on a broad range of agricultural biomass and can convert sugars to ethanol more rapidly as compared to other species.

Besides the major changes during the COSLIF pre-treatment process, some minor improvements in the fermentation procedure were also made and they undoubtedly affected overall efficiency of the final ethanol output. These improvements were as follows: a serum bottle with a crimp top was used instead of an Erlenmeyer flask with stopper for better air-tight seal; a flushing serum bottle with nitrogen was used to maintain anaerobic conditions prior to fermentation; a direct transfer technique was exploited to move concentrated Z. mobilis 8b cells from an inoculums tube to a serum bottle; and a growth curve was developed for the Z. mobilis 8b strain prior to fermentation tests which was important in order to identify the OD (optical density) range in the exponential phase of a curve. The OD values in the exponential phase were vital in determining the time to harvest the cells to start the fermentation process. There were two protocols that could be employed for harvesting the cells to start the fermentation process: 1) use of a direct transfer (10%) to the main fermentation bottle or 2) use of concentrated cells by centrifuging in a centrifuge tube and then re-suspending the cells in a hydrolysate before transferring it back into the fermentation bottle. The second protocol was chosen because the inoculated seed media contained not only cells but also a large amount of glucose sugar which would be transferred into the fermentation bottle. Unless distilled deionized water (DDW) blank was created, this would result in false and inaccurate HPLC readings of glucose and ethanol concentrations.

The high ethanol yield presented in Fig. 4 indicated that very little inhibitors were present in the hydrolysates that were pretreated by the modified COSLIF method. Depending on feedstock and process, the actual yield could be anywhere from 60% to 100% of the theoretical yield. Achieving a high yield may be costly compared to lower yield processes that are often more cost effective.

-Fig. 4 about here -

The ethanol concentration rate was calculated on the basis of sugars consumed as described in [20], and it yielded in 132.1g/L for the pre-treated samples by the modified COSLIF method after 24 hours. At 48 hours, the ethanol concentration reached 140 g/L, which is equivalent to 0.48 g ethanol/g biomass or 94% of the theoretical ethanol yield. As per this work, percent theoretical ethanol yield was calculated as in [15]. Although the ethanol concentration for some samples seemed to be fluctuating from time to time, over 90% ethanol yield in Fig. 4 can be attributed to the high accessibility of the pretreated cellulosic materials and low presence of lignin.

3.4. Comparison with Constructed Sugar Model

In a further series of experimental evaluations, enzymatic hydrolysate obtained from both COSLIF pre-treatments by batch culture fermentation with Z. mobilis 8b strain were compared with constructed sugar model (glucose/xylose ratio as 5:1) in SSO substrate. In a constructed model, after 24 hours, 100% of glucose and 40% of xylose were consumed. While in the enzymatic hydrolysate, pre-treated by COSLIF with ethanol washing reagent, the fermentation also advanced rapidly and 90% glucose and 40% xylose were also consumed, in the enzymatic hydrolysate, pre-treated by COSLIF with acetone washing reagent, the fermentation advanced slowly and 45% of glucose remained unused in the same period of time. Low bacterial activity in the fermentation process of SSO hydrolysates may be attributed to many factors including: longer lag phase for Z. mobilis 8b strain as the adaptation time to growth condition, low growth rate on SSO hydrolysates, unavoidable contamination during sample preparations, lack of nutrients, and presence of inhibitors.

3.5. Qualitative Analysis

As per qualitative comparison, SEM images of oven-dried SSO substrate before and after preatreatment were conducted in collaboration with [11] and provided in Fig. 5.

-Fig. 5 about here -

These images show the appearance of SSO before grinding – 1-1, after grinding – 2-1, and after COSLIF pre-treatment – 3-1. Each pre-treatment (physical and chemical) process changed the structure of the SSO biomass. It is clear that before the pre-treatment, the plant cell wall structures of the SSO and cellulose fibers were clearly identified. The SEM images from 1-1 and 2-1 present changes in particle size. The image from 3-1 shows all fibrous structures completely disrupted after pre-treatment, indicating that phosphoric acid and ethanol washing not only disrupted all linkages among cellulose, hemicelluloses and lignin, but also disrupted the orderly hydrogen bonds among glucose chains. These qualitative images are consistent with the images from similar studies [1], [17].

IV. CONCLUSION

The SSO waste samples utilized in this research were pre-processed by the thermal screw press (TSP) and further used as a substrate for all enzymatic hydrolysis and fermentation processes.

COSLIF pre-treatments were applied for cellulose extraction. Results indicate that the percent glucose conversion was considerable for the modified COSLIF method with a significant glucose yield. This study also demonstrated and confirmed that the COSLIF pre-treatment can be carried out on this innovative type of biomass with a relatively high percentage of glucose and ethanol yields, when certain modifications are made to the process.

In conclusion, given the satisfactory results obtained, there are still aspects of the process that need further investigation. For example, biomass size reduction by milling or grinding is energy intensive and costly which will affect the total cost of ethanol production. The extrusion process alone could disrupt the lignocellulosic structure, which would enable enzyme to gain access and attack the carbohydrates [21]. Detailed investigation on ethanol concentration and yield is still required. It was hypothesized that the large variations of ethanol concentration in this study were caused by interference of samplings. However, it has yet to be proven.

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Table 1: Compositional analysis of source-separated organic samples

Parameters	Value
A. Physical Properties	
Biomass as received	
pH	5 @ 25°C
Total Solids (TS)	33.14%
Moisture content	66.86%
VOC per dry mass	28.00%
Ash per dry mass	5.14%
Oven-dried and homogenized biomass	
pH	5.5 @ 25°C
Moisture content	6.60%
TS	93.40%
VOC	83.40%
Ash	16.60%
B. Structural Carbohydrate and Lignin (per oven-dried and homogenized biomass)	
Starch	NS
Free Sugar	NS
Glucan	26.80%
Xylane	5.40%
Arabinan	1.20%
Mannan	5.70%
Galactan	2.20%
Total sugars	41.26%
Acid Insoluble Lignin (AIL)	25.40%
Acid Soluble Lignin (ASL)	1.20%
Total Lignin	26.60%
Acetic acid, Lactic acid, and Formic acid	NS
C. Others	
Total Kjehldahl Nitrogen (TKN)	5450 μg/g
Extractives	11.00%
Digestibility	12.70%
Biodegradability	82.00%

NS - not significant
Source: Ehsanipour, 2010

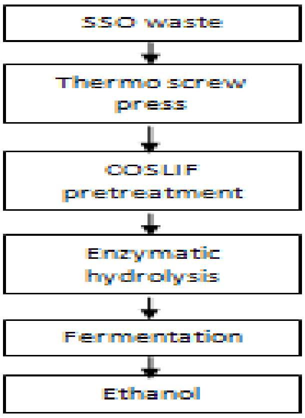

Figure 1: Experimental flowchart

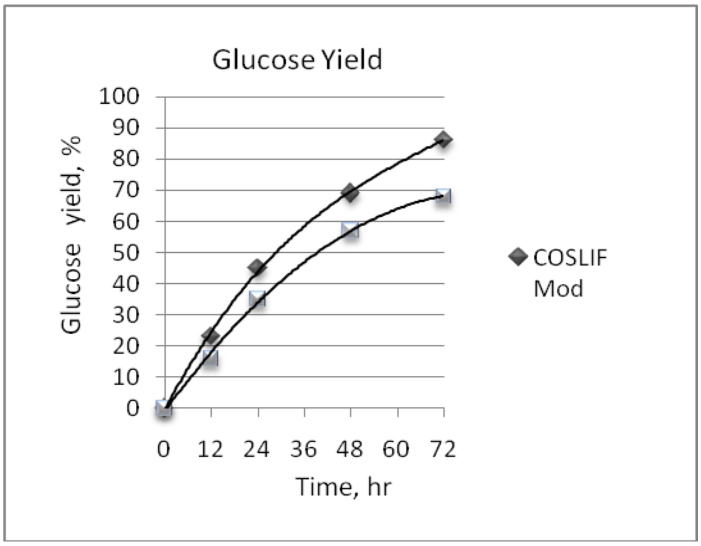

Figure 2: Glucose yields of standard and modified COSLIF pre-treatment performed at 50°C for 72 hours

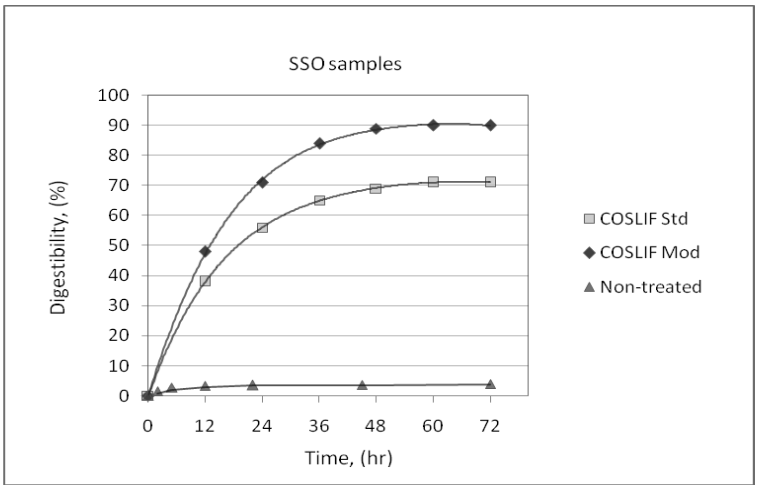

Figure 3: Time trend of glucose digestibility from the non-treated to standard and modified COSLIF pretreated samples

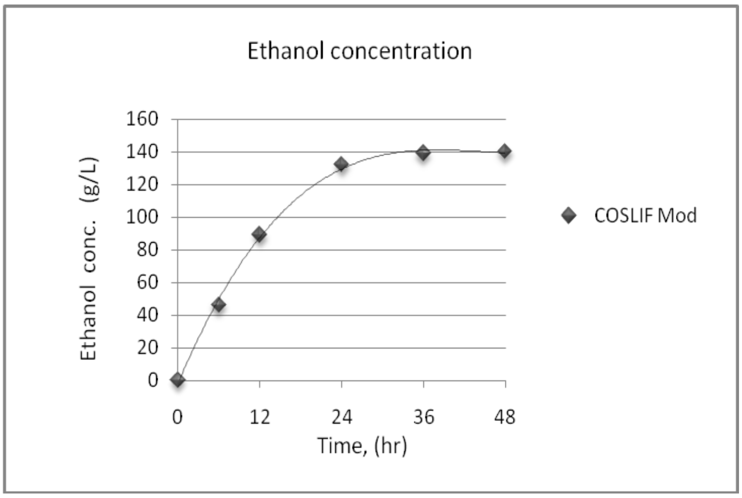

Figure 4: Ethanol concentration from modified COSLIF pre-treated samples

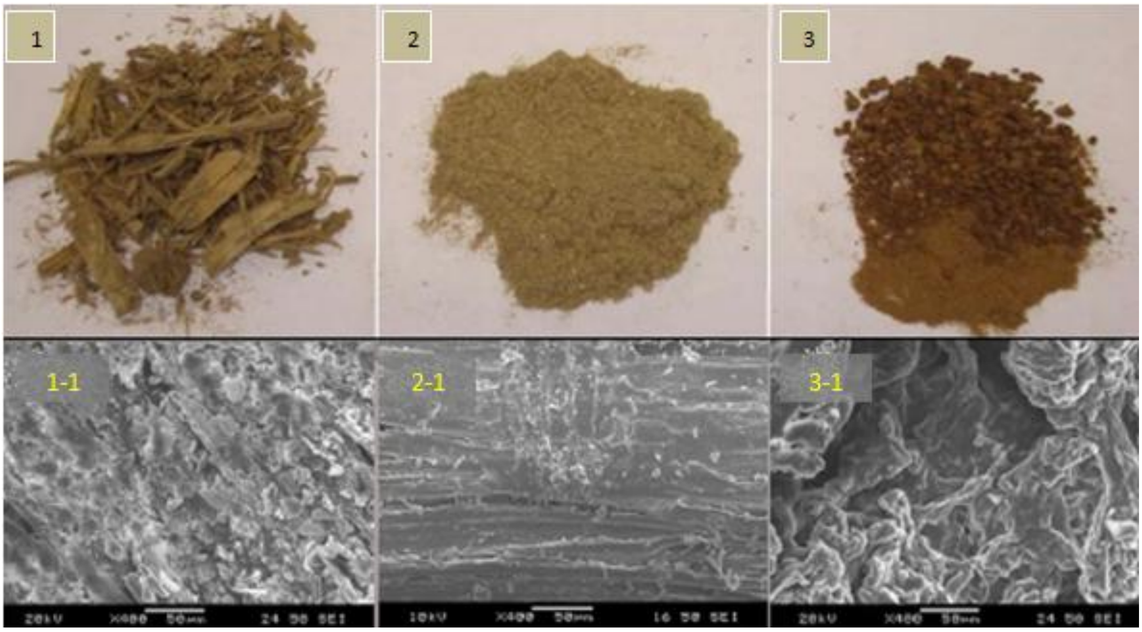

Figure 5: Scanning electron microscopy images of source-separated organic waste *Source:* Ehsanipour, 2010

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The Use Of Length/Diameter Ratio To Determine The Reliability Of Permeability Data From Core Samples

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Abstract: *Petroleum reservoir quality is governed by two important petrophysical parameters namely porosity and permeability. The length of test sample used for permeability measurement can affect the result. To determine the permeability of core samples, the length and cross-sectional area of the sample must be accurately measured. Hence, there should be a standard for testing in the laboratory. For every reservoir, it must be determined to know if the reservoir is permeable or not. The key factors that control permeability data are length and diameter of the core. In testing for reservoir that has not been evaluated, the sample length/diameter ratio is critical to the result that will be achieved. Therefore, it is imperative to determine a reference for testing in all laboratories. This study is conducted in order to confirm an acceptable length/diameter ratio that will serve as a guide during preparation of test samples before commencement of permeability measurement in the laboratory. The length/diameter ratio of core plugs was varied and their permeability determined experimentally using gas permeameter.*

Key words: *Porosity, Permeability, Darcy law, Core sample, permeameter*

I. INTRODUCTION

The reliability of permeability data obtained from core samples is critical to the measurement of permeability using core data. Different length/diameter ratios of core plugs will be used to ascertain a reliable permeability data which can be further used as a standard in comparison with the one obtained from institutions or industrial laboratories.

A rock is said to be permeable if a fluid can pass from one surface to another under the influence of external forces such as gravity and fluid pressure). The definition of rock characterization and permeability is based on measurable quantities as put forth by Darcy**.** Since, the early stage of oil well production, engineers have recognized that most reservoirs vary in permeability and other rock properties in the lateral direction. First attempt to quantify the areal permeability distribution from observed differences in well production history was that of Kruger in 1961. There are several factors that must be considered as possible sources of error in determining reservoir permeability. From these factors, the most critical is the Core sample which may not be representative of the reservoir rock because of reservoir heterogeneity. Moreover, the core recovery may be incomplete. Permeability of the core may be altered when it is cut, or when it is cleaned and dried in preparation for analysis. This problem is likely to occur when the rock contains reactive clays. Sampling process may be biased. There is also the temptation to select the best parts of the core for analysis, which may not be a good representation of the entire system.

II. MATERIALS AND METHODOLODY

Measurements made using gas (Nitrogen) are preferable because it minimizes fluid-rock reaction and also it is convenient. To determine the reliability of permeability data from core samples, the length and cross-sectional area of the sample must be accurately measured and standardized. A core plug of known length and diameter is important in the determination of actual value of permeability.

A core is a sample of rock from the section generally obtained by drilling into the formation. Normally, cores samples are prepared by cutting cylindrical plugs using a drill press and one-half inch diameter bit. A total of fifty sample plugs were drilled using a drill press of 1½ inches diameter drill bit to drill through a slabbed core surface up to a depth of about 3inches with liquid nitrogen to ensure integrity of the sample. The samples were encapsulated with nickel foil and stainless steel mesh at each end face to prevent grain erosion and then pressurized up to 200psi to maintain sample integrity.

Samples were placed in soxhlet equipment, and toluene was used to clean the oil and the system was allowed to reflux several times until the refluxed solvent is observed to appear colourless. Thereafter methanol was used to replace the toluene and remove salt. The samples after cleaning are then placed in a conventional Oven to dry to a constant weight at about 100^0C or 110^0C for clean sandstone and 60^0C for shaly sandstones until the dry weight was stable. After drying, the Samples are cooled in a desiccators to room temperature prior to measurement.

The gas permeameter is designed to measure the permeability of consolidated cores, when both gas viscosity and core dimensions are known.

The equipment used for gas permeability measurement include: Permeameter, Nitrogen source, Stopwatch, Core holder, Bubble tube and Digital calliper. The temperature is recorded at the beginning of the experiment, The dried samples length and diameter are measured using a digital caliper. Each dried sample is placed in a core holder assembly which consist of rubber boot and stems. The core holder is connected with connecting lines to a gas cylinder. The core is pressurized to 400psi overburden pressure using compressed air. Nitrogen gas is then flown through the connecting line to the sample in the core holder using a regulator to adjust flowing pressure until a laminar flow rate is established.

The resultant flow pressure is recorded from the gauge mounted on the core holder. The gas coming out of the sample drives a soap bubble through a burette. The time it takes for the bubbles to pass through 30cm calibration point on the burette and the volume of gas flow through the burette is measured and recorded using a stopwatch. The test pressure determined by the air regulator is recorded. The flow rate of the gas is determined. The viscosity of the gas is recorded and temperature taken again the barometric pressure at the time of measurement is recorded. The average length of sample and diameter is record and then using Darcy's equation the permeability of the core sample is calculated.

All the samples tested by the procedure described above are re-determined with a decreased length, while keeping the diameter constant, thereby generating a new length/diameter ratio. The permeability results determined by those 'new' samples are compared with the original results obtained from the one with maximum length.

Porosity Determination (Pore volume and Bulk volume)

1. Each plug sample was individually placed into a rapid access core holder connected to Ultrapore equipment.
2. Helium at a known reference pressure (P_1) and Volume (V_{Ref}) was isothermally expanded into the sample's pore space (V_{Pore}) and after pressure stabilization; the pressure (P_2) was recorded.
3. The sample's pore volume is derived from basic Boyles law.
4. The sample's true pore volume was obtained by deducting the volume of screens (for mounted samples only).
5. The bulk volume of the sample was determined using the callipered length and diameter of the samples. Grain volume + pore volume.

Porosity is reported as a percentage of the bulk volume as below:

$$\phi = \frac{Pore\,Volume}{Bulk\,Volume} * 100 \qquad 1$$

where Ø is porosity, %

RESULTS AND DISCUSSION

Fluid used: Nitrogen gas; Calibrated volume of gas in the burette = 30cm

Temperature T= 25^oC; Diameter of core = approximately 3.7cm

Varying Length used, L; Viscosity of the gas used = 0.0177cp

$$K = \frac{2000 B \mu g Q L}{A\left(\left(Pu + B\right)2 - \left(Pd + B\right)2\right)} \qquad 2$$

The result is computed using Microsoft excel and tabulated in the appendix. From the results obtained using Darcy's law, the direct proportional relationship between the effects of permeability using length variation is observed. At a specified temperature of 25^0C with varying pressure for different core samples, the permeability value is directly proportional to the length decreases (Assuming constant volume timed), therefore, the plot of permeability, K against standard length, L gives a scatter plot variation. It is also observed in the plot that there is higher concentration of permeability around 4500millidarcy.The plot of permeability against porosity also show the trend of high permeability with porosity. (See Figure 1)

When the length of the core was changed in order to have a length/diameter ratio of 1:1, there was a change in the permeability value, showing the effect of length variation. The permeability concentration changes from 4500millidarcy to 3500millidarcy when the length was reduced. The cross plot of permeability against porosity also shows that it is permeable around 3500 millidarcy, with given porosity constant.

When the length of the core was changed, to a ratio of 0.5:1, the permeability value drastically dropped, which a great change on the permeability. The plot of permeability against length shows that permeability value concentrated at 1500millidarcy which is far different from the standard length used. The cross plot of permeability against porosity also shows that the permeability is low due to the length of the core that has been reduced beyond limit.

Generally, it is observed from the result that when the length of the core sample is reduced permeability decreases and vice versa. The permeability obtained when standard length is used is almost the same as when the length is equal to diameter, but when the ratio was changed to 0.5:1, the permeability data seems to be unreliable.

III. CONCLUSIONS

This precisely agreed that for a permeability data to be reliable, the minimum length/diameter ratio should be 1:1, which shows that permeability is proportional to length of a core. The minimum length of the tested sample having a specified diameter approximately 3.7cm core has been determined and established which should be a reference for testing in the laboratory noting that samples having length smaller than this established value would give an erroneous result

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NOMENCLATURE

t = Time of each core samples, sec, v = Calibrated volume, cm^3, K_g= Permeability to gas (mD), B= Barometric pressure, atm, Q= Gas flow rate at B, cc/sec, μ_g = Gas viscosity, cp, L= Sample length, cm , P_u= Upstream Pressure, atm, P_d = Downstream Pressure, atm

APPENDIX

Table 1: Permeability of Samples with Length Conforming with Standard Practice

Sample. No.	Pressure (P) (atm)	barometric pressure (B) (atm)	Temperature T (^{0}C)	Gas viscosity C_p	volume timed (cc)	Average time (s)	Length (cm)	Diameter (cm)	Area (cm^2)	Flow rate Q (cc/s)	Perm. K (millidarcy)
53	0.001207	1.023027	25	0.0177	30	72.24	5.933	3.703	10.77094	0.404069767	3262.023
77	0.001114	1.023027	25	0.0177	30	67.04	5.561	3.706	10.7884	0.435411695	3564.082
5	0.001134	1.023027	25	0.0177	30	55.17	5.875	3.713	10.82919	0.529091898	4477.777
16	0.000888	1.023027	25	0.0177	30	67.74	5.522	3.719	10.86422	0.430912312	4363.737
43	0.001011	1.023027	25	0.0177	30	56.75	4.71	3.714	10.83503	0.514361233	3912.611
58	0.000815	1.023027	25	0.0177	30	59.17	5.919	3.711	10.81753	0.49332432	5859.971
73	0.000545	1.023027	25	0.0177	30	56.08	5.431	3.684	10.66069	0.520506419	8609.572
88	0.000864	1.023027	25	0.0177	30	65.32	4.437	3.736	10.96377	0.446876914	3703.340
8	0.000496	1.023027	25	0.0177	30	54.76	4.231	3.74	10.98726	0.533053324	7323.364
57	0.000643	1.023027	25	0.0177	30	52	5.565	3.768	11.15239	0.561346154	7708.214
61	0.000717	1.023027	25	0.0177	30	71.81	6.443	3.731	10.93444	0.406489347	5910.750
12	0.000864	1.023027	25	0.0177	30	61.85	5.42	3.74	10.98726	0.471948262	4767.388
68	0.001158	1.023027	25	0.0177	30	61.56	6.084	3.703	10.77094	0.47417154	4091.571
20	0.00079	1.023027	25	0.0177	30	64.46	6.082	3.732	10.94031	0.45283897	5638.184
6	0.001011	1.023027	25	0.0177	30	54.51	5.662	3.737	10.96964	0.535498074	4836.631
51	0.01198	1.023027	25	0.0177	30	64.57	5.289	3.781	11.22948	0.452067524	312.751
41	0.001907	1.023027	25	0.0177	30	60.3	4.312	3.708	10.80005	0.484079602	1792.206
48	0.002029	1.023027	25	0.0177	30	71.08	4.949	3.815	11.43234	0.410664041	1549.279
52	0.003514	1.023027	25	0.0177	30	64.26	4.308	3.713	10.82919	0.454248366	908.655
36	0.02641	1.023027	25	0.0177	30	66.07	5.395	3.794	11.30683	0.441804147	139.481
38	0.005355	1.023027	25	0.0177	30	64.55	4.392	3.745	11.01666	0.452207591	594.332
39	0.036275	1.023027	25	0.0177	30	58.07	3.902	3.712	10.82336	0.502669192	86.884

Table 2: PERMEABILITY RESULT OF SAMPLES WITH LENGTH/DIAMETER RATIO OF 1:1

	Press. P (atm)	Barometric B (atm)	Temp. (^{0}C)	Gas visc. C_p	Vol. timed (cc)	Avg. time (s)	Lgth (cm)	Diam. (cm)	Area (cm^2)	Flow rate Q (cc/s)	Perm. k (mdarcy)
53	0.001207	1.023027	25	0.0177	30	72.24	3.703	3.703	10.77094	0.404069767	2035.946
77	0.001114	1.023027	25	0.0177	30	67.04	3.706	3.706	10.7884	0.435411695	2375.200
5	0.001134	1.023027	25	0.0177	30	55.17	3.713	3.713	10.82919	0.529091898	2829.955
16	0.000888	1.023027	25	0.0177	30	67.74	3.719	3.719	10.86422	0.430912312	2938.924
43	0.001011	1.023027	25	0.0177	30	56.75	3.714	3.714	10.83503	0.514361233	3085.231
58	0.000815	1.023027	25	0.0177	30	59.17	3.711	3.711	10.81753	0.49332432	3673.991
73	0.000545	1.023027	25	0.0177	30	56.08	3.684	3.684	10.66069	0.520506419	5840.115
88	0.000864	1.023027	25	0.0177	30	65.32	3.736	3.736	10.96377	0.446876914	3118.251
8	0.000496	1.023027	25	0.0177	30	54.76	3.74	3.74	10.98726	0.533053324	6473.500
57	0.000643	1.023027	25	0.0177	30	52	3.768	3.768	11.15239	0.561346154	5219.147
61	0.000717	1.023027	25	0.0177	30	71.81	3.731	3.731	10.93444	0.406489347	3422.785
12	0.000864	1.023027	25	0.0177	30	61.85	3.74	3.74	10.98726	0.471948262	3289.673
68	0.001158	1.023027	25	0.0177	30	61.56	3.703	3.703	10.77094	0.47417154	2490.317
20	0.00079	1.023027	25	0.0177	30	64.46	3.732	3.732	10.94031	0.45283897	3459.669
6	0.001011	1.023027	25	0.0177	30	54.51	3.737	3.737	10.96964	0.535498074	3192.245
51	0.01198	1.023027	25	0.0177	30	64.57	3.781	3.781	11.22948	0.452067524	223.579
41	0.001907	1.023027	25	0.0177	30	60.3	3.708	3.708	10.80005	0.484079602	1541.164
48	0.002029	1.023027	25	0.0177	30	71.08	3.815	3.815	11.43234	0.410664041	1194.281
52	0.003514	1.023027	25	0.0177	30	64.26	3.713	3.713	10.82919	0.454248366	783.156
36	0.02641	1.023027	25	0.0177	30	66.07	3.794	3.794	11.30683	0.441804147	98.089
38	0.005355	1.023027	25	0.0177	30	64.55	3.745	3.745	11.01666	0.452207591	506.779
39	0.036275	1.023027	25	0.0177	30	58.07	3.712	3.712	10.82336	0.502669192	82.65358615

Table 3: PERMEABILITY RESULT OF SAMPLES WITH LENGTH/DIAMETER RATIO OF 0.5:1

Sample No.	Press. P (atm)	Barometric B (atm)	Temperature (^{0}C)	Gas viscosity C_p	volume timed (cc)	Average time (s)	Length (cm)	Diameter (cm)	Area (cm^2)	Flow rate Q (cc/s)	Perm. K (millidarcy)
53	0.001207	1.023027	25	0.0177	30	72.24	1.8515	3.703	10.77094	0.404069767	1017.973
77	0.001114	1.023027	25	0.0177	30	67.04	1.853	3.706	10.7884	0.435411695	1187.600
5	0.001134	1.023027	25	0.0177	30	55.17	1.8565	3.713	10.82919	0.529091898	1414.978
16	0.000888	1.023027	25	0.0177	30	67.74	1.8595	3.719	10.86422	0.430912312	1469.462
43	0.001011	1.023027	25	0.0177	30	56.75	1.857	3.714	10.83503	0.514361233	1542.616
58	0.000815	1.023027	25	0.0177	30	59.17	1.8555	3.711	10.81753	0.49332432	1836.995
73	0.000545	1.023027	25	0.0177	30	56.08	1.842	3.684	10.66069	0.520506419	2920.057
88	0.000864	1.023027	25	0.0177	30	65.32	1.868	3.736	10.96377	0.446876914	1559.125
8	0.000496	1.023027	25	0.0177	30	54.76	1.87	3.74	10.98726	0.533053324	3236.750
57	0.000643	1.023027	25	0.0177	30	52	1.884	3.768	11.15239	0.561346154	2609.573
61	0.000717	1.023027	25	0.0177	30	71.81	1.8655	3.731	10.93444	0.406489347	1711.393
12	0.000864	1.023027	25	0.0177	30	61.85	1.87	3.74	10.98726	0.471948262	1644.837
68	0.001158	1.023027	25	0.0177	30	61.56	1.8515	3.703	10.77094	0.47417154	1245.158
20	0.00079	1.023027	25	0.0177	30	64.46	1.866	3.732	10.94031	0.45283897	1729.834
6	0.001011	1.023027	25	0.0177	30	54.51	1.8685	3.737	10.96964	0.535498074	1596.122
51	0.01198	1.023027	25	0.0177	30	64.57	1.8905	3.781	11.22948	0.452067524	111.790
41	0.001907	1.023027	25	0.0177	30	60.3	1.854	3.708	10.80005	0.484079602	770.582
48	0.002029	1.023027	25	0.0177	30	71.08	1.9075	3.815	11.43234	0.410664041	597.141
52	0.003514	1.023027	25	0.0177	30	64.26	1.8565	3.713	10.82919	0.454248366	391.578
36	0.02641	1.023027	25	0.0177	30	66.07	1.897	3.794	11.30683	0.441804147	49.045
38	0.005355	1.023027	25	0.0177	30	64.55	1.8725	3.745	11.01666	0.452207591	253.389
39	0.036275	1.023027	25	0.0177	30	58.07	1.856	3.712	10.82336	0.502669192	41.327

TABLE 4: Porosity Values And Standard Permeability Values At Varying Length/Diameter Ratios

POROSITY	PERMEABILITY(>1:1)	PERMEABILITY(< 1:1)	PERMEABILITY (0.5:1)
29.6	3262	2035	1018
28.7	3565	2375	1188
36	4478	2829	1415
30	4364	2939	1469
27.3	3913	3085	1543
31.4	5860	3674	1837
26.4	8610	5840	2920
22.7	3703	3118	1559
24.4	7323	6473	3237
27.6	7708	5219	2610
30.1	5911	3423	1711
22.9	4767	3290	1645
25.2	4092	2490	1245
27.3	5638	3460	1730
35.9	4839	3192	1596
16.7	313	224	112
15	1792	1541	771
28.7	1549	1194	597
18.6	909	783	392
17.1	139	98	49
16.9	594	507	253
17.1	86	83	41

CROSS PLOT SHOWING PERMEABILITY AT STANDARD LENGTH AND POROSITY

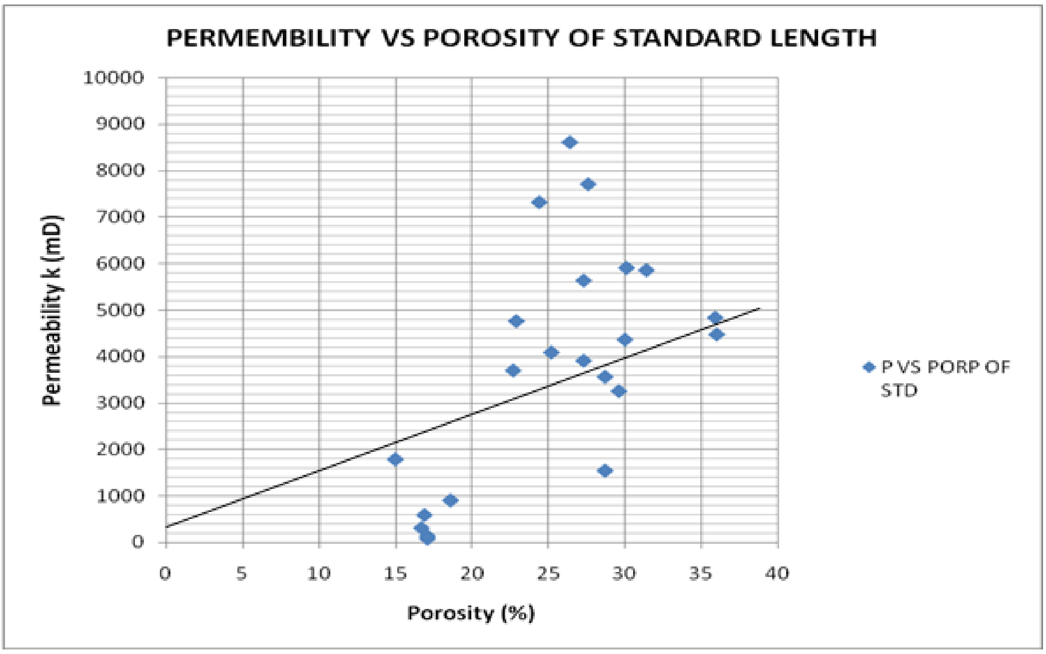

Figure 1: Standard Length and Porosity

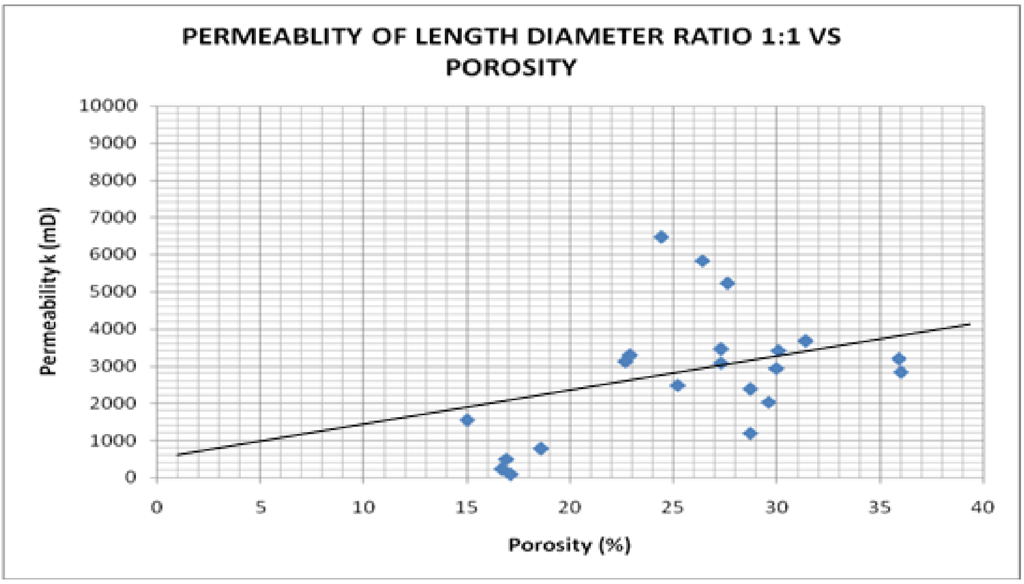

Figure 2: Length Diameter Ratio 1:1 and porosity

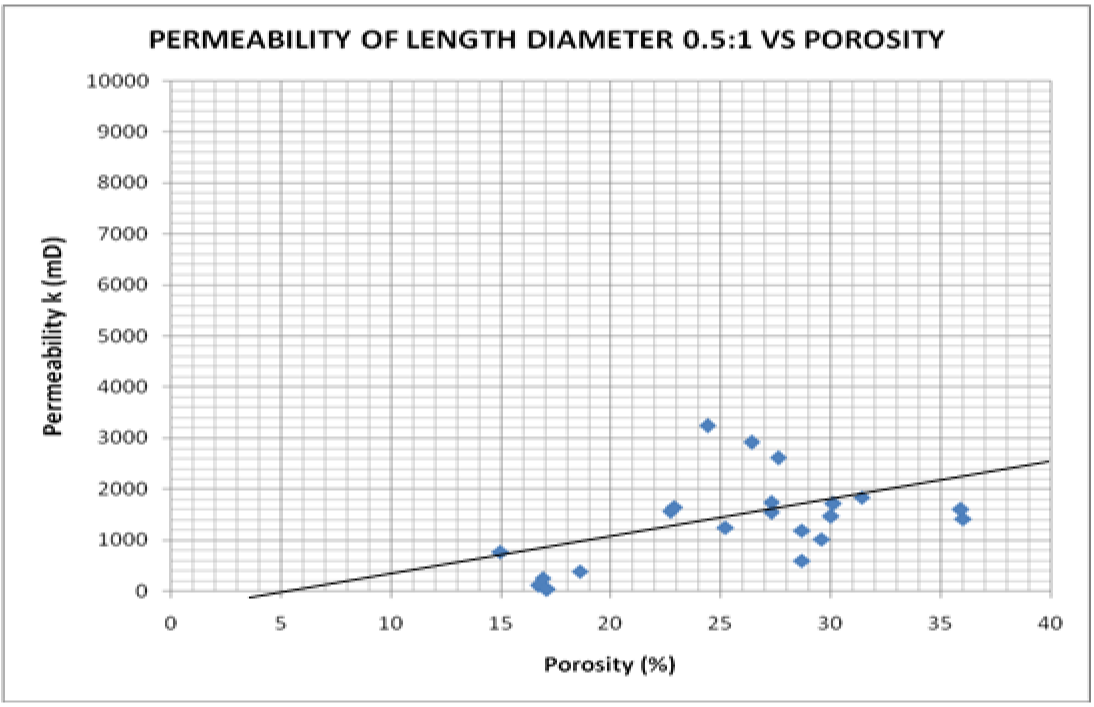

Figure 3: Length/Diameter Ratio 0.5:1 and Porosity

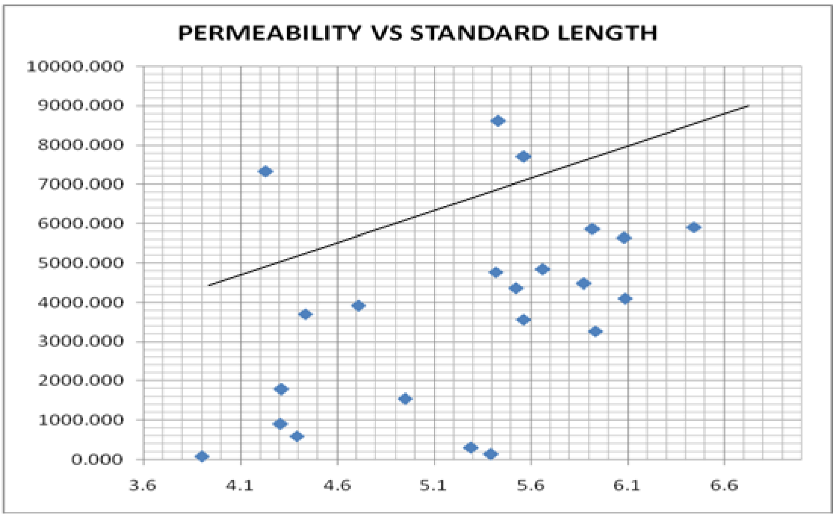

Figure 4: Permeability and Standard Length

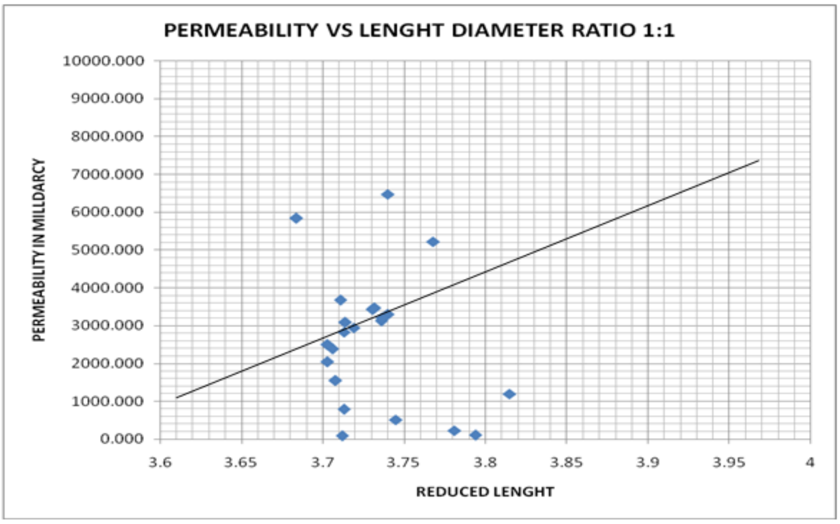

Figure 5: Permeability and Reduced Length

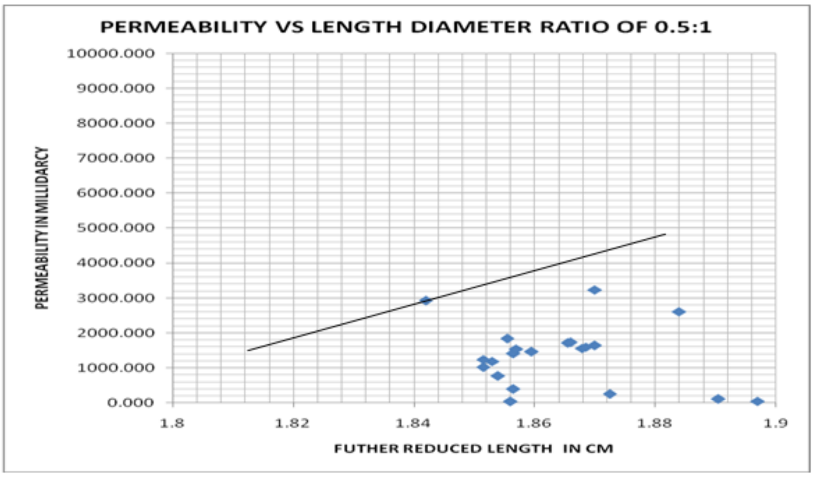

Figure 6: Permeability and Length/Diameter Ratio of 0.5:1

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Gold recovery from waste dam of Moute Gold Mine by flotation and optimization the process via Taguchi method

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ABSTRACT: *The waste dam of Mouteh Gold Mine in Iran has a gold content of about 0.5ppm mainly as constituents of activated carbon. Flotation is used for concentrating the gold bearing activated carbon. Effects of factors such as pulp pH, impeller speed and frother concentration in flotation experiments has been determined through Taguchi method. Using this method, maximum recycling rate of gold and concentrate gold carat are predicted about 74.5%, and 9.6ppm respectively.*

Key words: *Gold recovery, Flotation, Activated carbon, tailing treatment.*

I. INTRODUCTION

1.1. Mouteh Gold Mine

The treatment of flotation tailings is a subject of interest in mineral processing because of the potential of wasted materials as an actual mineral resource and also environmental reasons. As shown in Table 1 carat of gold in Mouteh Gold Mine is about 0.4ppm. Gold excavation in this mine is conducted using CIP method and activated carbon in waste is highly rich in gold, about 1280 ppm. Total amount of gold in the waste dam is calculated as 688 kg. The purpose of this work is to separate the activated carbon via flotation method for recovery of gold. Taguchi method also is used for finding the optimum condition of flotation in order to reach to the highest gold recovery and carat of gold in concentrate.

Table 1 carat and amount of some elements in waste dam of Mouteh Gold Mine and carat of elements on carbon

element	carat of element in waste dam (ppm)	carat of element placed on carbon (ppm)	amount of elements in wast dam (kg)
Au	0.43	1280	688
Ag	5	5	8,000
W	209	5	334,400
Ce	120.37	3	
Yb	6.04	1.5	
Nd	56.43	5	
Sm	12.18	0.1	
Lu	0.927	0.3	
Eu	1.78	0.2	
Tb	1.62	0.5	
Sc	10.24	1.1	
Ir	5	5	
La	73.37	0.5	

1.2. Gold flotation

Recovery of native gold from gold ores and base metal ores is an important industrial practice. Conventional gold recovery methods are gravity, flotation, amalgamation and leaching processes [1]. Gardner and Woods [2,3] showed that electrochemically-cleaned pure gold had a zero contact in buffer solution and zero natural flotation in alkaline of acid solution when using purified nitrogen gas bubble. However there are evidences that show native gold has natural hydrophobicity. Some possible explanation for natural floatability of native gold are: surface charge, variation in composition of native gold in presence of other minor alloying elements like silver and copper and surface contamination with organic maters and oils that can increase floatability of native gold. More-over, floatability of native gold is different depend on type of host mineral (pyrite, arsenopyrite, base metal sulfide minerals, quartz) [4,5].

1.3. Carbon flotation

Carbon and carbonaceous minerals surfaces has natural hydrophobicity. In different efforts for recovery of unburned carbon and carbonaceous sulfide ores by flotation, diesel oil and pine oil are used as collector and frother respectively. Diesel oil known as an effective reagent for increasing natural floatability of carbon and carbonaceous minerals [5, 6 , 7].

1.4. pH in gold flotation

The pH of flotation feed is an important factor in gold flotation even though gold can float over a pH range of about 3 to 11. The value used in plants depends on nature of feed, type of host mineral (pyrite, arsenopyrite, base metal sulfide minerals, quartz) and composition of collector. For some examples, in Australia, native gold (and pyrite) flotation has been conducted in soda ash circuit at pH 8-9. In south Africa, the preferred pH ranges are 3-4 and 10-11.5. Acidic circuits (pH 3-4) are preferred for floating uranium acid leach residues, old tailing dumps which are acidic, and some cyanidation residue. Alkaline circuits (pH 10-11.5 with lime) are preferred when the ore contains pyrophyllite [4].

II. EXPERIMENT

2.1. Flotation

Following materials are used in flotation:

- booster : diesel oil
- frother : pine oil
- pH regulator : sulfuric acid

Three factors, pH, impeller speed (rpm) and concentration of frother have been changed in three levels for finding the optimum condition. There could some other effective factors in flotation that have been taken constant in this work like: temperature, water composition, type of booster and its concentration, amount of aeration and bubble-size [4]. Denver-cell was used hear for performing the flotation experiments. Pulp concentration was taken 25% and was prepared by tap-water. After adding frother and booster, 20 minutes of agitating and aerating was done on pulp.

Measuring the amount of gold in concentrate was performed in five steps: 1) the concentrate was calcinated for getting rid of activated carbon that strongly adsorbs gold on itself. 2) gold was washed and separated from concentrate by hot aqua regia (nitric acid and hydrochloric acid in a volume ratio of 1:3 respectively). 3) gold in aqua regia was gained via activated carbon adsorption. 4) the activated carbon bearing gold was calcinated. 5) remained ash washed with hot aqua regia for separating gold. And finally carat of gold in the last solution measured by Atomic Adsorption Spectroscopy.

Tests results are reported in two viewpoints 1) concentrate carat 2) recycling percentage. The ideal situation is the one that both concentrate carat and recycling percentage are high in.

2.2. Optimization

Orthogonal array L9 that is shown in Table 2 is introduced by Taguchi method for three factors varying in three levels. In this table factors are in columns, symbolized by A, B and C. Different combinations of factors with three different levels are in rows. Numbers in three columns under A, B and C show levels of factors. Number of all possible tests in case of three 3-level factors is $3^3 = 27$, however Taguchi test designing method enables us to find the optimum condition by nine tests only. And of course it is possible that optimum condition wouldn't be among these nine tests [8].

Table 2. orthogonal array L9

Experiment number	A	B	C
1	1	1	1
2	1	2	2
3	1	3	3
4	2	1	2
5	2	2	3
6	2	3	1
7	3	1	3
8	3	2	1
9	3	3	2
Sum	18	18	18

For this work, factors are A: pH, B: impeller speed (rpm) and C: concentration of frother and each of them change in three levels Table 3. Qualitek-4 software is used for design and analysis of experiment according to Taguchi method.

Table 3. Factors and levels for flotation experiment

		Quantity of factors in three levels		
		1	2	3
pH	A	5	4	3
rpm	B	1600	1200	1000
concentration	C	2000 g/ton	1000 g/ton	200 g/ton

III. RESULTS AND DISCUSSION

3.1. Results

Results of the nine performed tests are reported in two different ways, 1) concentrate carat, 2) recycling percentage Table 4. Each test has been conducted two times.

Table 4. results of flotation

				concentrate carat (ppm)		recycling percentage	
test number	A	B	C	result 1	result 2	result 1	result 2
1	1	1	1	3.25	3.6	32.37	35.85
2	1	2	2	3.44	8.84	24.86	63.88
3	1	3	3	3.9	6	22.98	35.36
4	2	1	2	2.4	3.8	29.4	46.56
5	2	2	3	6.3	11.2	35.7	63.46
6	2	3	1	8.1	11.8	49.24	71.74
7	3	1	3	5.8	6	85.9	88.88
8	3	2	1	5.16	4.9	51.46	48.87
9	3	3	2	11.5	10	72.37	62.93

3.2. The larger, The better, for gold recycling percentage

With target of maximum amount of gold recycling the predicted optimum condition is $A_3B_3C_3$, Table 5. The predicted gold recycling in this situation is 74.5% although there was a 88.8% gold recycling among the performed tests (test 7 in Table 4). Probably this disagreement results from experimental error.

Factor’s contribution on the answers are shown In Table 5 quantitatively. Figures show that the role of pH on results is 10 times more active than of two other factors.

Table 5. optimum condition for gold recycling percentage

factors	levels	factors' contribution	predicted gold recycling
A: pH	3	3.347	
B: Rpm	3	0.368	74.5%
C: Concentration	3	0.359	

3.3. The Larger the better, for concentrate carat

With target of maximum concentrate carat the predicted optimum condition is $A_3B_3C_3$. The predicted concentrate carat in this situation is 9.6ppm. The desirable result obtained here is that both optimums for concentrate carat and gold recycling happen is same condition which is $A_3B_3C_3$.

Table 6 shows factors contribution on concentrate carat quantitatively. Figures show that the role of rpm on results is 1.5 times more active than of pH and also contribution of concentration of frother is not significant.

Table 6. optimum condition for concentrate carat

factors	levels	factors' contribution	predicted concentrate carat
A: pH	3	1.827	
B: Rpm	3	2.96	9.6 ppm
C: Concentration	3	0.666	

As mentioned earlier, regarding the case in which higher recycling rate is under consideration, pH contribution on results is about 10 times higher than for two other factors, Table 5. According to These results pH and Rpm play the main role on recycling rate and concentrate carat respectively.

IV. CONCLUSION

Conducting tests for predicting the optimum points for recycling rate and concentrate carat were performed. Luckily, both optimums happened in same condition, $A_3B_3C_3$, which implies for pH equal to 3 (the lowest pH level), Rpm equal to 1000 (the lowest Rpm level) and frother concentration equal to 200g/ton (the lowest concentration). Predicted maximum gold recycling percentage and concentrate carat in this condition were 74.5% and 9.6ppm respectively. For having optimum recycling rate and highest carat of concentrate, pH and Rpm play the main roles respectively.

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Development of Digital Computation of Building and Civil Engineering Quantities

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Abstract: *The work of Building and Civil engineering demands a greater knowledge, skill and precision in quantity estimation.The manual method of estimating quantities for building and civil engineering works has posed potential problem areas on work that is undertaken. The low reliability of manual estimation indicates discrepancies in the accuracy of quantities computed manually,hence,the introduction of a digital computation.It is envisaged that this method will greatly reduce the complexities of different aspects when computing quantities for projects, as well as reduce the time to complete the computation and therefore projects can be started earlier.The paper reviewed the procedures involved in the development of a computer program for the digital computation of Building and Civil engineering quantities.The program was developed using Microsoft Visual C SHARP (C#) programming language and Microsoft Visual studio. The steps/procedure used in achieving the development of the computer program was (1).designing the application interface,(2) adding controls to the window and (3)writing codes behind the interface.The digital computation was tested using a proposed Road project and a proposed administrative buildingand the results showed an average of 100% of the items has 0 to 10 percentage difference for the road and 92% for the building in the final outputs of the quantities obtained through the manual computation and the digital computation and the software could therefore be said to be accurate and reliable.*

Keyword: *Engineering, Estimating, Quantity, Microsoft, C SHARP.*

I. INTRODUCTION

The introduction of the microcomputer brought computing to all professions within the building and civil engineering industry. The cheap personal processing power of the microcomputer has provided the platform for the development of application software packages to meet the needs of the industries (McCaffer and Baldwin, 1991). Hence, the last decade according to Ekwueme (1997) has seen a considerable increase in the use of computers and associated information technology in all areas of the building and civil engineering industry. Although, comparatively fragile, computers have become in a very real sense construction equipment. For instance, in the area of construction management, computers are useful as aids in scheduling, planning and controlling projects of all sizes (O'Leary, 2007). The merits of applying computers in the area of construction management are numerous. Firstly, it can quickly provide vast amounts of information to the planner including large quantities of calculations under various assumptions likely to be encountered, to enable better informed engineering decisions to be made (Puerifoy and Ledbetter, 1985).

Computers are also currently being used by quantity surveyors in the preparation of bills of quantities and project estimate (Seeley, 1998). Civil engineering and Building works demands a greater knowledge, skill and precision in quantity estimation. This is due to the fact that the estimated quantities are major determinant of the estimated cost of a project (Douglas,1972).The introduction of software usage in building and civil engineering industry has greatly reduced the complexities of different aspects in quantity estimation and valuation, as well as reducing the amount of time necessary to complete the preparation of the Bill of Quantities. Concurrently, this saves time and energy. More complex projects are now easily solved with the use of computers. Some of the available software systems also incorporate the Standard Method of Measurement (SMM) and the Civil Engineering Standard Method of Measurement (CESMM) (Achenu 1999). There are various methods of data input available. The input method can incorporate traditionally prepared dimensions, suitably coded or the organization can use direct keyboard entry with automatic squaring or a fully integrated digitizer (Seeley, 1993). Most computer aided estimating systems are either based on spread sheets, or estimating packages. Computers equally contribute speed and accuracy which are both readily measured in terms of lower costs and/or better efficiency (Ekwueme, 1997).

Other areas where the application of computers is highly useful in the Building and Civil Engineering industry include: Architectural Design and draughting; Engineering design/detailing; Quantity survey/cost management, contract administration and so on. Architectural design may be aided by using the computer software which includes Computer Aided Designs (CAD) or computer Aided Design and Draughting (CADD). By using these software programs, an optimum solution in the architectural design may be reached since the architect can use the computer to examine a lot of designs before making a final choice (Achenu,1999).From the foregoing therefore, it could be observed that computer has a wide range of applications in the building and civil engineering industry where it could be used for estimating, controlling, scheduling, procuring and purchasing, quality assurance, administering of contracts as well as improving productivity.

1.1 Aim and Objectives.

The aim is to solve the problem of fatigue and to limit potential errors in quantity estimation and bill preparation.

The objectives are to:

i review the subject matter of quantity estimation;

ii use Microsoft Visual C SHARP (C#) programming language for the development of a digital computation software;

iii test the software on both building and civil engineering works and compare the results with manual computation and

iv recommend the use of the sofware if found to be accurate and reliable.

1.2 Justification

The aim of the bill of quantities is to set down the various items of work in a logical sequence and recognized manner, so that they may be readily priced by contractors and provide good basis for tendering. Stark (1983) indicated that actual quantities frequently vary from the estimated quantities listed in the proposal, and because receipts are based upon actual quantities, such variations have an obvious impact on the contractor’s cash flow. The manual practice of calculating the bill of quantities begins after the completion of the working drawings and with the preparation of a draft of the general specifications. Manual computation of quantities is a time-consuming task and hence to prepare this tedious task successfully, detailed drawings, explicit general specifications, and a clever estimator are required (Ogunlana 1991).The manual method of estimating quantities for building and civil engineering works has posed potential problem areas on work that is undertaken. The low reliability of manual estimation indicates discrepancies in the accuracy of quantities computed manually.

To produce quantities that are reliable, accurate and less time consuming, the need for digital computation comes into play. The work of quantity estimation requires a lot of precision. This is mainly due to the fact that the final result directly affects the overall approximate cost of work; hence accuracy becomes a critical issue. The development of digital computation will greatly reduce the complexities of different aspects when computing quantities for complex projects, as well as reduce the time necessary to complete the computation and therefore projects can be started earlier.The calculation component in computation programs facilitates the decision making and creative thinking by allowing the estimator to quickly recall and review issues relevant to the task at hand (Kim,1989).The digital computation will accelerate the work timeframe in quantity computation and ensure accuracy without decreasing the reliability and efficiency of the result(Eben-Saleh and Ravinder, 1998).

II. MATERIALS AND METHODS

The programming language used for the production of the digital computation is the Microsoft Visual C SHARP (C#). Microsoft Visual C# is a premier language for Microsoft Visual Studio.Net Development. A combination of good programming in C# and good use of Microsoft Visual studio allows an artistic application to be created, visually appealing and dynamically interactive. Microsoft C# was chosen for this project mainly because of its advantage of presenting a visually appealing and interactive graphical user interface as well as a powerful language to create code that properly executes the desired tasks when properly programmed.

2.1 Developing The Digital Computation Program

2.1.1 Designing the Graphical interface

The first step that was taken in the development of the computation program was the design of the users interface. Extensible Application Mark up Language (XAML) was used to implement the appearance of the application while code-behind was used to implement its behavior.The graphical interface was created using a windows application WPF in Visual studio. Net.

2.1.2 Adding controls to the Window

The next step that was taken was adding controls to the window.In general, the functionality of a window is expressed by two types of items: controls and menus. It is through these items that a user interacts with the program. The design process started by adding different controls from the toolbox to the application. Windows defines many different types of controls, including pushbuttons, check boxes, radio buttons, and list boxes, to name just a few. Although each type of control is different but they all work in more or less the same way.

2.1.3 Writing of Codes Behind the Interface

The last step was writing the code behind the interface.Before the application can would be capable of performing the tasks and responding to user interaction, the codes have to be written. Visual C# is an event-driven language, which means that code is executed in response to events. These events might come from users, such as a user clicking a button and triggering its Click event, or from Windows itself. The codes written for the developed application were triggered by the Button Click event. Generally, in the application, codes were written to achieve the following tasks;

i. Computation of the Quantities.
ii. Generation of the cost.
iii. Saving of Output to Database in form of bill of Quantities.

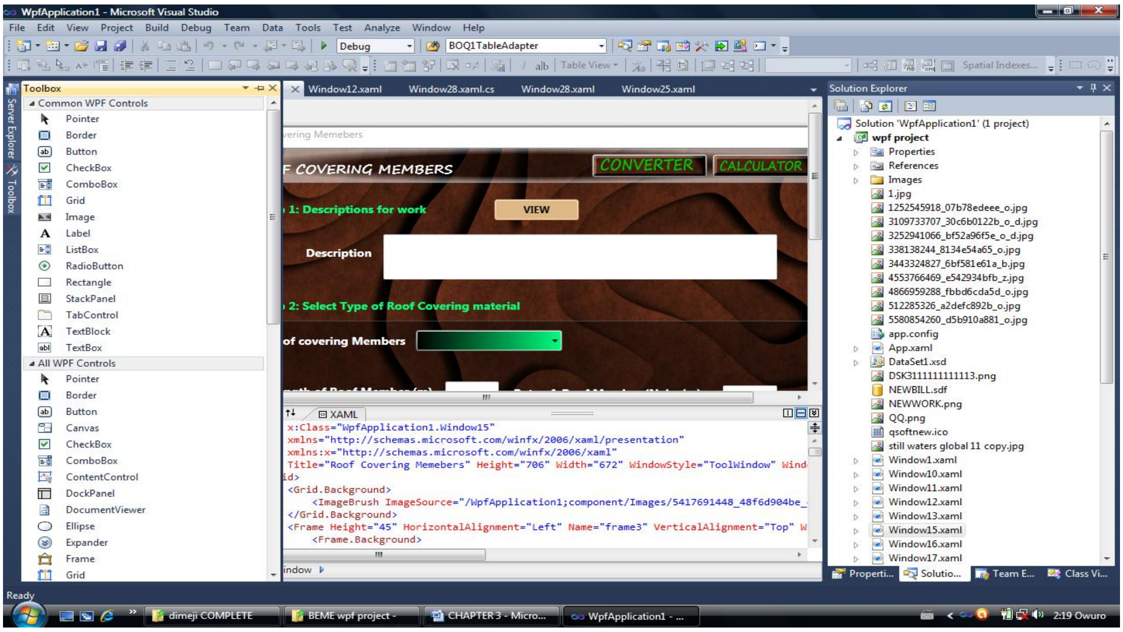

Plate 1: A view of the graphical interface in Csharp environment during design process.

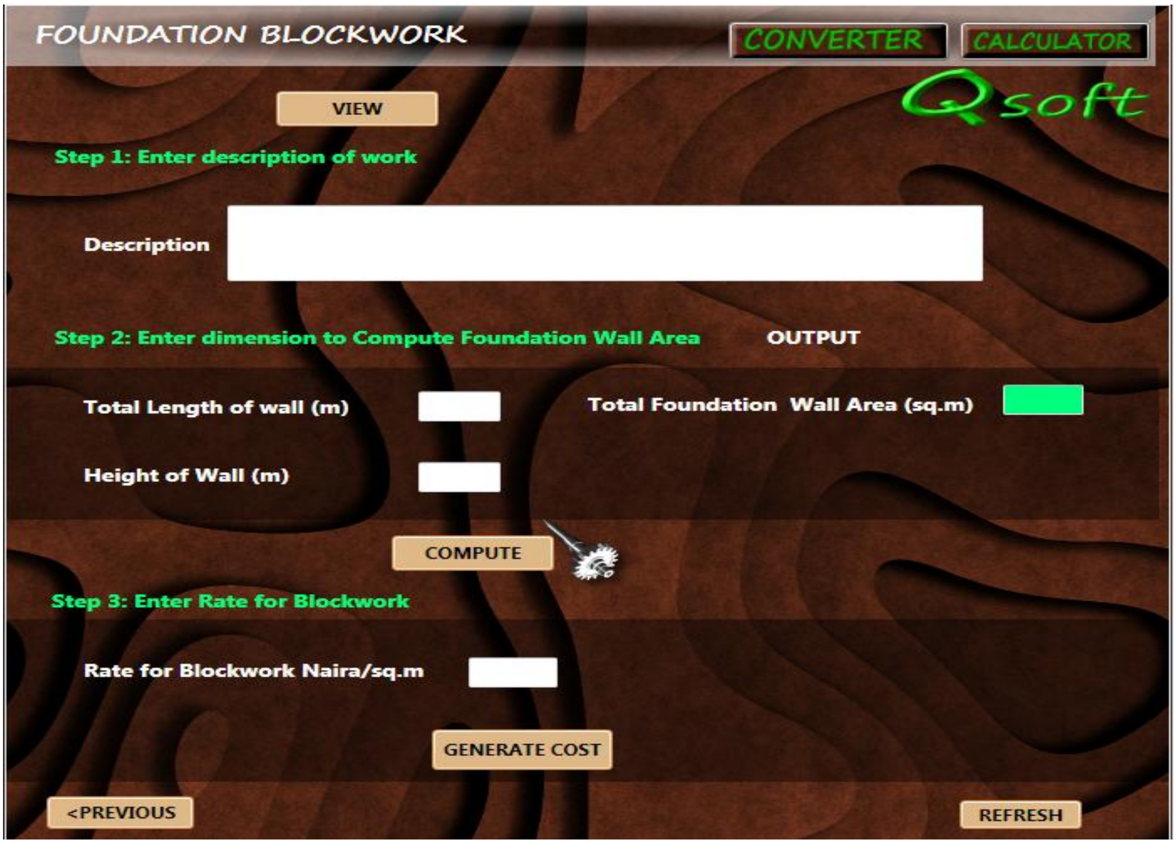

Plate 2.2: A view of the graphical interface showing the controls

2.1.4 Testing the Digital computation program

The developed computation program was tested on a Proposed Building project for the computation of quantities for following items;

i. Site Clearing
ii. Excavation and Backfilling
iii. Concrete works and Reinforcements
iv. Masonry and Block works
v. Roofing
vi. Surface finishes

It was also tested on a Road project for the computation of quantities for the following items;

i. Site Clearing and Earthworks
ii. Culverts and Drains
iii. Pavement and Surfacing

Data such as length, width and depth were inputed into the software and the program instantaneously calculates and displays the results on the screen using the above parameters:

i. Quantities (sq.m or cu.m or Nr or Lm)
ii. Amount (Naira)

The data such as length, width and depth used in the calculation were extracted from both the Architectural drawing and the engineering road layout.

2.2 Application Flow Chart

A Typical flow diagram showing the step by step process to compute quantities and generate cost is shown below.

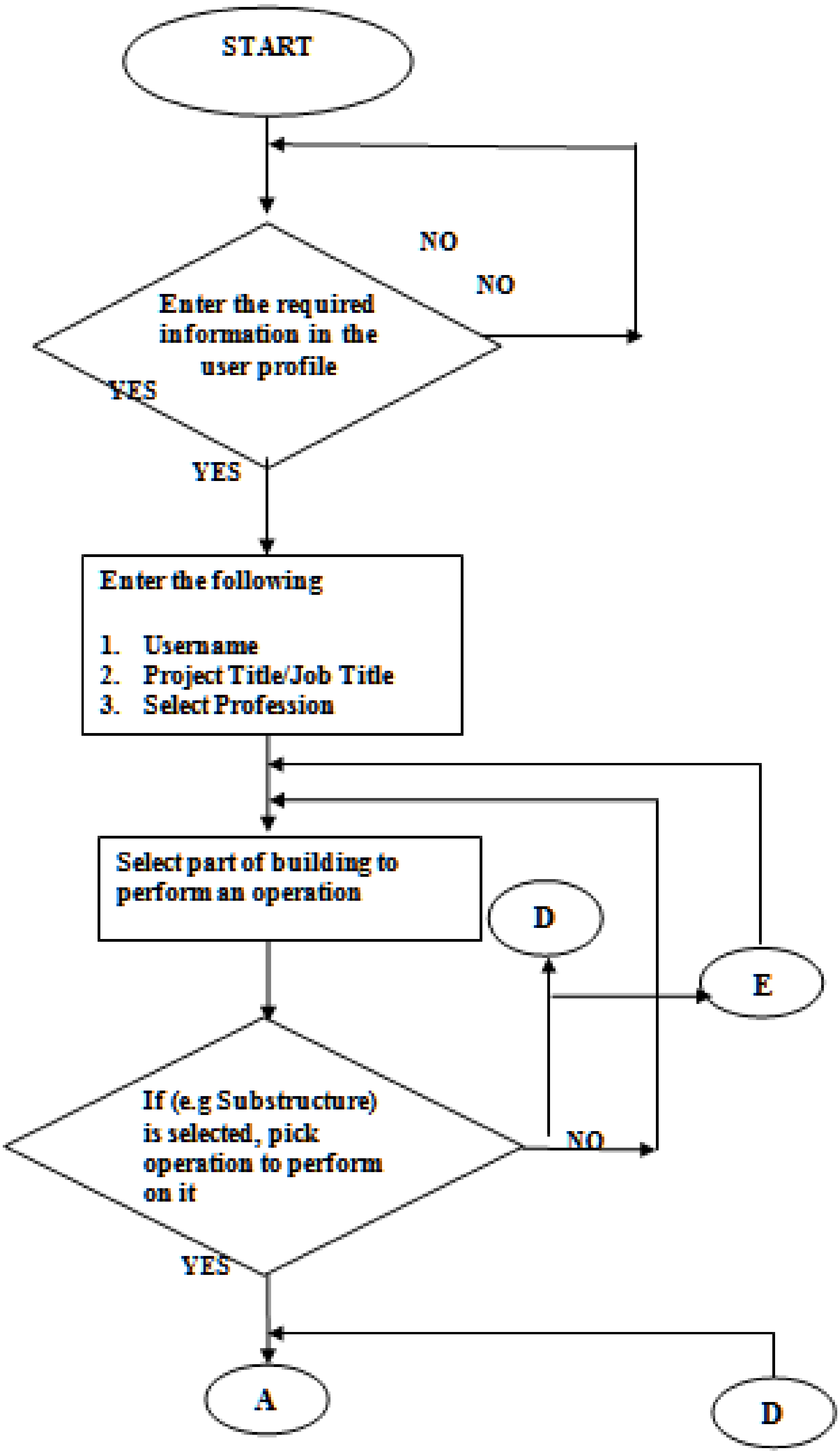

FIG. 1: A Typical Flow Diagram Illustrating step by step process of the Building Program

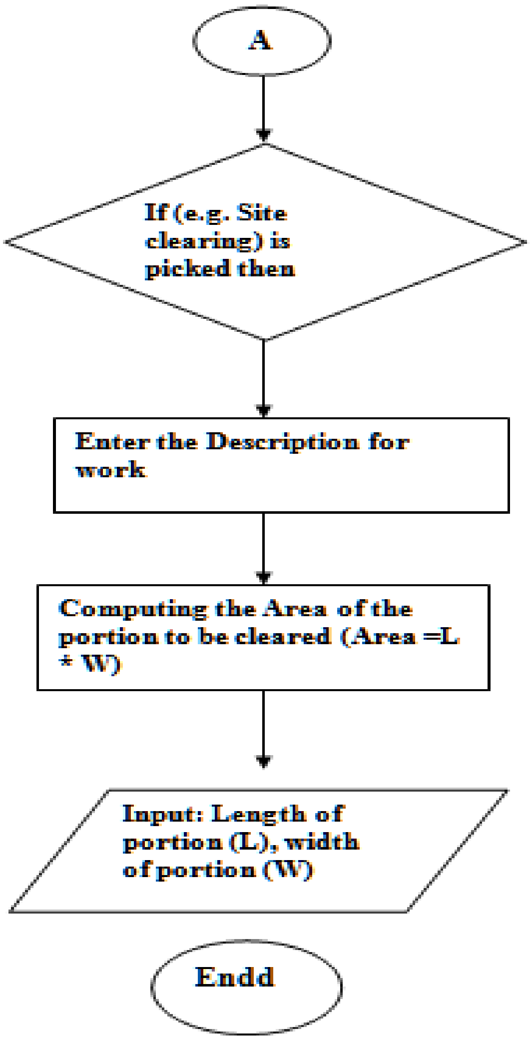

FIG. 1: A Typical Flow Diagram Illustrating step by step process of the Building Program

III. DISCUSSION OF RESULTS

The process of developing the digital computation of building and civil engineering quantities followed the same style and procedure as one would generally follow in a manual elementary calculation. The result got from the implementation of this study is the development of a digital computation of building and civil engineering quantities to ease quantity estimation. Throughout the execution of the computer program, ease-of use and flexibility was a major consideration.A lot of effort has been put together to make the program simple to understand and straight-forward for the users. That is, imputing the parameters and rate for building and road quantities from architectural or engineering drawing will instantaneously produce the results in an understandable manner.

3.1 Testing the Digital Computation Program

The developed program was tested using a proposedAkugbene Road Project in Delta State and a proposed Administrative Block at AdekunleAjasin University, Akungba-AkokoOndo State and the program was found to be accurate and reliable. The whole process of the digital computation followed the same style and procedure as one would generally follow in a manual calculation. The efficiency of the software was analysed by computing the two projects manually. The results are shown in Tables 1 and 2.From the Table 1, it is seen that 60% of the items in clearing and earthworks has 0 to 5 percentage difference and 40% has 6 to 10 between the manual and digital computation.This means that 100% of the items has 0 to 10 percentage difference. This showsthat there are little or no difference in the final outputs of the quantities obtained through the manual computation and the digital computation for the project. Similarly, the Table shows 67% of the items under culvert and drains, pavement and surfacing (separately) has 0 to 5 percentage difference and 33% has 6 to 10 percentage difference meaning that 100% of the items has 0 to 10 percentage difference in the final outputs of the quantities obtained through the manual computation and the digital computation for the project.

Table 1: Proposed Akugbene Road Project in Delta State

		Manual Computation	Digital Computation		
Item	**Description**	**QTY**	**QTY**	**Difference**	**% Difference**
Bill No 2: Site Clearing and Earthworks					
2.01	Clearing of site of all rubbish, grass, bush, shrubs and all trees.	20,000m^2	20,600m^2	600	3
2.02	Cut down large trees	5 No.	5No	0	0
2.03	Excavate and dispose all unsuitable material below subgrade in cut or fill area.	2000 m^3	2140m^3	140	7
2.04	Excavate in any material except rock to formation levels in cuttings and side drains	1 m^3	1 m^3	0	0
2.05	Excavate from approved borrow pits.	2000m^3	2160 m^3	160	8
Bill No 3: Culvert and Drains					
3.01	Excavate in any material and to any depth for culverts.	405 m^3	405 m^3	0	0
3.02	Level and compact bottom of excavation, provide and place concrete grade 10 as blinding (50mm thick) to box culverts only.	405m^2	405m^2	0	0
3.03	Provide, place & compact concrete grade 20 in box culverts, walls and aprons	810m^3	859m^3	49	6
3.04	Provide and fix high tensile reinforcement in box culverts, all walls, staircases, cover slabs, etc.	1780 kg.	1922 kg.	142	8
3.05	Provide and lay trapezoidal concrete – lined drain 100mm thick, in grade 20 concrete	405m	421m	16	4
3.06	Provide, place & compact reinforced concrete drains with internal dimensions 500mm deep x 450mm wide.	200m	210m	10	5

Also from Table 2, it is also seen that 58% of the items in the sbstructure has 0 to 5 percentage difference, 25% has 6 to 10 and 17% has 11 and above percentage difference between the manual and digital computation.This means that 83% of the items has 0 to 10 percentage difference and 17% of the items has percentage difference more than 10. Similarly, the Table shows 60% of the items for superstructure has 0 to 5 percentage difference and 40% has 6 to 10 percentage difference meaning that 100% of the items has 0 to 10 percentage difference in the final outputs of the quantities obtained through the manual computation and the digital computation for the proposed building project.Therefore, the developed digital computation program can be said to be efficient and accurate in its final outputs and can be used in place of manual computation with it's other advantages.

		Manual Computation	Digital Computation		
Item	**Description**	**QTY**	**QTY**	**Difference**	**% Difference**
Bill No 4: Pavement and Surfacing					
4.01	Provide, spread, shape and compact to 100% sub-base course .	3,750m^3	3,750m^3	0	0
4.02	Provide, spread, shape and compact approved granite crushed stone base.	2,250m^3	2,273m^3	23	1
4.03	Provide and lay MC1 to carriageway and shoulders at the rate of 1.1litres/m².	7,300 m^2	7,300 m^2	0	0
4.04	Provide, lay and compact surface dressing on shoulders using cut-back bitumen S-125 at 1.12litres	3,000 m^2	3,120 m^2	120	4
4.05	Provide, lay and compact asphaltic concrete wearing course for a compacted thickness of 40mm.	7,300 m^3	8,030 m^3	730	10
4.0 6	Provide, lay and compact asphaltic concrete binder course for a compacted thickness of 40mm as specified.	7,300m^3	7,957m^3	657	9

Table 1Cont'd :Proposed Akugbene Road Project in Delta State.

Table 2: Proposed Administrative Block in AdekunleAjasin University, Akungba-Akoko, OndoState(Substructure)

		Manual Computation	Digital Computation		
Item	**Description**	**QTY**	**QTY**	**Difference**	**% Difference**
A	Excavate to remove top soil	70m^2	72m^2	2	3
B	Excavate trench to receive foundation	22m^3	21m^3	1	5

C	Filling to excavation	14 m^3	13 m^3	1	7
D	Filling to make up levels do with granite	45 m^2	46 m^2	1	2
E	Filling to make up levels do with laterite earth filling	13 m^3	14 m^3	1	8
F	Pour mass insitu concrete in foundation footing	9 m^3	9m^3	0	0
G	Pour mass insitu concrete in Blinding	1 m^3	1m^3	0	0
H	Pour mass insitu concrete in Oversite concrete	8 m^3	9 m^3	1	13
I	Lay high tensile reinforcement bars sizes;12mm in diameter	12kg	11kg	1	8
J	Lay high tensile reinforcement bars sizes;12mm in diameter	56 kg	58kg	2	4
K	Lay high tensile reinforcement bars sizes;10mm in diameter	5 kg	6 kg	1	20
L	Lay 225mm thick solid blockwork in foundation	37 kg	38 kg	1	3

Table 2 Cont'd: Proposed Administrative Block in AdekunleAjasin University, Akungba-Akoko, Ondo State (Superstructure).

		Manual Computation	**Digital Computation**		
Item	**Description**	**QTY**	**QTY**	**Difference**	**% Difference**
A	Pour mass insitu concrete in columns	1 m^3	1 m^3	0	0
B	Pour mass insitu concrete in beams	1 m^3	1 m^3	0	0
C	Pour mass insitu concrete in Lintel	1 m^3	1 m^3	0	0
D	Reinforcement:column starter 12mm diameter	34kg	37kg	3	9
E	Reinforcement:column starter 10mm diameter	21 kg	23kg	2	10
F	Reinforcement:Beam 12mm diameter	32 kg	35kg	3	9
G	Reinforcement:Beam 10mm diameter	22 kg	23kg	1	5
H	Reinforcement:Lintel 12mm diameter	66 kg	68kg	2	3

I	Reinforcement:Lintel 10mm diameter	53 kg	56kg	3	6
J	Lay 225mm thick block in wall up to 1.5m height.	113 m^2	117 m^2	4	4

The program was also able to perform the following tasks:

i. Squaring of dimensions and display of quantities.
ii. Display of cost summaries during estimation process.
iii. Storing of results in a database
iv. Display of result in a Bill format.
v. Printing of output as at when due.

IV. CONCLUSION.

The developed program will be able to solve the problem of fatigue and limit potential errors in quantity estimation and bill preparation as well as reduce the time consumed. The program was designed in such a way that the users will be guided through the computation stages in a straight forward and understandable manner. The software was developed using a combination of good programming in Microsoft Visual C SHARP (C#-version 2010) and Microsoft Visual studio Environment (version 2010),which allows an artistic application to be created, visually appealing and dynamically interactive.A typical flow chart representing the relationships between the tasks involved in the development of the software was developed, in order to identify the required computer sequence of operation to be used and translate the logical sets of programs. The software was tested and the results found to be accurate and reliable for both building and civil engineering works and can therefore be used in place of manual computation.

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Compressed Data Transmission Among Nodes in BigData

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ABSTRACT: *Many organizations are now dealing with large amount of data. Traditionally they used relational data. But nowadays they are supposed to use structured and semi structured data. To work effectively these organizations uses virtualization, parallel processing in compression etc., out of which the compression is most effective one. The data transmission of high volume usually causes high transmission time. This compression of unstructured data is immediately done when the data is being transmitted from client to DataNode. Initially once unstructured or semi-structured data is ready for transmission, the data is compressed using some software tools or procedures. This compressed data is transmitted through certain medium that undertakes an effective transmission.*

Keywords–*BigData, Hadoop Architecture, Unstructured Data, Compression, Optimization, NameNode, DataNode, Data Transmission.*

I. INTRODUCTION

The corporation or organizations' success completely depends on how these corporations or organizations successfully manipulates or uses the vast amount of unstructured data. These unstructured data basically comes from website, XML files, Social Networks, etc. Some of common such examples includes Multimedia, web contents, satellite and medical contents.

1.1 Big Data

Big data is a large set of unstructured data even more than tera and peta bytes of data. Big Data[1] can be of only digital one. Data Analysis become more complicated because of their increased amount of unstructured or semi-structured data set. Predictions, analysis, requirements etc., are the main things that should be done using the unstructured big data. Big data is a combination of three v's those are namely Volume, Velocity and Variety. Big data will basically processed by the powerful computer. But due to some scalable properties of the computer, the processing gets limited.

1.2. Unstructured Data

Unstructured data is a data set those are in the form of logs. There won't be any items like rows, columns, records, etc., some unstructured data includes log details of website, multimedia contents, images, videos, satellite image contents, medical contents, etc. These unstructured data have become more complexes to be deal with. These unstructured data does not have any predefined data model. These unstructured data rather than having some text, will have vast amount of data like date, number, fact, etc., the unstructured data can never be readily classified. This kind of data cannot be contained in spreadsheet or relational database like structured data.

1.3. Compression

The compression[2] is a technique of reduction in size of large amount of structured or unstructured data. By using compression one can save some memory space and could be also able to minimize the transmission time. The compression could be made possible to be done for entre transmission unit or to certain data content.

By compression of data, the extra space characters can be removed. By introducing single repeat character for large repeated characters, substituting smaller bits can minimize the file up to 50% of its own contents. Algorithms can also be specified to determine how the compression should take place
Graphical data such as pictures, videos, animations, etc. are designed in such a way that it supports the data compression without any issues. The compression on these data can be of two kinds and they are

1 .Lossy compression
2. Lossless compression
In lossy compression, any certain information gets loss while the data is being compressed. In lossless compression there won't be any information loss during the data compression.

1.4. Need for Compression

Now relational database along with unstructured and semi-structured data evolves like xml, video, audio and images. These unstructured data are called large objects. Organizations are expected to deal with large amount of data volumes, any these kind of given data, the traditional data storage methods and tape can does not work anymore.
1.5. Compression Technique

- Huffman coding
- Arithmetic coding
- LZW compression
- LZ 77
- LZ 78, etc.

Among these compression techniques, the LZW[3] compression is favorable one with high performance ratio. It is an adaptive algorithm. Of the above mentioned methods, Huffman coding, Arithmetic coding are statistical methods. Whereas LZ (Lemple Ziv) algorithm is a dictionary method.

Here the basic idea used is replacing the recurring patterns with the references in the dictionary. In LZ Algorithm an explicit dictionary is maintained. The dictionary is primarily occupied with some set of data. Any further data could also be made to be added along with the dictionary. During the compression, initially every data is compared with the data in the dictionary. If the recurrence occurs, the original data is replaced the data n the dictionary. By this way the repeated data could be eliminated. Basically by LZ Algorithm, the previously processed data is used as dictionary.LZ 77 and LZ 78 are probably used to compress the data that consists of numbers and characters.

An advanced version of LZ Algorithm is LZW Algorithm. This algorithm is mostly used for the unstructured data like images, etc. But mostly used for the GIF images. Like other LZ algorithms, LZW is a patented one. By using LZ Algorithms, older entries are removed effectively.

II. HADOOP DATA TRANSMISSION TECHNIQUE

In existing methodology, the Hadoop architecture consists of master node or NameNode and DataNode[4]. The client uses the data from DataNode for the effective execution. Since BigData is a concept of distributed system. The replicas of data are made and placed in various Basic Blocks[5]. Certain set of Algorithms can be used for this replica placements.

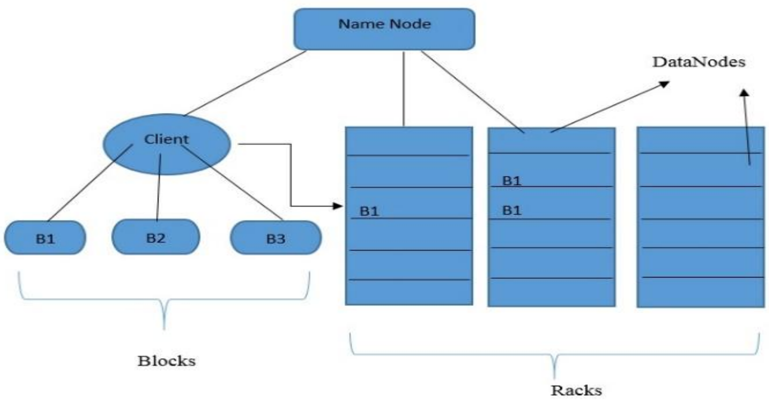

Fig 1. Data Transmission between Client and DataNodes

Initially the Large data set is divided into n number of blocks. These blocks are then replicated into some number of copies. Then, the blocks are placed in DataNodes as advised by the algorithm specified by the NameNode. The client then uses that DataNode. The Data set is transmitted to those DataNodes without any compression,

Node, the Mapping and Reducing is done for the execution of the data set. After once the execution gets completed, these data set with output is again send back to the client. This data sent was also a non-compressed one. The required analysis is made at the client side for business or organizational purposes. Here in this existing technique, it consumes more time for the transmission of the data. The block rocking algorithm which is an effective algorithm could be used for greater replica recovery purpose. The blocks thus created are arranged on the DataNode placing each replica of block in successive nodes

III. COMPRESSED DATA TRANSMISSION TECHNIQUE

In proposed method, the compression of unstructured data is made in effective manner. Initially the client, NameNode and DataNode are connected through some means of connection. Basically this connection is made through the TCP Connection. The TCP connection will be more advantageous as it always replies with a respond. The client receives the Acknowledgement from the DataNode about which DataNode should be used in the Rack. The client then as per the instructions given by the NameNode will effectively places the Blocks on the DataNode.

The Entire Dataset is at first spliced into basic blocks. The basic blocks are nothing but the splitting of the whole given dataset. These basic blocks are replicated into some number of copies. Then this Basic Block data are compressed by using a technique called LZ algorithm. Before performing the Compression, the basic Coupling of data set is made.

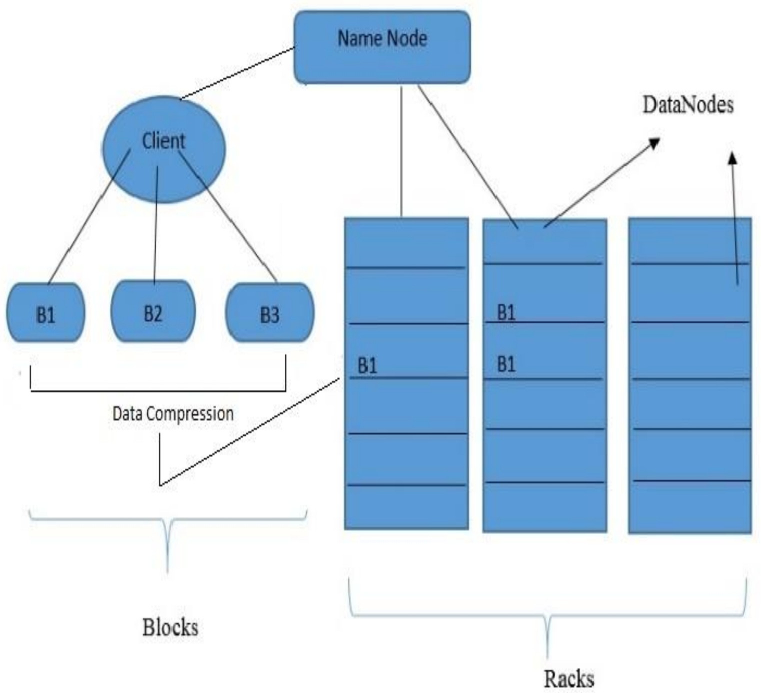

Fig 2.Compressed Data Transmission between Client and DataNode

3.1 Coupling

Coupling is nothing but grouping or classifying the dataset based on some criteria. Usually Coupling could be made based on the factors that includes size, type, etc. By Coupling, the dataset are initially grouped with certain similarities. Thus based on this grouping or classification, separate compression algorithms could be implemented for easy and elegant methods or Algorithms. For Graphical or Multimedia contents like Images, video, etc., an algorithm called LZW can be used in enrich able manner

3.2 Compression

The segregated data is at first made possibly grouped. Then the grouped similar kind of data is then again grouped. Once the data is grouped on some sort of similarities, the data Blocks are formed. Then on this data Blocks the compression is made. By this kind of compression a vast amount data could be eliminated from transmission. Since the data is considerably reduced, the transmission time obviously gets reduced. The compressed data then transmitted to the DataNodes. The Data is operated at the DataNode. In DataNode the Map Reduce Algorithm is executed. By map the data is again sub divided. Once the Sub division is made, the Map Algorithm will execute or will provide some sort of multi programmed technique to perform the required operation on those big set of data.

3.3 Decompression

Once the data is compressed and reaches the data node, there for the operations, the compressed data is again decompressed at DataNode level. By Decompression, the original Dataset is extracted, then the operation is performed on these original dataset. After the operations are performed, the data output is recovered. This recovered data is sent back to the client. The client receives this processed dataset. The Analysis on the data is basically made at this client side after all this steps are processed.

IV. MERITS AND DEMERITS

There are basically two kinds of compression methods. They are lossless and lossy compression. If the lossless compression method is used, the information after compression is extracted or decompressed without any data miss. But incase if the Lossy compression is prepared, then there will be some amount of data or information loss after the data extraction or decompression. Some advantages of compression includes the following,

- Reduction of cost
- Performance can be enhanced by achieving optimization.
- Great knowledge on which information the compression to take place.

V. RESULT AND CONCLUSION

Thus as a result, the large data set or BigData is transmitted after being performing the compression. Since data is completely compressed, the size gets reduced. As the Data size is reduced, it is much enough to transmit the lesser amount of data. This transmission of lesser amount of data achieves only a very low amount of transmission time. Thus the performance is enhanced. The speed of execution also gets increased, as the transmission time is reduced.

- Transmission time is inversely proportional to Amount of compression.
- Execution time is directly proportional to Transmission time
- Execution time is inversely proportional to Amount of compression

Generally the total performance of the Hadoop system gets increased. The optimization of the dataset is achieved by the enhanced Data Compression.

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Environmental Aggression and Corrosion of Reinforcements. A Real Case.

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ABSTRACT : *In the current economic climate, where cuts in investment in public works make construction site stoppages commonplace, the maintenance and conservation of those structural elements which are kept outside must be a priority for construction companies. Passive reinforcements constitute one of the elements most affected by the passing of time and exposure to weather conditions, and may risk losing their mechanical and physical characteristics. In this article the authors analyse the state of the physical and mechanical properties of the passive reinforcements AEH-500 on a construction site, which have been exposed to the weather conditions for four years. The construction site analysed is a motorway, located 2 km from the coastline.The results prove that the average sectional loss is below 4.5% and that the adhesion values satisfy the limitations of EHE-08. Moreover, as laid out under this same rule, carrying out structural checks on piles and abutments where losses have been detected is essential in order to confirm their structural safety.*

Keywords: *reinforcement corrosion, loss of section in reinforcements, adhesion, outdoors works, marine environment*

I. INTRODUCTION

Activity in the construction sector has been reduced to a minimum due to the continuing problems on the financial markets and the uncertainty of the economies in both Europe and Spain. These problems inevitably condition the short- and medium-term recovery of the construction sector.According to the most recent statistics published by the Ministry of Public Works, during December 2011, 6,224 major building permits were granted, 50.10% less than in December 2010 (1)In this climate of economic instability,site stoppages have become commonplace. In this situation the structural elements already in place on site remain outdoors for as long as the work is stopped, meaning that the maintenance, conservation and performance of these elements must be taken into consideration. In a marine environment, chloride is present both in the seawater and in the atmosphere. This chloride penetrates the pores and fissures in concrete, and when sufficient quantities reach the reinforcements it produces localised breakages in the protective coat of the steel [2].This phenomenon is known as corrosion [3].
Corrosion usually occurs when there is a reaction between the acidic substances in the atmosphere (carbon dioxide, sulphur dioxide, etc.) and the alkaline elements in the cement, which causes such a significant reduction in the pH levels (from about 13 to almost 7) that the protective coat on the steel dissolves [4]causing a general corrosion of the reinforcement. The consequences of this corrosion can be seen on three levels: a) on the steel, with a reduction in mechanical capacity brought about by a decrease in section; b) on the concrete, as the products corroding the steel are bulkier than the original elements, creating tension which can crack the material,c) on the steel-concrete adhesion, precisely because of the expanding nature of the corrosion products [3].This research was carried out on a site which was stopped in 2010, and where work was resumed after two years in September 2012. The objective is the analysis of the results collected during the experimental phase of tests carried out on the protruding rebars and the structural evaluation of the different piles and abutments, taking into account loss of resistance or adhesion caused by a decrease in section.

Photo 1: Corroded reinforcements.

II. MATERIALS AND METHODS

A detailed study of the conservation of structural reinforcementson the construction site was carried out. The site is located in the south of Granada province, Spain, 2 kilometres from the coast in a coastal Mediterranean climate, making it subject to the aggressiveness of a marine environment.

The affected structural elements are mainly:

- In the viaducts, the protruding rebars of the piling with a diameter of 2000 mm, given that the pile caps had not been executed, and the pile startingswhich foundation footings had not been stripped.
- In the overpasses, the lintel and shaft reinforcements.

Between 28th and 31st August 2012, a series of corrugated bars were extracted from the following locations:

- Viaduct III
- Viaduct II
- Viaduct I
- Overpass Intersection I
- Overpass Intersection III
- Underpass Wings

The location and tracking scheme in each structure is laid out in APPENDIX 1 – TESTS CARRIED OUT ON EACH STRUCTURAL ELEMENT.

Each case deals with:

- Steel quality type 500-SD.
- The diameter measurements on thin [10], medium [12, 16, 20] and largebars.

2.1 Sample

A total of 60 thin, medium and large-diameter corrugated bars were used, from different manufacturers. Identification and brands of the bars were:

- ACECOR: 17 units. Diametres: 32, 25, 16 and 12 mm.
- ACEROS BALBOA: 7 units. Diametres: 25 and 20 mm.
- CELSAMAX 500 SD: 11 units. Diametres: 20 and 16 mm.
- DUCTICELSA: 3 units. Diametres: 32 mm.
- EURA: 2 units. Diametres: 32 and 25 mm.
- NERVACERO: 2 units. Diametres: 32 and 20 mm.
- NERVADUCTIL: 6 units. Diametres: 32 and 20 mm.

48 of the 60 bars were identified, in other words, 20% of the samples taken were unidentifiable.

2.2 Number of tests

The number of tests was set out by batch. Batch means the same structure, the same element within the structure (pile cap, foundation footing, abutment, wing), the same bar diameter and the same date of execution (see Table 1).

The number of tests on bars of each type was:

- For the tests used to determine mass, 1% of the bars in a batch were tested, with a minimum of two tests per batch, and always on the oldest elements.
- For the traction tests, two tests were carried out per batch.
- The adhesion tests were carried out on two bars for each diameter, and always on the oldest bars, or those bars first used on site, with the aim of assuring maximum corrosion. This test was carried out on eight bars.

						Nº. of Tests		
Structure	Element	Nº. Elements	Nº. Bars	Diametre	Total Bars	Geometry	Traction	Adhesion
Overpass IntersectionIII	Piles	5	52	25	260	3	2	
	Abutments	2	38	12	76	2	2	
Underpass	Wings	4	0	0	0			
Overpass IntersectionI	Abutments	4	77	12	308	3	2	
Viaduct III	Foundation footing P-3	2	200	16, 20	400	2+2	1+1	2+2
	Foundation footing P-2	2	200	16, 25	400	2+2	1+1	
	Pilings E-2	5	75	25	375	4	2	
	Pilings P-1	7	45	20	315	3	2	
	Pilings E-1	5	70	25	350	4	2	
Viaduct II	Foundation footing P-2 Left.	1	200	20, 25	200	1+1	1+1	2+2
	Foundation footing P-2 Right	1	200	16, 20	200	1+1	1+1	
	Pilings E-2	5	75	25	375	4	2	
	Pilings P-1	7	45	20	315	3	2	
	Pilings E-1	5	70	25	350	4	2	
Viaduct I	Foundation footing P-2	2	200	16	400	4	2	
	Foundation footing P-4	2	200	16, 20 y 25	400	1+1+2	2	
	Pilings E-2	5	70	25	350	4	2	
	Pilings P-1	7	45	20	315	3	2	
	Pilings P-3	7	45	20	315	3	2	
	Pilings E-1	5	70	25	350	4	2	
				Total	6054	64	38	8

Table 1. Number of Tests

2.3 Types of test

The tests carried out to determine the characteristics of the adhesion of the steel are those laid out in Article 32.2 of EHE-08., with an additional mechanical characterization.

- Geometric tests on the corrugation and on the determination of mass and the area of the transverse cross section to determine the realdiameter.
- Mechanical tests, traction tests to determine the stress-strain curves of the bars.
- Adhesion tests using Pull-out. For this test a specimen of the concrete with the features to be used on site and the planned coatings must be taken.
  To enable tests to be carried out on the samples taken they were cleaned as follows:
- On bars with significant incrustations: an electrical steel wire brush was used to eliminate the largest adhesions, followed by careful removal of further adhesions using a manual steel wire brush.
- On bars with few incrustations: Manual steel wire brush.

III. RESULTS

Following the geometric tests outlined above the following table has been drawn up to show the loss of resistant area in each structure.

Structure	Average loss (%)	Maximum loss (%)
Viaduct I	2.47	4.40
ViaductII	2.57	4.32
ViaductIII	3.20	4.39
Overpass IntersectionI	3.23	3.80
Overpass IntersectionIII	3.08	3.98

Table 2. Section loss

As seen in the table above, for all structures, the maximum loss of resistant area is similar and always below 4.5%, whilst average loss falls between 2.5 and 3.2 %.

As laid out in Article 32 of the EHE 08 “Steel for passive reinforcements”, the equivalent section will not fall below 95.5% of the nominal section, if the equivalent section is:

$$S_e = \frac{W}{7.85 * L}$$

where:

S_e = equivalent section (cm^2), to three significant figures.
W = Weight of the specimen (grams).
7,85 = specific mass of steel (kg/dm^3) or (g/cm^3)
L = length of specimen (cm), given that $L \geq 50$ cm.

According to the results in Table 2, loss of area never exceeds 4.5%, therefore section loss caused by corrosion of reinforcements is admissible.

However, weight loss does exceed the minimum 1%, so, according to Title 7 “Execution” Article 69 “Construction, reinforcing and assembly processes for passive reinforcements” and Title 8 “Control” Article 88 “Control of passive reinforcements” of the EHE-08, a numeric justification which proves compliance of the sections of piles and abutments, under calculations of Project force, and with section losses found during the tests, is necessary.

Given that loss obtained through corrosion is similar in all structures, a constant loss is considered at 4.5%. Coefficients of safety for each element and structure have been compared with the reinforced section where no loss is incurred. This brought to light the fact that in all cases, the coefficient of determination was above a unit, so no additional reinforcement is required.

Using the results from the adhesion tests the following table has been drawn up:

Results of adhesion tests and minimum prescriptions from EHE-08 (art. 32.2):

Bar	τbm, test	τbm, EHE-08	τbu, test(MPa)	τbu, EHE-08

	(MPa)	(MPa)		(MPa)
Φ25	8.91	4.84	14.92	7.99
Φ20	9.28	5.44	15.41	8.94
Φ16	10.73	5.92	16.33	9.70

Table 3. Adhesion results

Furthermore, the geometry of the corrugated bars tested meets the values indicated in their corresponding Certificates of Approval of Adhesion.

Thus, relating to the level of aptitude of both the adherent and mechanical properties (shown through the traction test) of the corrugated steel bars laid out in article 32.2 of the EHE-08:

- 100% of bars tested conform to the minimum mechanical characteristics prescribed by table EHE 32.2.a.
- 100% of bars tested and identified by brand name conform to geometric characteristics (mass per linear metre, transverse cross section, roundness and characterization of corrugations) when the experimental results obtained are compared to the values stipulated by the reference standards and in the Certificates of Approval of Adhesion for each brand.
- For bars tested but not identified, 100% conform to the parameters of mass per linear metre, transverse cross section and roundness, compared to the values stated in the reference standards.
- 100% of the bars tested using the BEAM-TEST meet the reference values stated in article 32.2 of the EHE-08.

Regarding security tests against breakage in the starting sections, bearing in mind losses of section of passive reinforcements caused by corrosion, and considering the loss of bars used in the laboratory tests, in all cases the coefficient of determination was always superior to a unit, so no additional reinforcement was required.

IV. CONCLUSIONS

In this case study the maritime Mediterranean climate did not significantly affect the protruding rebars. The tests brought to light the following:
The average resistant section losses to corrosion are around 3%, the maximum losses are below 4.5%.
As for adhesion, the results of the tests show "τbm" and "τbu" values far above those prescribed by Article 32.2 of the EHE-08, and furthermore the geometry of the corrosion falls within the values stated in the corresponding adhesion homologation certificates. As stated in EHE-08 Articel 32 "Steel for passive reinforcements", the equivalent section must not fall below 95.5% of the nominal section. However Articles 69 and 88 of the EHE-08 advise against the use of passive reinforcements which have suffered a weight loss due to corrosion of over 1%. Structural tests are therefore essential on piles and abutments where losses have been detected to confirm structural safety. These safety tests have been satisfactory in every case.

V. ACKNOWLEDGEMENTS

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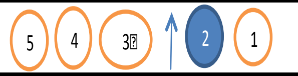
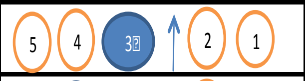
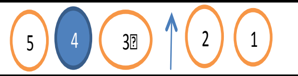
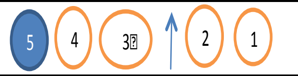
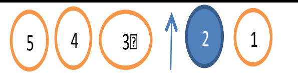
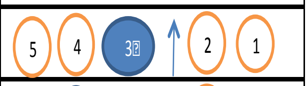
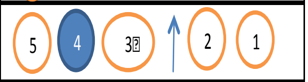
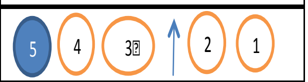
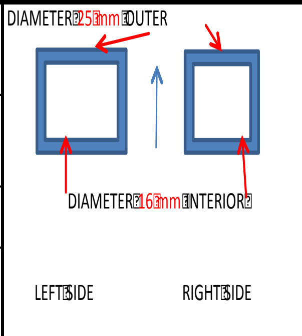
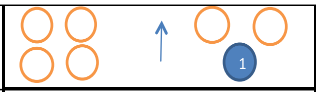
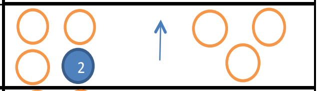
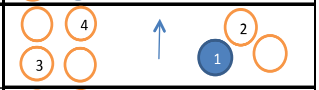
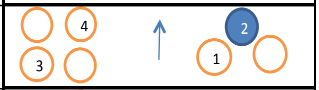
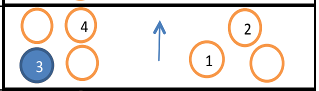
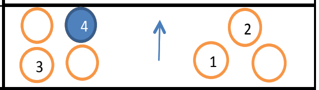
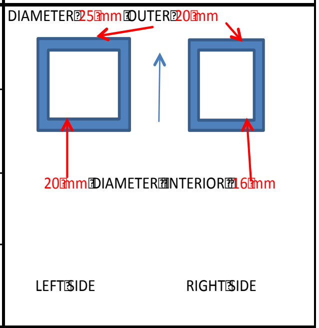
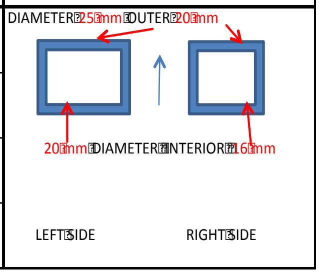
APPENDIX 1 – TESTS CARRIED OUT ON EACH STRUCTURAL ELEMENT.

DATE COLLECTED	Nº GLB	Ø	STRUCTURAL ELEMENT	SIDE	LENGTH (m)	GEOMETRIC CHARACTERISTICS	MECHANICAL CHARACTERISTICS	PULL-OUT	DIAGRAMM
28/08/12	5170	32	PONTES II PILING 1 ABUTMENT 2	RIGTH	1,25	×			5 4 3 2 1
28/08/12	5171	32	PONTES II PILING 2 ABUTMENT 2	RIGTH	1,20	×	×		5 4 3 2 1
28/08/12	5172	32	PONTES II PILING 3 ABUTMENT 2	LEFT	1,25	×			5 4 3 2 1
28/08/12	5173	32	PONTES II PILING 4 ABUTMENT 2	LEFT	1,20	×	×		5 4 3 2 1
28/08/12	5174	16	PONTES II PILE 3	RIGTH	1,20	×			DIAMETER 25 mm OUTER; DIAMETER 16 mm INTERIOR; LEFT SIDE; RIGHT SIDE
28/08/12	5175	25	PONTES II PILE 3	RIGTH	1,20	×	×		
28/08/12	5176	16	PONTES II PILE 3	LEFT	1,20	×	×		
28/08/12	5177	25	PONTES II PILE 3	LEFT	1,20	×			
28/08/12	5178	20	PONTES II PILE 2	RIGTH	1,20	×	×		DIAMETER 20 mm OUTER; DIAMETER 16 mm INTERIOR; LEFT SIDE; RIGHT SIDE
28/08/12	5179	16	PONTES II PILE 2	RIGTH	1,20	×			
28/08/12	5180	20	PONTES II PILE 2	LEFT	1,20	×			
28/08/12	5181	16	PONTES II PILE 2	LEFT	1,20	×	×		
29/08/12	5182	32	VIADUCTO PROVINCIAS ABUTMENT 1	RIGTH	0,95	×	×		4 3 2 1
29/08/12	5183	32	VIADUCTO PROVINCIAS ABUTMENT 1	RIGTH	0,80	×			4 3 2 1
29/08/12	5184	32	VIADUCTO PROVINCIAS ABUTMENT 1	LEFT	1,05	×	×		4 3 2 1
29/08/12	5185	32	VIADUCTO PROVINCIAS ABUTMENT 1	LEFT	0,96	×			4 3 2 1
29/08/1012	5186	20	VIADUCTO PROVINCIAS PILE 1	LEFT	0,80	×			2 3 1 4 5
29/08/1012	5187	20	VIADUCTO PROVINCIAS PILE 1	LEFT	0,75		×		2 3 1 4 5
29/08/1012	5188	20	VIADUCTO PROVINCIAS PILE 1	LEFT	0,63	×			2 3 1 4 5
29/08/1012	5189	20	VIADUCTO PROVINCIAS PILE 1	RIGTH	0,82	×			2 3 1 4 5
29/08/1012	5190	20	VIADUCTO PROVINCIAS PILE 1	RIGTH	0,62		×		2 3 1 4 5
29/08/1012	5191	16	VIADUCTO PROVINCIAS PILE 2	LEFT	1,15	×	×		DIAMETER 16 mm OUTER; DIAMETER 16 mm INTERIOR; LEFT SIDE; RIGHT SIDE
29/08/1012	5192	16	VIADUCTO PROVINCIAS PILE 2	LEFT	1,15	×			
29/08/1012	5193	16	VIADUCTO PROVINCIAS PILE 2	RIGTH	1,15	×	×		
29/08/1012	5194	16	VIADUCTO PROVINCIAS PILA 2	RIGTH	1,15	×			
29/08/1012	5195	20	VIADUCTO PROVINCIAS PILE 3	RIGTH	0,65	×	×		3 2 4 1
29/08/1012	5196	20	VIADUCTO PROVINCIAS PILE 3	RIGTH	0,60	×			3 2 4 1
29/08/1012	5197	20	VIADUCTO PROVINCIAS PILE 3	LEFT	0,62	×	×		3 2 4 1
29/08/1012	5198	25	VIADUCTO PROVINCIAS PILE 4	LEFT (OUTER DIAMETER)	1,20	×			DIAMETER 25 mm OUTER 20 mm; DIAMETER 16 mm INTERIOR; LEFT SIDE; RIGHT SIDE
29/08/1012	5199	16	VIADUCTO PROVINCIAS PILE 4	LEFT (INTERIOR DIAMETER)	0,83	×	×		
29/08/1012	5200	20	VIADUCTO PROVINCIAS PILE 4	RIGTH (OUTER DIAMETER)	1,20	×	×		
29/08/1012	5201	16	VIADUCTO PROVINCIAS PILE 4	RIGTH (INTERIOR DIAMETER)	0,93	×			
29/08/1012	5202	32	VIADUCTO PROVINCIAS ABUTMENT 2	RIGTH	1,20	×			4 3 2 1
29/08/1012	5203	32	VIADUCTO PROVINCIAS ABUTMENT 2	RIGTH	1,26	×	×		4 3 2 1
29/08/1012	5204	32	VIADUCTO PROVINCIAS ABUTMENT 2	LEFT	1,30	×			4 3 2 1
29/08/1012	5205	32	VIADUCTO PROVINCIAS ABUTMENT 2	LEFT	1,20	×	×		4 3 2 1
30/08/1012	5206	32	VIADUCTO PONTES I ABUTMENT 1	RIGTH	0,84	×	×		4 3 2 1
30/08/1012	5207	32	VIADUCTO PONTES I ABUTMENT 1	LEFT	0,90	×			4 3 2 1
30/08/1012	5208	32	VIADUCTO PONTES I ABUTMENT 1	LEFT	0,80	×	×		4 3 2 1
30/08/1012	5209	32	VIADUCTO PONTES I ABUTMENT 2	RIGTH	1,20	×	×		5 4 3 2 1
30/08/1012	5210	32	VIADUCTO PONTES I ABUTMENT 2	LEFT	1,20	×	×		5 4 3 2 1
30/08/1012	5211	32	VIADUCTO PONTES I ABUTMENT 2	LEFT	1,20	×			5 4 3 2 1
30/08/1012	5212	32	VIADUCTO PONTES I ABUTMENT 2	LEFT	1,20	×			5 4 3 2 1
30/08/1012	5213	32	VIADUCTO PONTES II ABUTMENT 1	RIGTH	1,20	×	×		5 4 3 2 1
30/08/1012	5214	32	VIADUCTO PONTES II ABUTMENT 1	LEFT	1,20	×			5 4 3 2 1
30/08/1012	5215	32	VIADUCTO PONTES II ABUTMENT 1	LEFT	1,20	×	×		5 4 3 2 1
30/08/1012	5216	32	VIADUCTO PONTES II ABUTMENT 1	LEFT	1,20	×			5 4 3 2 1
30/08/1012	5217	25	VIADUCTO PONTES II PILE 3	RIGTH (OUTER DIAMETER)	1,50			×	DIAMETER 25 mm OUTER; DIAMETER 16 mm INTERIOR; LEFT SIDE; RIGHT SIDE
30/08/1012	5218	16	VIADUCTO PONTES II PILE 3	RIGTH (INTERIOR DIAMETER)	1,20			×	
30/08/1012	5219	25	VIADUCTO PONTES II PILE 3	LEFT (OUTER DIAMETER)	1,50			×	
30/08/1012	5220	16	VIADUCTO PONTES II PILE 3	LEFT (INTERIOR DIAMETER)	1,30			×	
31/08/1012	5221	10	ENLACE MOTRIL ABUTMENT 1 OVERPASS	LEFT	1,36	×			
31/08/1012	5222	12	ENLACE MOTRIL ABUTMENT 1 OVERPASS	RIGTH	0,90		×		
31/08/1012	5223	10	ENLACE MOTRIL ABUTMENT 2 OVERPASS	RIGTH	1,36	×	×		
31/08/1012	5224	12	ENLACE MOTRIL ABUTMENT 2 OVERPASS	LEFT	0,90	×			
31/08/1012	5225	10	VIADUCTO N-340 ABUTMENT 1	LEFT	1,20	×			
31/08/1012	5226	12	VIADUCTO N-340 ABUTMENT 1	RIGTH	1,20		×		
31/08/1012	5227	25	VIADUCTO N-340 PILES	BY ABUTMENT 1	1,90	×			
31/08/1012	5228	25	VIADUCTO N-340 PILES	PILE	1,50	×			
31/08/1012	5229	25	VIADUCTO N-340 PILES	PILE	1,60		×		
31/08/1012	5230	25	VIADUCTO N-340 PILES	PILE	1,40		×		
31/08/1012	5231	20	VIADUCTO N-340 PILES	BY ABUTMENT 2	1,40	×			
31/08/1012	5232	12	VIADUCTO N-340 ABUTMENT 2	LEFT	1,22	×			
31/08/1012	5233	10	VIADUCTO N-340 ABUTMENT 2	RIGTH	1,20		×		

30/08/1012	5209	32	VIADUCTO PONTES 3 ABUTMENT 2	RIGTH	1,20	X	X		
30/08/1012	5210	32	VIADUCTO PONTES 3 ABUTMENT 2	LEFT	1,20	X	X		
30/08/1012	5211	32	VIADUCTO PONTES 3 ABUTMENT 2	LEFT	1,20	X			
30/08/1012	5212	32	VIADUCTO PONTES 3 ABUTMENT 2	LEFT	1,20	X			
30/08/1012	5213	32	VIADUCTO PONTES 3 ABUTMENT 1	RIGTH	1,20	X	X		
30/08/1012	5214	32	VIADUCTO PONTES 3 ABUTMENT 1	LEFT	1,20	X			
30/08/1012	5215	32	VIADUCTO PONTES 3 ABUTMENT 1	LEFT	1,20	X	X		
30/08/1012	5216	32	VIADUCTO PONTES 3 ABUTMENT 1	LEFT	1,20	X			
30/08/1012	5217	25	VIADUCTO PONTES 3 PILE 3	RIGTH (OUTER DIAMETER)	1,50			X	
30/08/1012	5218	16	VIADUCTO PONTES 3 PILE 3	RIGTH (INTERIOR DIAMETER)	1,20			X	
30/08/1012	5219	25	VIADUCTO PONTES 3 PILE 3	LEFT (OUTER DIAMETER)	1,50			X	
30/08/1012	5220	16	VIADUCTO PONTES 3 PILE 3	LEFT (INTERIOR DIAMETER)	1,30			X	
31/08/1012	5221	10	ENLACE MOTRIL ABUTMENT 1 OVERPASS	LEFT	1,36	X			
31/08/1012	5222	12	ENLACE MOTRIL ABUTMENT 1 OVERPASS	RIGTH	0,90		X		
31/08/1012	5223	10	ENLACE MOTRIL ABUTMENT 2 OVERPASS	RIGTH	1,36	X	X		
31/08/1012	5224	12	ENLACE MOTRIL ABUTMENT 2 OVERPASS	LEFT	0,90	X			
31/08/1012	5225	10	VIADUCTO N-340 ABUTMENT 1	LEFT	1,20	X			
31/08/1012	5226	12	VIADUCTO N-340 ABUTMENT 1	RIGTH	1,20		X		
31/08/1012	5227	25	VIADUCTO N-340 PILES	BY ABUTMENT 1	1,90	X			
31/08/1012	5228	25	VIADUCTO N-340 PILES	PILE	1,50	X			
31/08/1012	5229	25	VIADUCTO N-340 PILES	PILE	1,60		X		
31/08/1012	5230	25	VIADUCTO N-340 PILES	PILE	1,40		X		
31/08/1012	5231	20	VIADUCTO N-340 PILES	BY ABUTMENT 2	1,40	X			
31/08/1012	5232	12	VIADUCTO N-340 ABUTMENT 2	LEFT	1,22	X			
31/08/1012	5233	10	VIADUCTO N-340 ABUTMENT 2	RIGTH	1,20		X		

10/09/1012	5408	20	VIADUCTO PONTES PILE 1	RGHT	0,80	x	x		
10/09/1012	5409	20	VIADUCTO PROVINCIAS PILE 1	LEFT	0,80	x	x		
10/09/12	5410	20	VIADUCTO PONTES PILE 1	RGHT	1,20	x			
10/09/12	5411	25	VIADUCTO PONTES PILE 1	RGHT	1,20		x		
10/09/12	5412	20	VIADUCTO PONTES PILE 1	LEFT	1,20	x	x		
10/09/12	5413	25	VIADUCTO PONTES PILE 1	LEFT	1,20	x			
10/09/12	5414	20	VIADUCTO PONTES PILE 2	RGHT (OUTMETER)	1,50	x			
10/09/12	5415	16	VIADUCTO PONTES PILE 2	RIGHT (INTERIOR)	1,10	x	x		
10/09/12	5416	25	VIADUCTO PONTES PILE 2	LEFT (OUTER)	1,20	x			
10/09/12	5417	20	VIADUCTO PONTES PILE 2	LEFT (INTERIOR)	1,20	x	x		
10/09/12	5418	20	VIADUCTO PONTES PILE 2	LEFT (OUTER)	1,50			x	
10/09/12	5419	25	VIADUCTO PONTES PILE 2	LEFT (INTERIOR)	1,50			x	
10/09/12	5420	20	VIADUCTO PONTES PILE 2	RGHT (OUTMETER)	1,50			x	
10/09/12	5421	16	VIADUCTO PONTES PILE 2	RIGHT (INTERIOR)	1,15			x	

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The Study Of Briquettes Produced With Bitumen, $Caso_4$ And Starch As Binders.

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ABSTRACT : *The work was based on production and study of the properties of smokeless briquettes of various compositions with coal and rice husk. Different briquettes were produced with starch, bitumen and $CaSO_4$ as the binders while $Ca(OH_2)$ was the desulphurizing agent. The proximate analysis of the raw coal sample showed ash content 19.12%, moisture content 6.25%, volatile matter 41.12%, fixed carbon 33.51% and calorific value 117 KJ/g, the rice husk had the following values ash content 7.53%, moisture content 10.48%, volatile matter 68.74%, fixed carbon 13.25% and calorific value 65.24 KJ/g. The briquettes produced are in the following ratio of mixtures of coal and rice husk 100:0, 80:20, 60:40, 40:60, 20:80 and 0:100 respectively. The prepared briquettes were sun dried for seven days, subjected to various tests to assess their fuel quality. The briquettes produced with starch as the binder had better results for faster ignition time, lower amounts of sulphur emissions during burning, highest calorific values and longer burning time for all the different compositions.*

Key words: *briquette, coal, rice husk, starch, bitumen.*

I. INTRODUCTION

Bio-coal briquette is a type of solid fuel prepared by compacting pulverized coal, biomass, binder and sulphur fixation agent. The high pressure involved in the process ensures that the coal and the biomass particles are sandwiched and adhere together, as a result do not separate during transportation, storage and combustion (Onuegbu *et al.*,2010) A briquette is a block of compressed coal, biomass or charcoal dust that is used as fuel (Grainger *et al*., 1981).Coal is burned in coal-fired plants to produce energy in the form of electricity. Domestically, coal is burnt in un-vented stoves producing heat energy for cooking and heating up homes. Over the years, it has been recognized that certain impurities in coal can have a significant impact on the types of emissions produced during coal combustion. However, various processes employed in converting coal into more useful forms emit considerable amounts of pollutants such as SO_2, NO_X, CH_4, etc (Rahman *et al*., 2000).In the production of briquettes, the materials can be compressed without addition of adhesive, while in others adhesive materials called binders are added to assist in holding the particles of the material together depending on the type of raw material used for the production (Bhattacharya, 1985). During combustion, the co-combustion of the coal and the biomass gives a better combustion performance and reduces pollutant emission i.e bio-coal briquette has a favourable ignition, better thermal efficiency, emits less dust and soot (Somchai *et al.*, 1988). Briquetting can be regarded as a waste control measure. Depending on the material of interest, briquetting can be used to provide fuel source, as a preventive measure to many ecological problem. Certain materials like coal, agricultural waste such as rice husk, corn cob, paper and saw dust can be briquetted to serve as cooking fuel (Bhattacharya, 1985).Furthermore, the presence of sulphur fixation agent otherwise known as desulfurizing agent ensures that most of the sulphur content of the coal is fixed into the ash instead of being liberated into the atmosphere as SO_2 (Somchai *et al.*, 1988).

$$CaO_{(s)} + SO_{2(g)} + ½O_{2(g)} \longrightarrow CaSO_{4(s)}.$$

II. OBJECTIVE OF THE STUDY

To produce smokeless briquettes from coal and rice husk using starch, bitumen and $CaSO_4$ as binders. To compare the results of the proximate analyses carried out on the briquettes to determine the binder with the best quality for use in briquette production.

III. MATERIALS

Pulverised coal, rice husk, bitumen, starch, $CaSO_4$, calcium hydroxide, electronic weighing machine, manual briquetting machine, electric milling machine, stop watch, muffle furnace, oxygen bomb calorimeter machine model-OSK 100A.

IV. METHODS

Preparation of the coal sample

The coal sample was sun dried for five days to reduce its moisture content, broken into smaller sizes using a hammer. The coal samples were then ground in an electric milling machine to pass through 1mm sieve and stored.

Preparation of the biomass

The biomass (rice husk) was collected, sun dried for five days to reduce the moisture content, ground and sieved through 1mm sieve and stored.

Preparation of the briquette samples

The briquettes were produced using a manual hydraulic briquetting machine with three cylindrical moulds. Briquettes of coal and rice husk of different compositions were produced with a specific amount of $Ca(OH)_2$ added as desulphurizing agent based on the quantity of coal added, starch paste formed with hot water was added as binder. Specific quantity of water was added and mixed properly. The pressure was maintained at 5MPa for 15 minutes and was allowed to stand for 5 minutes before removal from the mould. After production, the briquettes were sun dried for 7days before analysis.

PROXIMATE ANALYSIS OF SAMPLES

Calorific value: The calorific value of the raw rice husk, raw coal and the briquettes were determined using Oxygen Bomb Calorimeter of model-OSK 100A. The calorific value (KJ/g) of the samples under test was calculated from the temperature rise VI in the calorimeter vessel and the mean effective heat capacity of the system. (Sumner *et al.*, 1983)

VI= (Ee + W1) TR–C)/S x 4.1868

Where Ee is the water equivalent of the calorimeter (581g), W_1 = quantity of water in the vessel, TR = Temperature rise ^oC, C = correction factor from ignition 154 Cal, S = weight of sample in grams (g).

Moisture content: The moisture contents of the raw coal, rice husk and briquettes were determined. A portion (2g) each of the samples was weighed out in a wash glass. The samples were placed in an oven for 2 hours at 105ºC. The moisture content was determined using:

$$MC = \frac{W_1 - W_2}{W_1} \times 100$$

W_1= Initial weight, W_2= Weight after drying

Ash content: The ash contents of the raw coal, rice husk and briquettes were also determined. A Portion (2g) were placed in a preweighed porcelain crucible and transferred into a preheated muffle furnace set at a temperature of 600ºc for 1hour after which the crucible and its contents were transferred to a desiccator and allowed to cool. The crucible and its content were reweighed and the new weight noted. The percentage ash content was calculated thus:

$$AC\ (\%) = (W_2/W_1) \times 100.$$

W_1 = Original weight of dry sample, W_2 = Weight of ash after cooling.

Volatile matter: The volatile matter of the raw coal, rice husk and briquettes were also determined. A portion (2g) of the sample was heated to about 300ºC for 10minutes in a partially closed crucible in a muffle furnace. The crucible and its content were retrieved and cooled in a desiccator. The difference in weight was recorded and the volatile matter was calculated thus:

$$VM = \frac{(W_1 - W_2)}{W_1} \times 100$$

W_1 = Original weight of the sample. W_2 = Weight of sample after cooling.

Fixed carbon: The fixed carbon of the raw coal, rice husk and briquettes were also determined. The fixed carbon was determined using the formula
FC (%) = 100 – (%VM + %AC + %MC)
Where VM = Volatile matter, AC = Ash content, MC = Moisture content (ASTM 1992).

Density: A calibrated graduated cylinder was used for the estimation of destiny. The cylinder was packed with the samples and compacted. The density was thus calculated thus:

$$\text{Density (g/cm}^3) = \frac{\text{Mass (g)}}{\text{Volume (cm}^3)}$$

Total Sulphur Content: The different samples of the briquettes was pulverized, 1g of the finely powdered samples was mixed with 5g of Na_2NO_3 and 0.2g of $NaNO_3$ in a crucible. The mixture was preheated at 400°C for 30 minutes in an electric muffle furnance and then fused at 950°C, after fussion, the crucible was allowed to cool and was placed on its side in a 150 cm^3 beaker. HCl was added to neutralize the Na_2CO_3 and boiled to precipitate the sulphate by treating with $BaCl_2$. The precipitate treated with drops of HF and H_2SO_4, ignited and weighed again. Total sulphur is determined by the expression (Jackson, 1958).

$$\% \text{ sulphur} = \frac{BaSO_4\,(g) \times 13.7}{\text{Weight of sample}} \text{ X } 100$$

Porosity Index: The porosity of the briquettes was determined based on the amount of water each sample was able to absorb. The porosity index was calculated as the ratio of the mass of water absorbed to the mass of the sample immersed in the water (Montgomery, 1978).

$$\text{Porosity Index} = \frac{\text{Mass of water absorbed} \times 100}{\text{Mass of the sample}}$$

Ignition time (secs) : The different samples were ignited at the edge of their bases with a burnsen burner. The time taken for each briquette to catch fire was recorded as the ignition time using a stopwatch.

Burning time (mins) : This is the time taken for each briquette sample to burn completely to ashes. Subtracting the time is turned to ashes completely from the ignition time gives the burning rate.
Burning rate = Ashing time – Ignition time.

Water boiling test (mins) : This was carried out to compare the cooking efficiency of the briquettes .It measures the time taken for each set of briquettes to boil an equal volume of water under similar conditions.100g of each briquette sample was used to boil 250ml of water using small stainless cups and domestic briquette stove. (Kim *et al*., 2001).

RESULTS

Table 1: The results of proximate analysis of the raw coal and rice husk.

Samples	Moisture content(%)	Volatile matter(%)	Ash content(%)	Fixed carbon(%)	Calorific value (KJ/g)
Coal	3.25	20.12	19.12	57.51	117.18
Rice husk	8.48	42.14	7.53	41.85	65.24

Table 2: The results of ash contents of the briquette samples

Briquette samples (%)	Bitumen (%)	$CaSO_4$ (%)	Starch (%)
100% C	21.05	29.63	22.06
80% C + 20% RH	20.27	26.38	21.79
60% C + 40% RH	19.67	25.92	20.26
40% C + 60% RH	18.21	24.86	19.45
20% C + 80% RH	17.56	23.45	18.91
100% RH	16.23	19.23	16.82

Table 3: The results of fixed carbon of the briquette samples

Briquette samples (%)	Bitumen (%)	$CaSO_4$ (%)	Starch (%)
100% C	65.04	57.46	61.76
80% C + 20% RH	60.95	53.59	53.71
60% C + 40% RH	57.94	47.18	50.06
40% C + 60% RH	49.75	38.88	39.87
20% C + 80% RH	40.90	32.74	31.55
100% RH	37.37	32.30	27.00

Table 4: The results of moisture content of the briquette samples

Briquette samples (%)	Bitumen (%)	$CaSO_4$ (%)	Starch (%)
100% C	2.15	2.47	2.78
80% C + 20% RH	2.34	2.71	3.37
60% C + 40% RH	2.92	3.82	4.42
40% C + 60% RH	3.51	4.21	4.55
20% C + 80% RH	4.08	5.17	5.68
100% RH	4.68	5.94	6.95

Table 5: The results of density of the briquette samples

Briquette samples (%)	Bitumen (g/cm^3)	$CaSO_4$ (g/cm^3)	Starch (g/cm^3)
100% C	0.714	0.824	0.724
80% C + 20% RH	0.574	0.684	0.594
60% C + 40% RH	0.401	0.474	0.414
40% C + 60% RH	0.294	0.374	0.334
20% C + 80% RH	0.264	0.304	0.274
100% RH	0.201	0.244	0.224

Table 6: The results of volatile matter of the briquette samples

Briquette samples (%)	Bitumen (%)	$CaSO_4$ (%)	Starch (%)
100% C	11.76	10.44	13.40
80% C + 20% RH	16.44	17.32	21.13
60% C + 40% RH	19.47	23.08	25.26
40% C + 60% RH	28.53	32.05	36.13
20% C + 80% RH	37.46	38.64	43.86
100% RH	41.72	42.53	49.23

Table 7: The results of porosity index of the briquette samples

Briquette samples (%)	Bitumen (%)	$CaSO_4$ (%)	Starch (%)
100% C	22.02	25.10	24.96
80% C + 20% RH	31.33	34.01	33.66
60% C + 40% RH	38.74	42.53	40.76
40% C + 60% RH	47.61	59.98	50.48
20% C + 80% RH	56.95	66.72	62.52
100% RH	64.72	73.65	70.13

Table 8: The results of calorific values of the briquette samples

Briquette samples (%)	Bitumen (KJ/kg)	$CaSO_4$ (KJ/kg)	Starch (KJ/kg)
100% C	156.88	142.93	164.34
80% C + 20% RH	142.63	127.52	151.51
60% C + 40% RH	128.68	108.44	142.86
40% C + 60% RH	112.40	95.84	126.25
20% C + 80% RH	102.88	82.22	108.09
100% RH	84.21	69.45	90.23

Table 9: The results of water boiling test of the briquette samples

Briquette samples (%)	Bitumen (g/min)	$CaSO_4$ (g/min)	Starch (g/min)
100% C	1.63	1.44	1.42
80% C + 20% RH	1.84	1.60	1.62
60% C + 40% RH	2.25	2.14	2.15
40% C + 60% RH	3.17	2.85	2.91
20% C + 80% RH	3.75	3.28	3.42
100% RH	4.38	4.07	4.12

Table 10: The results of burning time of the briquette samples

Briquette samples (%)	Bitumen (min)	$CaSO_4$ (min)	Starch (min)
100% C	24.89	26.84	26.21
80% C + 20% RH	20.76	23.75	24.15
60% C + 40% RH	17.81	19.85	20.43
40% C + 60% RH	14.55	18.96	19.22
20% C + 80% RH	12.88	16.34	17.48
100% RH	11.71	15.68	16.17

Table 11: The results of ignition time of the briquette samples

Briquette samples (%)	Bitumen (sec)	$CaSO_4$ (sec)	Starch (sec)
100% C	37.00	46.66	47.33
80% C + 20% RH	27.67	39.33	41.00
60% C + 40% RH	21.67	33.10	33.67
40% C + 60% RH	19.33	28.67	29.67
20% C + 80% RH	17.67	25.67	27.00
100% RH	16.00	24.33	23.33

Table 12: The results of sulphur contents of the briquette samples

Briquette samples (%)	Bitumen (%)	$CaSO_4$ (%)	Starch (%)
100% C	8.22	7.87	6.21
80% C + 20% RH	8.02	7.18	5.52
60% C + 40% RH	7.78	7.04	4.69
40% C + 60% RH	7.43	6.72	4.42
20% C + 80% RH	6.29	5.91	4.14
100% RH	4.21	4.12	3.45

V. DISCUSSIONS

From the results of the proximate analysis, the briquettes of $CaSO_4$ had higher ash contents due to the presence of more non combustible compounds, as such they had lower calorific values when compared with briquettes of similar compositions produced with starch as binder. The briquettes made using the bitumen as binder had the lowest moisture content value because of the sticky nature of the binder that made absorption of water molecules into the pores of the briquettes difficult. The fuel briquette's density will affect its bulk thermal properties, the thermal conductivity will be reduced as the density is decreased (increased fuel porosity), but the lower the density, the less heat is required for a specific volume of fuel to reach the ignition temperature (Loo *et al.*, 2008). This effect is seen in the increased burning time of briquettes of binders like $CaSO_4$ which tend to exhibit greater burning time than those of starch. When the particles of a combustible material are loose, the briquettes produced would have more volatile matter during pyrolysis. Since rice husk are less bonded to each other than coal, 100% rice husk briquettes produced more volatile matter than 100% coal briquettes for the different binders under consideration. The calorific value (or heating value) is the standard measure of the energy content of a fuel. It is defined as the amount of heat evolved when a unit weight of fuel is completely burnt and the combustion products are cooled to 298 k (BSI, 2005). When fuels contain compounds such as hydrocarbons, which have a lower degree of oxidation, this tends to raise the heating value of the biomass (Jenkins *et al*., 1998). The results showed that 100% coal briquettes of all the binders had the highest calorific value and progressed downward as rice husks was added to the coal for producing briquettes. The water boiling test measures the time it takes a given quantity of fuel to heat and boil a given quantity of water. The results showed that briquettes produced using bitumen as the binder took longer time to boil water when compared to the other briquettes. The reason being that the briquettes smoked more than the other briquettes made with different binders, and much heat energy was lost as smoke thereby affecting its water boiling property. The briquettes of $CaSO_4$ showed similar trend of values in the water boiling tests. From the results, 100% coal briquettes of the different binders had the longest burning time of all the briquettes produced followed by 100% corn cob briquettes while 100% rice husk briquettes of all the different binders had the least burning time. The briquettes of starch as the binder showed longer burning time for the different compositions when compared with other compositions produced with different binders. This might be due to the incombustible compounds that are present in the briquettes produced using $CaSO_4$ as binder. Another reason was the smoky nature of briquettes made from bitumen also succeeded in affecting the rate of combustion of the briquettes The addition of the desulphurizer in the coal and rice husk briquettes produced reduced the amount of sulphur content for the briquettes produced for different binders. On the average starch briquettes had the least values of sulphur content.

VI. CONCLUSION

In conclusion, bio-mass briquettes have drawn worldwide interest as an energy source because it does not negatively affect the environment. The results showed that the various briquette compositions produced with starch as binder showed remarkable values of low ash contents, higher calorific values, longer burning time and low sulphur contents when compared to the other binders used for the briquette production. The binder bitumen was not suitable due to the much smoke emitted during cooking. $CaSO_4$ is expensive, fouls stoves during cooking and not easily affordable. For the binders under consideration the use of starch as a binder is strongly recommended during briquetting.

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Assessing Changes in the Local Tropical Rainfall Seasons

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ABSTRACT:*A single procedure to assess possible changes in the tropical nominal rainfall seasons (rainless,transition and rainy) for almost any tropical location has beenwritten and applied. That procedure uses monthly rain gauge data series of a location embracing a reasonably large period of register. Three kindsof episodes(scarce, mild and copious) to characterizethe seasons of each year are defined. Two tropical thresholds of 25 mm and 50 mm define the seasons but four local thresholds define events. The period is divided into two segments (antique and modern) for frequency calculations.Occurrences of zero rainfall in the segments are carefully stated to verify results. Missing data items may be filled with adjusted satellite data obtained by Internet in a National Aeronautics Space Administration web portal. Annual enterprises plans could be enhanced with theannual perform of procedure application to their tropical operative locations. The procedure comes from simplified versions of two previous papers. Procedure application to the El Dorado tropical location data of 46 years divided into antique (31 years, 1968-1998) and modern (15 years, 1999-2013) segmentsgave as main preliminary result that frequency of copious(much rain) episodes of the rainless(no rainy) local season (January-March) have increased in +23% between segments; this fact is classified as a possible weak enhancement to wet in the rains indicated by an inner classification issued as part of the procedure. El Dorado frequency of the zero rainfalloccurrencesremained nearly constant from 2/31 (antique) to 1/15 (modern) requiring further verification. This kind of assessment must be constituted as a permanent activity inside tropical weather-sensitive enterprises.*

Keywords :*Change, frequency, procedure, rainfall, season, tropical.*

I. INTRODUCTION

Most locations in the inter-tropical latitudinal belt of the Earth (23.5°S to 23.5°N) undergo the annual sequence of the rainless (RL)and rainy (RN)seasons. In the rainy RN season the accumulated rain amounts received at the surface from atmospheric clouds and dew are greater than those received in the rainless (RL) season. It is possible to find more than one RL and more than one RN in a location in a year. Even more, intermediate or transitionalseason (RT) occurs between RL and RT.The most single case embraces one season either RL or RN only.Monthly rainfall data (*R*, mm) will be used here to assess rainfall variations.As in [1] monthly rainfall data appear in climatic research frequently. Of course, any analysis will evidence *R* is not constant but very variable from location to location and from year to year introducing uncertainties in weather sensitive enterprises. The minimum monthly rainfall is *R*=0 mm anywhere but the largest possible monthly rainfall in sometropical locations reaches gross order of *R*=1000 mm.Months of absolute drought with *R*=0 mm require accurate verification. To cope with this variability, enterprises managers have made yearly operational plans including nominalrainfall seasons but in last years in some locations the rains seems to be outside the expected, thus the possibility of loss of investments could be high. The word *nominal* indicates that the monthly time spans of seasons aretaken constant as defined by mean monthly rainfall values.For some locations the hydrological year beginning with the first rainy months and ending with the last rainless months is used to include a complete cycle. Thus, the hydrological year from April to March has been used in Venezuela.

The words scarce(S), mild(M) and copious(C) were selected to characterize the seasons of each year as will be defined later.Most of the time, quantitative analysis of seasonalvariability is required but formally stated tropical procedures to do that are no easy to find. Here is outlineda simplified procedure that may be applied by non-meteorological personnel of tropical enterprise. This issue comes from a simplification of two previous papers on monthly tropical characterization where was assimilated satellite Outgoing Long-wave Radiation (*OLR*, W/m^2) as a second variable after *R* [2,3]. Those papers resulted complex to be replicated for non-meteorologist personal; thus a return was made to the single classical assessment based on *R*only. Due to the recently availability of interpolated *OLR* data, in next issues the inclusion of *OLR* will be made again. The procedure is outlined below and later a location is selected and its data gathered to finally undertake change assessment and drawn of conclusions.

II. THE PROCEDURE

Main steps of the above mentioned procedure are: (a) Select a location in the area of interest with a reasonable large period of register of N years. (b) Gather monthly values of *R* (mm) for each year of register and after filling missed data constructa matrix of monthly data with twelve columns one for each month of the year and N rows one for each year using the mm (millimeter) as rainfall unit. An inch equals2.54 cm or 25.4 mm. If necessary modify the original matrix using the concept of hydrological year. (3) Calculate twelve meansone mean for each month and N rows. (c) With those twelve mean values determine the months of the RL, RTand RN nominal seasons; use categories of Table 1. (d) Calculate accumulated rainfall values for each season and each year and prepare a column of data for each season. (e) Calculate means and deviations for RL, RT and RN using N years. (f) Definescarce (S), mild (M) and copious(C) classes of episodes using thresholds for each season as indicated in Table 2 for RL and RN but not for RT. Thresholds are computed with the format $\mu \pm 0.75\sigma$ where μ (mm) is a mean and σ (mm) is a standard deviation.The factor 0.75 can be modified for each location. (g) After the study of the weather history of the location divide the register into two segments of consecutive years named the antique with N_1years and the modern with N_2 years; of course $N=N_1+N_2$. (h) Count the frequency of episodes in each season for both antique and modern segments. (i) Calculate frequency changes and define categories using Table3. (i) Finally, verify results counting cases of R=0 in the segments. Small modifications mightbe necessary for eachlocation.

Table 1. Definitions of categories for monthly rainfall means

Category	Range in mm
True Rainless (RL, □)	0 to 25
True Transition (RT, ◘)	26 to 49
True Rainy (RN, ■)	50 or greater

Table 2. Episodes definition based in threshold for both antique and modern times

Class of episode	Required parameter in mm	Range of episode in mm
Scarce (S, ☼) for RL	*A* the mean rainfall of a RL season *B* the standard deviation of RL season	0 to *A*- 0.75B
Mild (M, ○) for RL		A - 0.75*B* to *A* + 0.75*B*
Copious (C, ⭘) for RL		greater than *A* + 0.75*B*
Scarce (S, ⊙) for RN	*C* the mean rainfall for a RN season *D*the standard deviation for a RN season	0 to*C*- 0.75*D*
Mild (M, ◉) for RN		*C* - 0.75*D* to *C* + 0.75*D*
Copious (C, ●) for RN		greater than *C* + 0.75*D*

Table 3. Categories for the changes of relative frequency in (%) from antique to modern

Category	Range of change
Inexistent	0% to +10%
Weak toward *wet*	+11% to 20%
Moderate toward *wet*	+21% to +30%
Strong toward wet	>= + 31%
Inexistent	-10% to 0%
Weak toward *dry*	-20% to -11%
Moderate toward *dry*	-30% to -21%
Strong toward *dry*	<= -31%

The most strict studies of the climates are based on periods of thirty years named *standards* (1901-1930, 1931-1960, 1961-1990, 1991-2020,...) established by the *World Meteorological Organization*

(WMO)early. Most stations run outside those *standards* and the trouble caused in human affairs by rainfall changes represents a strong motive to avoid the strict study based in *standards*thereafter using the available register after a data enhancement process. As an empirical rule, minimum tropical registers must cover more than 15 years antique and more than 15 years modern, in total 30 years for preliminary studies. The outputs of this procedure must to include data and frequencies without the use of expressions as the *climatic change* that need of very large register and further analysis of variables as air temperature and water vapor pressure. Some missing data items can be filled with adjusted satellite data obtained by Internet in a NASA online web page named *Giovanni*.

III. PROCEDUREAPPLICATION

After the inspection of several old computer paper prints with *R* data of Venezuelan stations was selected *El Dorado*(6.75°N, -61.63°W, 120 m)by the minimum number of months with *R*=0 mm and large *R* values in much months catalogingthe station as *truly wet* with a unique RN station. The location of *El Dorado* is depicted in Fig. 1. The modern monthly data (*R*, mm) was recovered from some data banks and some missing values were filled using satellite data obtained from the above mentioned *Giovanni*web page of *NASA* (*GSFC*). The matrix of data of 12 monthly columns with*N*=46 rows one per year is shown in Appendix 1. From reviews of unusual rainy episodes in Venezuela after about 1998, we decide to define the two segments antique (31 years, 1968-1998) and modern (15 years, 1999-2013).

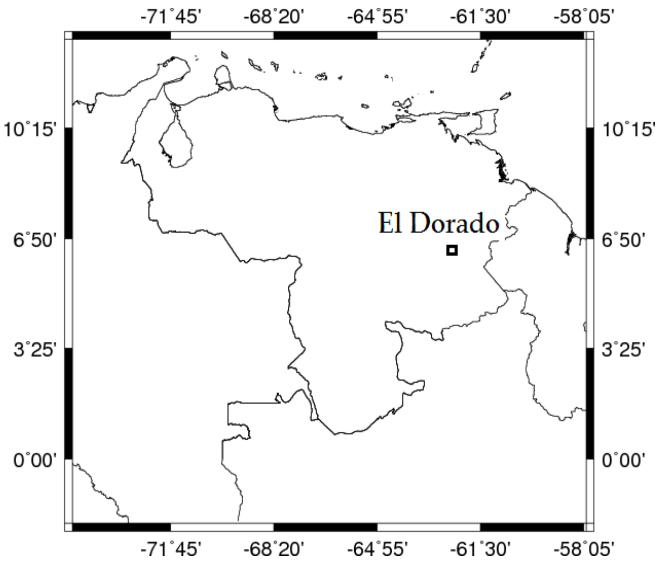

Figure I. *El Dorado*location in the northern western hemisphere.

The Table 4 shows the 12 monthly means for the 46 years of whole register; all means are greater than 50 mm indicatingneither rainless RL nor transitionalRT seasons. The mean annual rainfall of *El Dorado*can be calculated in 1385.5 mm as the sum of the twelve items of Table 4. Even thou there are neither RL nor TR seasons we will use seasonsas indicated in Table 5. Thus, the Jan-Mar rainless season must be redefined as the season with minor rainfalls and the Apr-Decseason as the season with greater rainfalls as understood by the people in the area.

Table 4. Monthly mean rainfall values in mm for *El Dorado* (1969-2013)

Month	Value	True icon	Month	Value	True icon	Months	Value	True icon
Jan	83.5	■	May	121.9	■	Sep	119.8	■
Feb	53.6	■	Jun	203.5	■	Oct	116.7	■
Mar	52.7	■	Jul	200.0	■	Nov	100.5	■
Apr	73.4	■	Aug	150.6	■	Dec	102.5	■

Table 5.Nominal season's definition for *El Dorado* obtained from Tables 1 and 4

Season	Number of Months	Range of months
Rainless RL (☐) season*	3	January to March
Rainy RN (■) season	9	April to December
*This is not a true RL season but a low intensity RN small season		

Appendixes 2 and 3 were developed processing Appendix 1 to initiate the study of the seasons as a part of the procedure. Further processing of Appendixes 2 and 3 gives Table 6 which contains the *El Dorado*basic statistic. Of course, similar items for the rainless RL season are greater than those for the rainy RN season.Newly, even thou there is not a real rainlessdry season in *El Dorado*, four thresholds were defined to express RL and RN variability. Those thresholds are DTRL=112.0 mm, DTRN=989.2 mm, WTRL=269.4 mm and WTRN=1400.4 mm as seen in Table 6.

Table 6.Main *El Dorado*statistics for rainless (RL)and rainy (RN) seasons

Statistic for k=0.75	Rainless RL (☐)	Rainy RN (■)
Mean (mm)	*A*=190.7	*B*=1194.8
Standard deviation (mm)	*C*=104.9	*D*=274.1
Dry threshold (DT, mm)	112.0	989.2
Wet threshold (WT, mm)	269.4	1400.4

Tables 7-10 were made by counting occurrences in Appendixes 2 and 3 with the help of Tables 2 and 6. The changes of frequencies are low except +23% and +14% for copious RL and RN episodes. Those values represent more water for the hydrologic cycle and human consumptionin both seasons RL and RN. The kind of water use of each enterprise must be analyzed to insert variations in the yearly operational plans. To verify trends toward humid is necessary to count the frequency of *R*=0 in the segments finally. As unexpected, the Table 11 shows that this frequency has minimum decrement from *antique* to *modern* that can be forgotten by the time. As a main characterization of change for *El Dorado* is possible to say that there are possible changes to wet but new verifications in next years are necessary.

Table 7.Occurrences of rainless RL episodes for antique and modern years

Segment	Scarce (S, ☼)	Mild (M, ○)	Copious (C, **O**)	All
Antique	10	14	7	31
Modern	3	6	6	15

Table 8. Percentages (%) of rainless RL episodes for antique and modern years

Segment	Scarce (S, ☼)	Mild (M, ○)	Copious (C, **O**)	All
Antique	32	45	23	100
Modern	21	40	40	100
Δ	-9	-5	+23	

Table 9. Occurrences of rainy RN episodes for antique and modern years

Segment	Scarce (S, ⊙)	Mild (M, **◉**)	Copious (C, ●)	All
Antique	8	17	6	31
Modern	3	7	5	15

Table 10. Percentages (%) of rainy RN episodes for antique and modern years

Segment	Scarce (S, ⦿)	Mild (M, ◉)	Copious (C, ●)	All
Antique	26	55	19	100
Modern	20	47	33	100
Δ	-6	-8	+14	

Table 11. Frequency of R=0 month for *El Dorado*

Segment	Years	Counts	Frequency
Antique	N_1=31	2	2/31
Modern	N_2=15	1	1/15

IV. CONCLUSION

After aresearchof nearly20 years, the development of a replicable procedure for assessment of changes in the rainfall of tropical rainless and rainy seasons has been possible. We could get for *El Dorado* location a single number of +23%quantifying an increment in the frequency number of copious episodes of the rainless season that surely will help to enhance yearly plans of tropical enterprises. A strong restriction for location selection represented by regional missing data items in the registers has been overcome by the use of interpolated satellite monthly data from the *Giovanni*Internet tool maintained operational by NASA. Thus, the availability of stations in mostarchivesturns higher than before and procedure applicability thereafter increased largely. This page will permit future recovering of several rain gauge data sets forgotten by register interruptions at regional level making the filling of gaps cumbersome. A limitation could be the possible inaccurate identification of the real *R*=0 condition in some data banks but this feature represents a minimum limitation at verification time that could be resolved by single field observations in future years. The very possible yearly procedure application will permit to weather sensitive enterprises cope with the variability of seasons characterized by variablefrequencies of scarce, mild and copiouscases discussed here.The procedure can be seen as diagnostic tool.Studies like this result in a never end affair.

V. ACKNOWLEDGEMENTS

The rainfall data sets used here were gathered mainly by open Internet access maintained by both the Venezuelan Institute of Meteorology and Hydrology (INAMEH) and the GES-DISC Interactive Online Visualization and Analysis Infrastructure (*Giovanni*) as part of the NASA's Goddard Earth Sciences (GES) Data and Information Services Center (DISC). The large effort of those organizations tokeep access on line made possible the realization of the present issue.

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Appendix 1
Monthly rainfalls (mm) for *El Dorado* (1968-2013)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Ago	Sep	Oct	Nov	Dec
1968	86	64	57	222	137	228	73	69	68	34	126	77
1969	151	65	51	81	131	193	290	242	50	107	141	98
1970	147	55	113	90	185	181	272	231	65	40	167	96
1971	66	62	47	62	91	257	199	165	227	105	215	108
1972	177	56	127	244	229	194	118	129	76	99	92	54
1973	26	15	19	20	57	183	242	246	261	179	69	178
1974	160	76	93	63	68	104	195	86	107	91	106	63
1975	122	42	12	32	138	150	38	94	161	129	26	205
1976	154	137	149	202	116	226	202	18	33	211	14	136
1977	28	17	39	59	150	204	109	190	98	96	1	46
1978	58	17	4	44	164	367	143	273	156	125	30	104
1979	72	17	101	125	109	276	54	124	106	71	72	74
1980	38	12	11	108	223	220	202	103	50	115	110	31
1981	33	60	50	101	92	255	146	219	131	113	0	52
1982	57	155	90	135	115	211	250	81	21	67	31	43
1983	21	15	17	129	125	131	28	62	18	22	40	107
1984	99	37	18	1	185	141	146	154	133	109	164	124
1985	71	25	27	101	71	169	186	77	110	166	195	98
1986	47	44	11	30	131	263	296	47	63	107	153	119
1987	107	15	5	54	192	165	191	38	158	52	53	38
1988	26	68	18	0	90	228	235	506	265	222	136	142
1989	133	115	54	28	97	197	352	95	170	199	109	84
1990	147	87	74	124	144	253	227	216	81	98	65	166
1991	111	25	57	42	108	189	131	333	85	143	88	144
1992	21	23	30	48	74	78	139	194	150	14	19	46
1993	66	51	143	47	197	253	106	129	72	131	242	148
1994	74	44	87	28	132	254	185	405	198	273	40	27
1995	28	3	6	26	145	304	217	331	216	43	91	89
1996	70	94	59	19	27	311	377	117	185	29	25	40
1997	79	110	41	32	118	165	143	36	52	37	10	63
1998	10	5	0	50	81	308	110	94	177	105	71	150
1999	169	98	63	140	47	259	222	206	228	210	134	105
2000	91	107	113	196	104	358	231	92	192	19	274	102
2001	46	22	5	32	88	181	413	84	2	152	95	152
2002	93	31	63	124	147	127	130	124	112	20	87	71
2003	19	11	1	18	121	195	312	100	158	143	156	108
2004	91	32	45	83	192	145	232	93	245	92	63	80
2005	189	87	8	126	109	116	266	196	4	127	95	147
2006	165	45	69	2	192	146	324	91	61	197	40	119
2007	53	16	75	71	78	267	311	169	108	183	66	172
2008	93	103	51	82	83	239	301	125	147	264	142	164
2009	121	63	62	50	8	111	102	73	37	180	25	78
2010	30	0	3	134	138	207	467	156	263	77	216	100
2011	48	102	160	9	115	150	35	78	126	274	394	105
2012	105	78	91	92	148	28	111	114	45	68	13	131
2013	56	67	28	139	114	173	142	123	40	31	123	132

Appendix 2
Antique rainfalls (mm) calculated for seasons and years
Spans: RL (Jan-Mar), RN (Apr-Dec) and Year (Jan-Dec)

Year	m	RL (mm)	RL icons	RN (mm)	RN icons	Year (mm)
1968	1	207	○	1034	⭘	1241
1969	2	267	○	1333	⭘	1600
1970	3	315	⭘	1327	⭘	1642
1971	4	175	○	1429	●	1604
1972	5	360	⭘	1235	⭘	1595
1973	6	60	☼	1435	●	1495
1974	7	329	⭘	883	⊙	1212
1975	8	176	○	973	⊙	1149
1976	9	440	⭘	1158	⭘	1598
1977	10	84	☼	953	⊙	1037
1978	11	79	☼	1406	●	1485
1979	12	190	○	1011	⭘	1201
1980	13	61	☼	1162	⭘	1223
1981	14	143	○	1109	⭘	1252
1982	15	302	⭘	954	⊙	1256
1983	16	53	☼	662	⊙	715
1984	17	154	○	1157	⭘	1311
1985	18	123	○	1173	⭘	1296
1986	19	102	☼	1209	⭘	1311
1987	20	127	○	941	⊙	1068
1988	21	112	☼	1824	●	1936
1989	22	302	⭘	1331	⭘	1633
1990	23	308	⭘	1374	⭘	1682
1991	24	193	○	1263	⭘	1456
1992	25	74	☼	762	⊙	836
1993	26	260	○	1325	⭘	1585
1994	27	205	○	1542	●	1747
1995	28	37	☼	1462	●	1499
1996	29	223	○	1130	⭘	1353
1997	30	230	○	656	⊙	886
1998	31	15	☼	1146	⭘	1161

Appendix 3
Modern rainfalls (mm) calculated for seasons and years
Spans: RL (Jan-Mar), RN (Apr-Dec) and Year (Jan-Dec)

Year	m	RL (mm)	RL icons	RN (mm)	RN icons	Year (mm)
1999	32	330	⭘	1551	●	1881
2000	33	311	⭘	1568	●	1879
2001	34	73	☼	1199	⭘	1272
2002	35	187	○	942	⊙	1129
2003	36	31	☼	1311	⭘	1342
2004	37	168	○	1225	⭘	1393
2005	38	284	⭘	1186	⭘	1470
2006	39	279	⭘	1172	⭘	1451
2007	40	144	○	1425	●	1569
2008	41	247	○	1547	●	1794
2009	42	246	○	664	⊙	910
2010	43	33	☼	1758	●	1791
2011	44	310	⭘	1286	⭘	1596
2012	45	274	⭘	750	⊙	1024
2013	46	151	○	1017	⭘	1168

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The Impact Of Higher Qualification?... (A New Theory on "Common Sense Deficiency")

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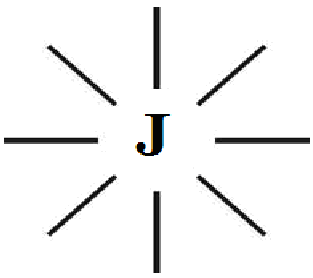
[1,]B.E. (Engineer) , [2,]M.A., M.Sc., M.Phil. (Biologist)

ABSTRACT: *The Scientific research article focus that the "**Common Sense domain**" of Human Brain shall be considered subject to consistent deficiency due to impact of "**SALT CONTENTS**" deficiency rather than acquired higher Qualification and sometimes deviate brain system.*

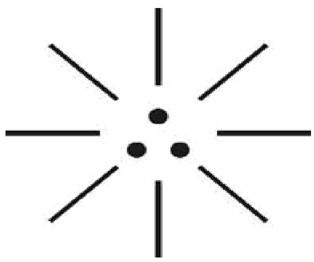
This Research focus that "**SALT**" shall be considered as the "**Natural Product**" formed due to impact of "**J-RADIATION**" (also called as "Virgin Light"). The Natural salt shall also be called as "**White crystal**" having balanced Minerals which play vital role on "**human cell growth**" under three domain of human cell system **"RNA", "HORMONE", "DNA"** region.

(i)



(WHITE CRYSTAL)

(ii)



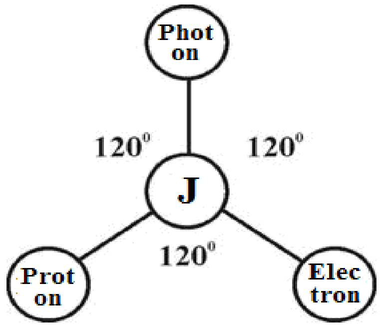
(THREE DOMAIN SALT)

This research further focus that the Imbalance in the intake salt contents shall be considered as affording imbalance to **three domain of brain system**.

[1] Common sense domain
[2] Intelligence domain

[3] Wisdom domain

The imbalance in salt intake shall lead to salt deficiency during **cell growth** and ultimately lead to various disease like **Mental stress, Thyroid, Memory loss** etc.



(Fundamental Salt Ions)

The "**three fundamental ions**" of salt considered essential for balanced growth of Brain System of human.

[1] "**Photon**" essential for "**RNA**" balance
[2] "**Electron**" essential for "**HORMONE**" balance
[3] "**Proton**" essential for "**DNA**" balance

It is further emphasized that the **Natural salt** shall be considered as "**SOUL**" of Human system and for promoting "**PEACE**" of human Brain system.

*"**White crystal**" shall be considered as fundamental "**Element**" and considered as "**Genus**" to Various "**Species matters**" such as White sugar, Brown sugar, sugar free ice cream, etc."*

-Author

Key Words:

a) **Infant** common sense
b) **LKG** common sense
c) **UKG** common sense
d) **Primary** common sense
e) **Secondary** common sense
f) **Higher Secondary** common sense
g) **Academic** common sense

I. INTRODUCTION:

It is focused that under the present environment condition human immunity and thinking level shall be considered as gradually lost due to impact of "**White crystal deficiency**" and lead to **various disease**. Case study shows that world vide 2 billion people affected by salt deficiency leading to physical and mental disabilities.It is focused that the **Ancient human** (Ist generation population) shall be considered as having "**enriched common sense**" due to balanced environment. During the course of **expanding Universe** the Balance of Neutrino ions **photon, electron, proton** considered disturbed in three "**Nuclear ages**" and hence scientists have to find out new solution for balanced intake of **Sodium, Chloride, Iodine** substitute for sustainability of comfortable life by **modern human** (3rd generation population) It is further focused that the **Ancient human** population shall be considered as strong in physical, Mental, Instructional power environment and hence they could be able of construct huge structure like "**Egyptian Pyramids**" with advanced **mystic Technology power** though they don't have any higher Qualifications such as **MBA., M.Sc., M.Phil., M.Tech.**, etc.

This research further strongly emphasize that enriched common sense shall be considered as essential rather than scientific empirical application.

[1] "**Common Sense**" is like "**Rajya Saba**"
[2] "**Intelligence**" is like "**Lok Saba**"
[3] "**Wisdom**" is like "**Supreme Court**"
[4] "**White crystal**" is like "**President**"

"My illiterate mother having ***ENRICHED COMMON SENSE*** *could produce a scientific product like me"*
- Author

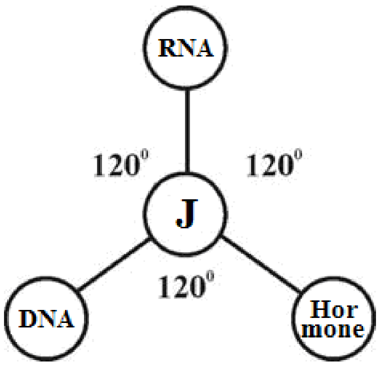
II. HYPOTHESIS AND NARRATION

a) Philosophy of SALT?...

Case study shows that in **ancient period** the main source of salt was considered as "**Dead Sea**" salt is also considered "**Holy product**" and Sacramental element. "**Gandhiji**" also focused about the importance of salt through his "**Salt Movement**". Salt is also used for preservation of Dead body to prevent **environmental Hazard**. In "**Ancient Tamil Custom**" there is a proverb that "**The salt provider should be remembered till death**".

If so what is Salt?...

It is hypothesized that the "**J-RADIATION**" (Virgin light) shall be considered as the "**Divine Tonic**" for sustainability of comfortable balanced life.

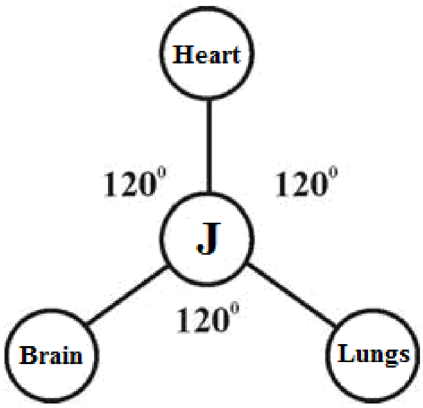


(SALT BALANCE)

- **Proton**" (Common sense) is like "**DNA**" (Magnetic)
- **Electron**" (Intelligence) is like "**Hormone**" (Electric)
- "**Photon**" (wisdom) is like "**RNA**" (Optic)

Etymology of word SALT?...

The philosophy of "**SALT**" shall be considered as "**SOUL**", "**PEACE**" of Human system. In medical term soul, peace shall be called as "**J-POINT**" and "**Life Point**" connecting Brain, Lungs, Heart. For keeping the J-Point under **saline condition** doctors are advising for frequent goggling with salt solution.



(SANKU)

It is focused that the etymology of word "**SALT**" might be derived from the proto-indo-Europe language roof "**SALANAM**", "**SANKU**". Salanam, Sanku shall mean "**Life Balance**" (or) "**Life knot**".

Philosophy of Word Salvation?...

It is focused that the word "**Salvation**" shall be considered associated with three fundamental parameters required for human life system. The philosophy of word "**Salvation**" might be derived from the philosophy of **SALT, SOUL**.

[1] "**Hope**" is like "**Photon**" (like Iodine)
[2] "**Mercy**" is like "**Electron**" (like Chlorine)
[3] "**Love**" is like "**Proton**" (like sodium)

Case study on Infant common sense?...

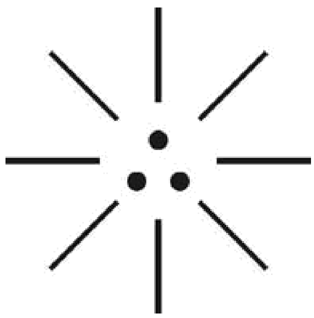
The philosophy of infant common sense shall be considered as the **state of brain** within mother's womb having enriched common sense.

(ENRICHED COMMON SENSE)

No worry… No Tension… my mother takes care…

b) Case study on LKG common sense?...

Ba… Ba… Black sheep… **Have you any salt**?... Yes Sir… Yes Sir… **Three kinds of Salt** (Muthamil Salt)



(MUTHAMIL SALT)

[1] Right dot is like **Alkali balance** (High PH)
[2] Left dot is like **Acid balance** (Low PH)
[3] Center dot is like **Neutral balance** (PH 7.0 – 7.4)

Case study on UKG common sense?...

The state of common sense of human in next stage shall be described as below.

We are all **children of God**

We will build **sand house** and live happily.

Case study on Primary common sense?...

The State of Commonsense under primary education stage shall be described bellow.

We are all **human**…
We are all **Indians**…
We are all **one family**…

Case study on Secondary common sense?...

Lord Jesus… bless us for **Today Bread**
Lord Alla… bless us for **Good Health**
Lord Shiva… bless us for **Good Marks**

Case study on Higher Secondary Common Sense?...

I want to become **Great Doctor** and **Serve the nation**
I want to become **Great Engineer** and **Serve the nation**
I want to become **IAS topper** and **Serve the nation**
I want to become **Eminent Politician** and **Eradicate casteism**
I will marry **poor black girl** and **give life to her**

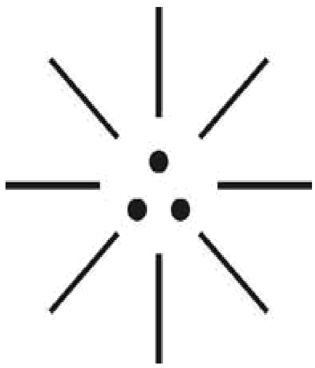
Case study on Academician common sense

I am Indian… **I love India…**
Bride is ok… But How much **dowry they give?...**
Bride groom is ok… But **Caste is not ok…**
We love India… but we will not obey **SUPREME COURT JUDGMENT…**
We are all Human… but we will kill our brothers **on Casteism…**
We love India… but we will not give **DAM WATER** to neighbour Indian…
We settled in US… Good bye to Indian **old parents…**
We become citizens of Canada… India is **too hot** to live…
We are great scientist… Indian mothers are **illiterate…**

Philosophy of salty mother?...

The Salty mother shall be considered as enriched with Immense of common sense rather than "**Intelligence**". The Salty mother shall be considered having huge stock of commonsense in the form of "**OCEAN OF TEARS**" and shed for the needy people for Sustainability of their "**Balanced Healthy life**". The Salty mother shall also be called in Proto Indo Europe language as "**THAI-e**"

(i)



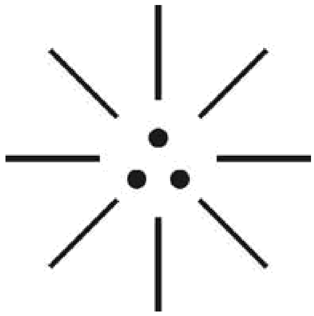
(WHITE CRYSTAL)

(ii)

THAI-e
(THE SALTY MOTHER)

III. CONCLUSION:

It is focused that the existence of Various Oceans on the **earth planet** shall be considered as the **water compound** derived from "**Ancient White Crystals**" in three **geological evolutions**. In proto Indo Europe language the "**Ocean**" shall be called as "**KANNEER**". Kanneer shall mean "**TEARS**"



(KANNEER)

Right drop - Common sense (Love)
Left drop - Intelligence (Mercy)
Centre drop - Wisdom (Hope)

Previous Publication: The philosophy of origin of first life and human, the philosophy of model Cosmo Universe, the philosophy of fundamental neutrino particles have already been published in various international journals mentioned below. Hence this article shall be considered as **extended version** of the previous articles already published by the same author.

[1] Cosmo Super Star – IJSRP, April Issue, 2013
[2] Super Scientist Of Climate Control – IJSER, May Issue, 2013
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[26] UNIVERSE IS LIKE SPACE SHIP?!... (AJER, October Issue, 2013)
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[28] ROSETTA STONE IS PREHISTORIC "THAMEE STONE" ?!... (IJSER, November Issue, 2013)
[29] The Supernatural "CNO" HUMAN?... (IJOART, December Issue, 2013)
[30] 3G HUMAN ANCESTOR?... (AJER, December Issue, 2013)
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[34] 3G Mobile Phone Induces Cancer?... (IJERD, December Issue, 2013)
[35] "J" Shall Mean "JOULE"?... (IRJES, December Issue, 2013)
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[37] The Supersonic JET FLIGHT-2014?... (IJSER, January Issue, 2014)
[38] "J"-RADIATION IS MOTHER OF HYDROGEN?... (AJER, January Issue, 2014)
[39] PEACE BEGINS WITH "J"?... (IJERD, January Issue, 2014)
[40] THE VIRGIN LIGHT?... (IJCRAR, January Issue 2014)
[41] THE VEILED MOTHER?... (IJERD, January Issue 2014)
[42] GOD HAS NO LUNGS?... (IJERD, February Issue 2014)
[43] Matters Are Made Of Light Or Atom?!... (IJERD, February Issue 2014)
[44] THE NUCLEAR "MUKKULAM"?... (IJSER, February Issue 2014)
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[46] STAR TWINKLES!?... (IJERD, March Issue 2014)
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Introduction to corridor selection & assessment for Bus Rapid Transit System (BRTS) in Hyderabad

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ABSTRACT*: Bus rapid transit system is an innovation and it is up gradation to the present transport system. BRT is affordable, adaptable and cost effective. The term of rapid transit system means a form of high speed urban passenger transportation. Here, the mode of transportation is bus hence it is called as bus rapid transit system (BRTS). Transportation facilities and the system will be different form different countries. Especially for the developing countries, transportation is a problem and BRT is the best way to overcome it. If a country gets richer the development will be seen in different aspects like education, industry, science and technology etc., except transport which will get worse. There are many ways to get rid of these traffic issues and transport problems. What attracted the countries to install BRT is the bus way concept as that it can cover whole city and is cheaper than the rail. BRT is a high speed rapid transit system using high capacity vehicles, physically separated bus ways, modern station with electronic fare collection, rapid boarding and high service frequency which result more passengers and less congestion. This paper presents an overview of BRTS and corridor selection & assessment for it in Hyderabad through surveys etc.*

Keywords: *BRTS, PCU, Traffic congestion, Transportation, Level of Service, LRT, ITS, SPS.*

I. INTRODUCTION

Bus Rapid Transit System (BRTS) takes part of its name from "Rapid Transit", which describes a high-capacity transport system with its own right-of-way, implemented using buses through infrastructural and scheduling improvements, to provide a high level of service [1]. Normally BRT includes the following features like dedicated lanes, off board fare collection, intersection treatment, platform level boarding. The Bus Rapid Transit system is expected to revolutionize public transport with new buses, special lanes and new routes, all at a low cost. When compared to regular mode of transportation, the operation of BRTS is a bit challenging. That is because there will be some frequency between the buses, at the time of traffic jams the buses will give the estimated time of arrival to the signals using the intelligent transport system (ITS). This sort of operation leads to delay the red signal or extending the green signal. This operation can be technically termed as signal priority system (SPS). In India, roads are often designed to take a particular number of users, say 30,000 persons per hour per direction. A single dedicated lane BRTS is known to carry 20,000 passengers per hour per direction. A well implemented efficiently-run BRTS will also cause citizens to switch travel modes from car to bus, which will further alleviate the traffic situation. The Selection of a corridor is done by conducting various number of surveys in Hyderabad by which the BRTS can be easily implemented in it.

II. INDENTATIONS AND EQUATIONS

2.1 How BRTS is applicable for Hyderabad???

Hyderabad has a well developed ring radial structure, high density development and dispersed travel pattern. No Single mode is adequate to meet with the mobility needs in cities. Improvements in existing bus system alone are not adequate to bring about significant modal shifts [2]. Literally BRTS is new sort of transportation system to Hyderabad city. Recently it has been proposed in Vijayawada, India.Primarily the corridor selection is made on the basis of the traffic volume in the city and especially the particular corridor is selected because currently there is a facility i.e. construction of metro rail is under progress. So that the traffic volume count will be drastically change after operation of Hyderabad metro rail in the other areas. Hence, the people in the corridor suffering from the heavy traffic, traffic jams and traffic congestions may make use of BRTS. In order to make sure the survival of the BRTS in Hyderabad, a survey was started with the specific route or corridor. Some of the interesting facts and values are discovered in the surveys. This paper describes the surveys conducted in the corridor and the related values and the effects for the values obtained and the graphical representation of the values for a better idea.The Selected corridor is from Prashanth Nagar to Secunderabad (via bowenpally).The traffic volume in this corridor is fairly high because it connects to the educational centre like Kukatpally, industrial hub like Balanagar, business centre like Paradise and Patny center and the most crowded area like Secunderabad which is one of the important railway junctions in country and headquarters for railways South Central Division (SCR-South Central Railway).

The corridor consists of 5 junctions they are,
1.Balanagar 2.Bowenpally 3.Tarbund 4.Paradise 5.Patny.

The different surveys done in the specific corridor are like Reconnaissance survey, dividing the corridor and studying in to homogeneous sections, survey on passenger car unit, annual daily traffic survey and survey on level of service.

Reconnaissance survey
Before selecting the BRTS corridor the visual surveys are done and the corridor is selected [4] shown in Fig.1.

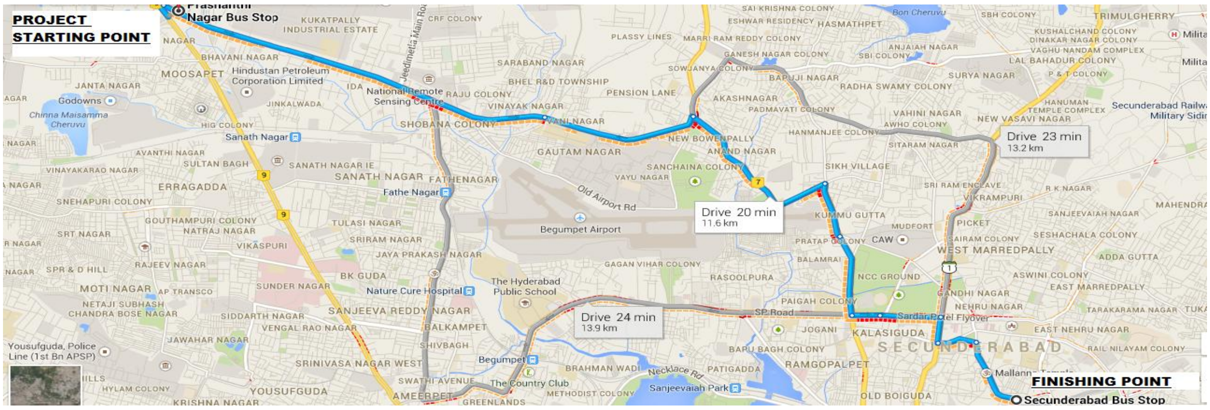

Fig.1 : Map of selected corridor

By the reconnaissance survey the orientation of the corridor can be obtained and the rough assessment of the project can be done easily, even the length of corridor can be identified. As per survey it is observed that the length of the corridor is 12.24km.

2.3 Dividing the corridor and studying in to homogeneous sections
With a view to capture section-wise traffic flow characteristics, the total project stretch has been segmented into four traffic-homogeneous sections, based upon the locations of major intersections/ urban settlements. These acts as main collectors or distributors of traffic along the project corridor; i.e. sections of more or less similar traffic characteristics would form one homogeneous section. The homogeneous sections identified are given in Table 1.

Table 1: Identified homogeneous sections.

Homogeneous section	Length (Km)
Prashanth nagar to Balanagar (HS-1)	2.3
Balanagar to Bowenpally (HS-2)	4.02
Bowenpally to Paradise (HS-3)	3.72
Paradise to Secunderabad (HS-4)	2.2

Survey on passenger car unit

The traffic flow is measured in terms of number of vehicles per unit time. Since Indian traffic is heterogeneous in nature, it is common practice to convert the traffic in terms of Passenger car units (PCUs). Table 2 gives PCU factors mentioned in IRC : 106-1990.

Table 2:Equivalent PCU factors.

Vehicle type	Equivalent PCU factors with percentage composition	
	5%	10% and above
2 wheelers scooter (or) motor cycle	0.5	0.75
Passenger car and pick van	1	1
Auto rickshaw	1.2	2
Light commercial vehicles	1.4	2
Truck or bus	2.2	3.7
Agricultural tractor	4	5
Cycle	0.4	0.5
Cycle rickshaw	1.5	2
Tonga	1.5	2
Hand cart	2	3

By using the above PCU values the traffic volume count is converted in to per passenger car unit at every homogeneous section the survey is done. The number distribution of vehicles is given in Table 3.

Table 3: Number distribution of different types of vehicles.

Vehicle composition	section 1	section 2	section 3	section 4
2-wheeler	1888	1049	2073	1827
Car	465	406	1045	276
Auto	177	123	133	99
Bus	206	229	137	158
Cycle	10	2	2	16
Light commercial vehicles	41	98	33	26
2-Axle truck	61	65	43	38
3-Axle truck	12	28	22	19
Multi axle truck	1	8	5	7

The histogram representation of the different number of vehicles is given in Fig.2.

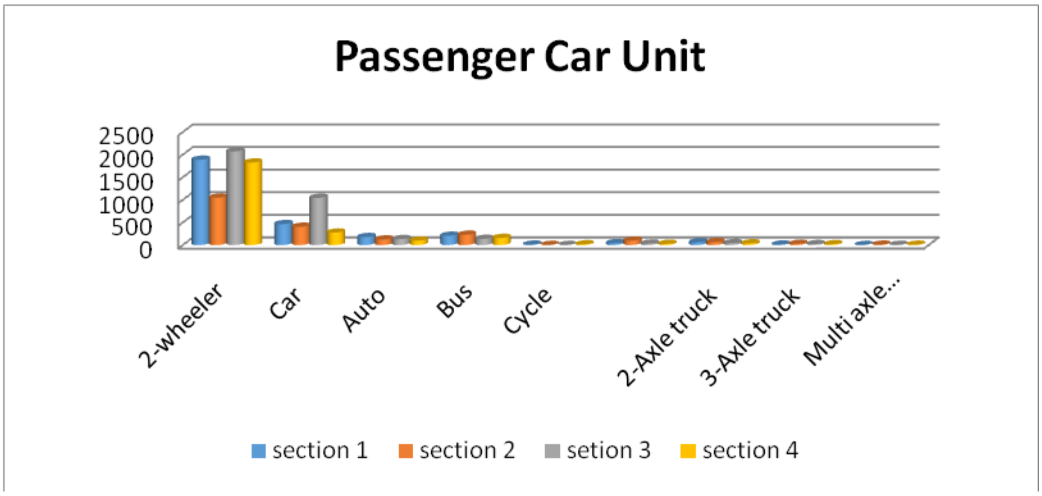

Fig.2 : Frequency distribution of different types of vehicles.

From the above values and graphs it is clear that the 2-wheelers are the majority number of the vehicles in the traffic composition. The surveys done on the peak hours to identify the maximum traffic volume, that leads to the absence of the multi axle and 2 axle trucks.

Annual daily traffic survey

The classified traffic volume count data collected in between March and April 2014 is analyzed to assess the traffic intensity along the project corridor. The detailed analysis of data is given in Table 4.

Table 4: Traffic volume data.

Vehicle Type	Km. 2.3		Km. 4.02		Km. 3.72		Km. 2.2	
	To Balanagar	To Prashanth nagar	To Bowenpa lly	To Balanagar	To Paradise	To Bowenpall y	To Secunderab ad	To Paradise
Two Wheelers	17809	17153	9634	14046	18915	20325	18323	18255
Auto	539	439	398	390	596	794	821	1008
Car	3514	3240	2614	2989	5132	6108	2074	3859
Bus	757	685	719	747	507	616	797	800
LCV	245	199	269	299	70	63	42	62
2-Axle Truck	91	48	85	24	11	8	5	3
3-Axle Truck	10	14	21	2	2	4	0	0
Multi Axle Truck	9	5	16	4	0	5	0	0
Cycle	151	216	196	80	277	343	372	397

Survey on level of service

Level of service is defined as the qualitative measure describing the operational conditions within a traffic stream, and their perception by drivers/ passengers. Level of service generally describes the factors such as speed and travel time, freedom to manoeuvre, traffic interruptions, comfort, convenience and safety.
A level of service chart taken from IRC: 106-1990 is given in Fig.3.

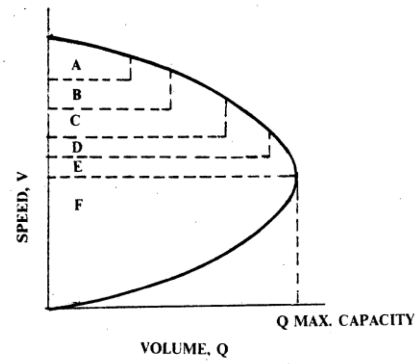

Fig.3: Level of Service chart [3].

Six levels of service are recognized commonly ,designated from A to F , with level of service “A” representing the best operating condition(i.e.., free flow) and Level of Service “F” the worst (i.e.., forced or break down flow).

Level of service for homogeneous section 1

Over all PCU values at mid block 1 = 2777 PCU/hour
Total design service volume = 2900
2777/2900= 0.957 => 95.7%(which is greater than 80%)
So, level of service for mid block 1 falls under category ‘E’.

Level of service for homogeneous section 2

Over all PCU values at mid block 2 = 2625 PCU/hour
Total design service volume = 2900
2625/2900= 0.905 => 90.5%(which is greater than 80%)
So, level of service for mid block 2 falls under category ‘E’.

Level of service for homogeneous section 3
Over all PCU values at mid block 3 = 2829 PCU/hour
Total design service volume = 2900
2829/2900= 0.975 => 97.5%(which is greater than 80%)
So, level of service for mid block 3 falls under category 'E'.

Level of service for homogeneous section 4
Over all PCU values at mid block 4 = 2433.6 PCU/hour
Total design service volume = 2900
2433.6/2900= 0.839 => 83.9%(which is greater than 80%)
So, level of service for mid block 4 falls under category 'E'.

Level of Service E : It represents operating conditions when traffic volumes are at or close to the capacity level. The speeds are reduced to a low, but relatively uniform value, average value being 1/3rd the free flow speed. Freedom to manoeuvre within the traffic stream is extremely difficlt, and is generally accomplished by forcing a vehicle to give way to accommodate such manoeuvres. Comfort and convinience are extremely poor, and driver frustration is generally high. Operations at this level are usually unstable, because small increases in flow or minor disturbances within the traffic stream will cause breakdowns.By this level of service the inconvinience range for the driver will be increased and it would lead to discomfort for the traffic [3].

III. CONCLUSION

The above surveys state that, we cannot trust the current mode of transportion completely and it may not be able to bear if traffic volume increases. It is necessary to upgrade the current system of transportation in case of increase in traffic volume. In this context BRTS would be the best choice, as it is cheaper compared to other systems and it can be easily adaptable, flexible, requires no special faclites, needs lower capital costs can serve a larger geographical area.The capital costs of implementing BRT are lower than for light rail transit (LRT). A study by the United States government accountability office from 2000 found that the average capital cost per mile for bus ways was $13.5 million while light rail average costs were $34.8 million [5].By the Surveys done on the selected corridor in Hyderabad states clearly that the upgradation of the current transportation system should be done with BRTS.

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Adsorption Equilibrium Study Of Dyestuff from Petroleum Industry Effluent Using the Biomass and Activated Carbon Of The Prop Root Of *Rhizophora Mangleplant*

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ABSTRACT : *The comparative equilibrium adsorption study of three different types of dyestuff effluent on the biomass and activated carbon prepared from wastes of rhizophora mangle root has been carried out as a function of initial concentration, contact time and pH variations. The sorption processes which were examined by means of Freundlich and Langmuir models revealed the effectiveness of both BRR and ACRR adsorbents in uptaking the dyes investigated by the level of agreement of the adsorption constants. Acidic and disperse dyes show higher adsorption at higher pH whereas basic dyes showed higher adsorption at lower pH. The binding capacity experiments revealed the following amounts of dyestuff bound per gram of adsorbent (mg/g): 2.67 BG4, 4.97 DB6 and 1.30 DB26 on biomass and 2.16 BG4, 3.73 DB6 and 6.78 DB26 on carbon. The separation factor (S_F), values obtained for the three dyes showed that the interactive processes on both adsorbents were a mixture of physisorption and chemisorption mechanisms . A single factor analysis of variance (ANOVA) showed that there is no significant difference in the sorption behaviour of the three dyes between the two adsorbents. The study also revealed that the rhizophora based adsorbents compared favourably with commercially available grades. The optimum conditions obtained in this investigation are relevant for the optimal design of a dyestuff effluent treatment column.*

KEYWORDS: *Dyestuff Adsorbent, Biomas, Activated Carbon, Effluent, Petroluem*

I. INTRODUCTION

The products of the petroleum industry are major contributors to our present standard of living. The activities of the upstream and downstream petroleum industry can impact the environment and the greatest impact arises from the release of wastes into the environment in concentrations that are not naturally found. These wastes which are organic and inorganic in nature include hydrocarbons such as traces of crude oil, solids contaminated with hydrocarbons such as heavy metals and a wide variety of chemicals including dye-stuff.Dyes are coloured substances that can be used to produce a significant degree of coloration when dispersed in or reacted with other materials. The primary use for dyes is textile coloration, although substantial quantities are consumed for coloring such diverse materials as leather, paper, Plastics, petroleum products and food (James, 1962). In the petroleum industry, solvent dyes and azo dyes are used to colour or “mark” petroleum products like gasoline, diesel, kerosene, and lubricants etc. solvent dyes are economical, easy to use, have high and low flash point and are stable. They are designed to provide an outstanding easy brand or grade identification, leak detection and fraud detection in some countries. Dyes are also used as traces to identify poor producing zones of a dual-completed well.Azo dyes can give about 22 aromatic ammines as their degradation products which may be carcinogenic. This means that they constitute a health risk. Although environmental authorities have regulated industrial discharges for many years, considerable quantities of azo dyes may have accumulated in the environment as a result of refinery effluent discharged in Nigeria. Unless this colour is removed by chemical or physical means, it may lead to pollution of water. The presence of dyes in the effluent impart high biochemical Oxygen demand BOD) load to the liquid waste.

When dissolved oxygen reduces below a certain level, the aquatic life is affected adversely. This is because strong colour could result in high turbidity leading to reduction in light penetration, thus, affecting the growth of animal and plant life in the water. Studies by Crips and Bumpus (1990) revealed that dry biomass of marine plants can decolorize certain pigments and dyes in water. This actually informed the choice of the biomass of root of *Rhizophora mangle* plant as bio-adsorbent for the removal of dyes used to colour petroleum products in this study. Various methods used for the treatment of colour effluent are coagulation, flocculation and precipitation (Cooper, 1993), adsorption (Yeh and Thomas 1995), biological treatments (Laszlo, 1994) and membrance technology (Churchley, 1994). Out of these methods, adsorption at solid/liquid interface is one of the most economical and effective treatment methods for removal of dyes and has an edge over other methods due to its sludge-free clean operation. This actually informed the choice of the biomass and activated carbon of the *rhizophora mangle* plant as a low-cost land biodegradable adsorbent used for the treatment of coloured effluent by adsorption technique in this investigation.This paper presents the adsorption equilibrium of dyes as a function of initial concentration, contact time and pH, conducted at laboratory scale using synthetic dye waste water of acidic, basic and disperse dyes. The effect of dye structure on adsorption capacity is also discussed.

II. EXPERIMENTAL

2.1 Preparation of Biomass and Activated Carbon of *Rhizophora* root

The detailed experimental procedure for sample preparation and activation has been published elsewhere (Horsfall and Abia 2003, Jadhav and Vanjara, 2004). The bark of the *rhiophora* root was air dried for 5 days and then oven dried at 90°C for 24 hours to constant weight then ground and screened to 2.36mm size with Tyler screen to obtain granules of biomass. 500 grams of the finely divided granules of biomass was soaked in excess 0.3M $HNO3$ for 4hrs to remove any metals and soluble biomolecules followed by washing thoroughly with deionized water until a pH of 7 was attained and then air dried. This air dried Biomass was then washed with deionized water and centrifuged at 3000 xg for five minutes using a portable refrigerated test tube centrifuge model Pr-2. The supernatant obtained was discarded whereas the biomass was collected and spread on filter paper for air drying and it was ready for use as adsorbent.The activated carbon was prepared from the biomass of *rhizophora* root by incinerating the biomass in an iron tubing of 30mm diameter using the furnace carbolite equipment (GallenKamp model OV-160 England). The tubing was heated in an oxygen deficient atmosphere for 2hours and at 500°C. This was to eliminate most of the volatile matter in the biomass. The carbon was then physically activated by partial gasification in limited supply of air using $CO2$ gas as the gasification agent at 900°C. This was to develop the porosity and the surface area (Wauquier, 1995). The activated carbon was then stored in stoppered bottle after sieving to particle size of 2.36mm through the appropriate mesh tyler screen. The biomass of *rhizophora* root (BRR) and the activated carbon of *rhizophora* root (ACRR) were the two adsorbents used in this study.

2.2 CHARACTERIZATION OF THE BRR AND ACRR ADSORBENTS

The adsorbent used in this study were characterized through FTIR spectroscopy to ascertain some of the important functional groups responsible for their behaviour during the adsorption process using the SHIMADZU I. R. PRESTIGE-21 (200VCE) model. The samples were prepared in KBr pellet. The porosity of the adsorbents was determined using the Pore- 200 manually operated Gas porosimeter.

The analysis and characterization of both BRR and ACRR adsorbents is given in table 1.

Table 1: Analysis and characterization of BRR and ACRR

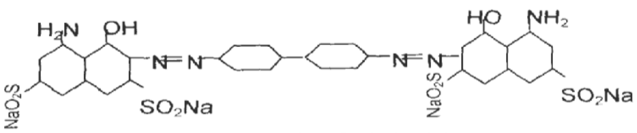
	BRR	ACRR
Apparent Density (g/m^3)	0.32	0.37
Particle size (mm)	2.36	2.36
Porosity (%)	17.90	19.62
FTIR Analysis		
Frequency (cm^{-1})	**Groups**	
At 3400 in BRR	-C-H Stretching from CH_2 groups	
AT 1600 in BRR	C=O Stretching from – COOH	
At 3300 in BRR	-OH stretching from – COOH	
At 1700 in ACRR	Normal Carbonyl Groups	
At 1565 in ACRR	Conjugated hydrogen bonded carbonyl groups	

2.3 EXPERIMENTAL PROCEDURE

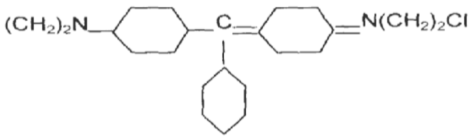
The details of the batch experimental procedure to determine dye stuff binding on biomass and activated carbon as a function of initial concentration, contact time and pH were essentially the same as those described elsewhere (Jadhav and Vanjara, 2004; Gardea-Torresdey et al 1998; Horsfall and Spiff, 2005) but which were suitably modified and adapted.Three types of dyestuff were used in all the experiments i.e. Acidic (DB6), Basic (BG4) and Disperse (DB26). The details of dyes used are given in table 2. The concentration of the dye in each solution was determined using a spectrophotometer with a glass cell of 1.0cm path length. All measurements were made at the wavelength corresponding to maximum absorbance (γ_{max}) of each dye.For adsorption experiments, a constant mass of 0.5g of each of the adsorbents was in the different experiments, added to an Erlenmeyer flask containing 50ml of dye solution. The system was equilibrated for a time period of 6hours in a flask shaker. The time period of 6hours was sufficient for equilibration. Residual dye concentrations at equilibrium were then determined spectrophotometrically. All the equilibrium studies were carried out at the natural pH of the dye solutions used: DB6-7.2; BG4-4.0; DB26-6.5.

Table 2: Details of Dyes Used

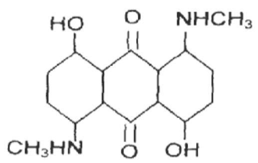
C.1.Name of Dyes	C.1 No	Molecular weight	Ionic nature	λ_{max} (nm)
Direct Blue 6 (DB6)	22610	932.20	Anionic	585.0
Basic Green 4 (BG4)	42000	927.02	Cationic	617.5
Disperse Blue 26 (DB26)	63305	310.39	Cationic	570.0



Direct Blue 6 (Anionic)



Basic Green 4 Cationic



Disperse Blue 26 Cationic

2.4 DATA ANALYSIS

The amount of dyestuff sorbed by both biomass and activated carbon of *rhizophora* root during the series of batch investigations was determined using a mass balance equation (Chu and Hashim, 2001) expressed as in eq. (1).

$$q_e = \frac{v}{m}(c_o - c_e) \quad \ldots\ldots (1)$$

Where q_e = Concentration of the sorbate on the sorbent (mg/g) at equilibrium
C_e = Concentration of sorbate in solution (mg/l) at equilibrium
C_o = Initial sorbate concentration in solution (mg/l)
M = Mass of sorbent used (g)
V=Volume of initial dyestuff solution used (L)
The percentage of adsorbate sorbed on the adsorbent is calculated using the equation:

$$\% \ adsorbed = \frac{C_o - C_o}{C_o} x100$$ ………………………………………………………..……………….(2)

2.4.1. LANGMUIR AND FREUNDLICH MODELS:

Sorption equilibrium provides fundamental physicochemical data for evaluating the applicability of phytosorption processes as a unit operation usually described by isotherm models whose parameters express the surface properties and affinity of the sorbent at fixed conditions.Two models were used to fit the experimental data, the Langmuir and Freundlich models. The Langmuir equation is chosen for the estimation of maximum adsorption capacity corresponding to complete monolayer coverage on the adsorbent surface and expressed by

$$q_e = \frac{q_{\max} K_L C_e}{1 + K_L C_e}$$ ……………………………………………………………………………………..……(3)

Where:
K_L (md^3/g) is a constant related to the adsorption energy
q_{max} (mg/g) is the maximum sorption upon complete saturation of the adsorbent surface.

The linearized form of the above equation (3) after rearrangement is given as

$$\frac{C_e}{q_e} = \frac{1}{q_{\max} K_L} + \frac{C_e}{q_{\max}}$$ ……………………………………………………………………….…………..………..(4)

The experimental data are fitted into equation (4) for linearization by plotting Ce/q_e against C_e.

The Freundlich model was chosen to estimate the adsorption intensity of the sorbate 1Thards the sorbent and is represented in equation (5)

$$q_e = K_F C_e^{\frac{1}{n}}$$ ……………………………………………………………………………………..………..(5)

Where

q_e=		The amount adsorbed per unit mass of adsorbent at equilibrium
$\frac{1}{n}$	=	Adsorption intensity
Ce	=	Concentration of sorbate in solution at equilibrium
K_F	=	Experimental Constant related to the sorption energy

The value of n indicates the affinity of the sorbent towards the adsorbent. Equation (5) conveniently used in linear form by taking logarithm of both sides as

$$\ln q_e = \ln K_F + \frac{1}{n} C_e$$ ……………………………………………………………………..…………..(6)

A plot of InC_e against Inq_e in equation (6) yielding a straight line indicates the confirmation of the Freundlich adsorption isotherm.

ANALYSIS OF VARIANCE

Due to the bias resulting from experimental errors, the internal structures not accessible at first glance of the amount adsorbed (q_e values) for the different adsorbates in the various tables of experimental results were determined by single factor analysis of variance (ANOVA). This helps to describe the relationship between the two adsorbents (BRR and ACRR) to adsorb the different contaminants.

SEPARATION FACTOR

The shape of the Langmuir isotherm can be used to predict whether a sorption system is favourable or unfavourable in a batch adsorption process (Poots et al 1978). Accordingly, the essential features of the Langmuir isotherm can be expressed in terms of a dimensionless constant called the equilibrium parameter or separation factor, SF which is defined by the following relationship.

$$S_F = \frac{1}{1+K_L C_o} \quad \ldots(7)$$

Where

SF	=	Dimensionless Separation Factor
C_o	=	Initial Adsorbate Concentration (mg/I)
K_L	=	Langmuir Constant related to the apparent energy (dm3/mg)

The parameter, SF indicates the shape of the isotherm and nature of the sorption process as given below:

If $S_F > 1$, this implies unfavourable isotherm (there is an unfavourable interaction between adsorbate and adsorbent and therefore, adsorbate may not be possible)If $S_F = l$, this implies linear isotherm (there is a linear relation between adsorbate and adsorbent interaction and the possible interactive process is a mixture of physisorption and chemisorption mechanism.When $O < S_F < l$, this implies favourable isotherm (there is a favourable interaction between sorbate and sorbent, and the predominant mechanism is physisiorption).

If SF=O, this implies irreversible isotherm (there is an indefinite stoking between sorbate and sorbent and the predominant mechanism is chemisorption.

III. RESULTS AND DISCUSSION

3.1 Characterizations of the Biomass and Activated Carbon Adsorbents

The adsorbents used in this study were characterized to ascertain some of the important function groups, porosity, apparent density and particle size using appropriate instrumentation as described in section 2.2. Table 1 shows the results for the characterization of BRR and ACRR.The FTIR analysis carried out on both adsorbents confirmed the presence of some important functional groups by correlating their known wavelength or wave-number values with the actual peaks in the respective infrared spectral (Fig1 and 2). The reference material used for interpreting the spectral is (David, 1989).

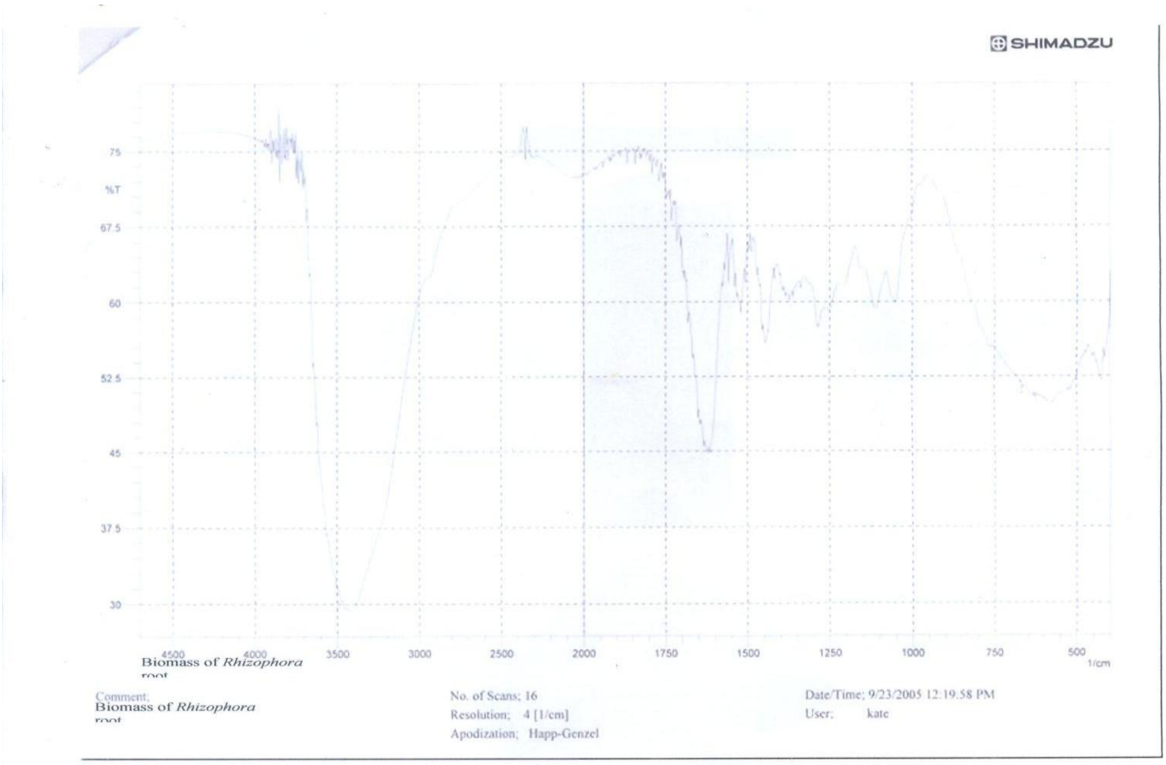


Figure 1: The FTIR Spectrum of Biomass of Rhizophora Root

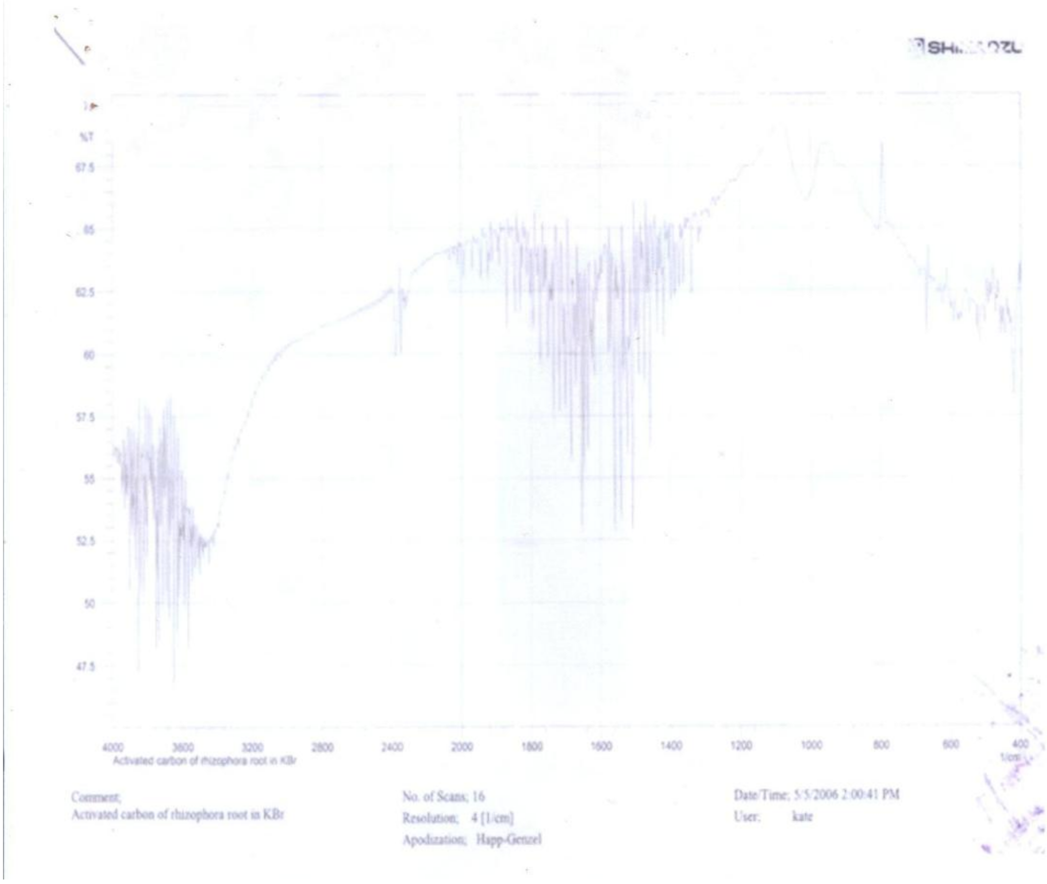


Figure 2: The FTIR Spectrum of Activated Carbon of Rhizophora Root in KBr pellet

EQUILIBRIUM ADSORTION STUDIES

Results of the adsorption of dye stuff on the adsorbents as function of concentration and pH are shown in figures 3-8.

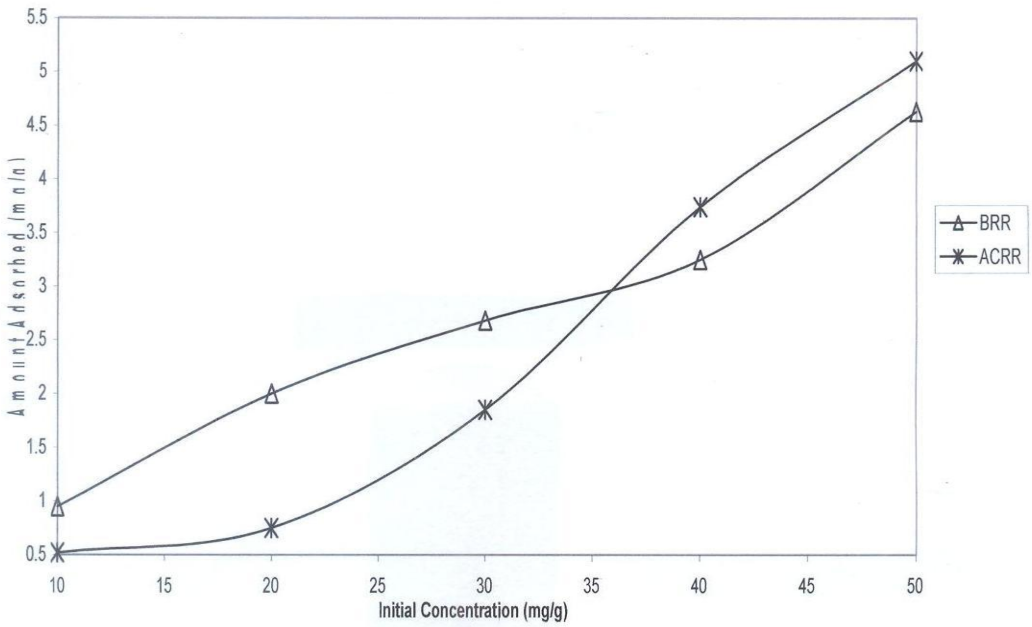


Figure 3: Comparative plots of Effect of Concentration on the adsorption of DB26 on ACRR using pH Values

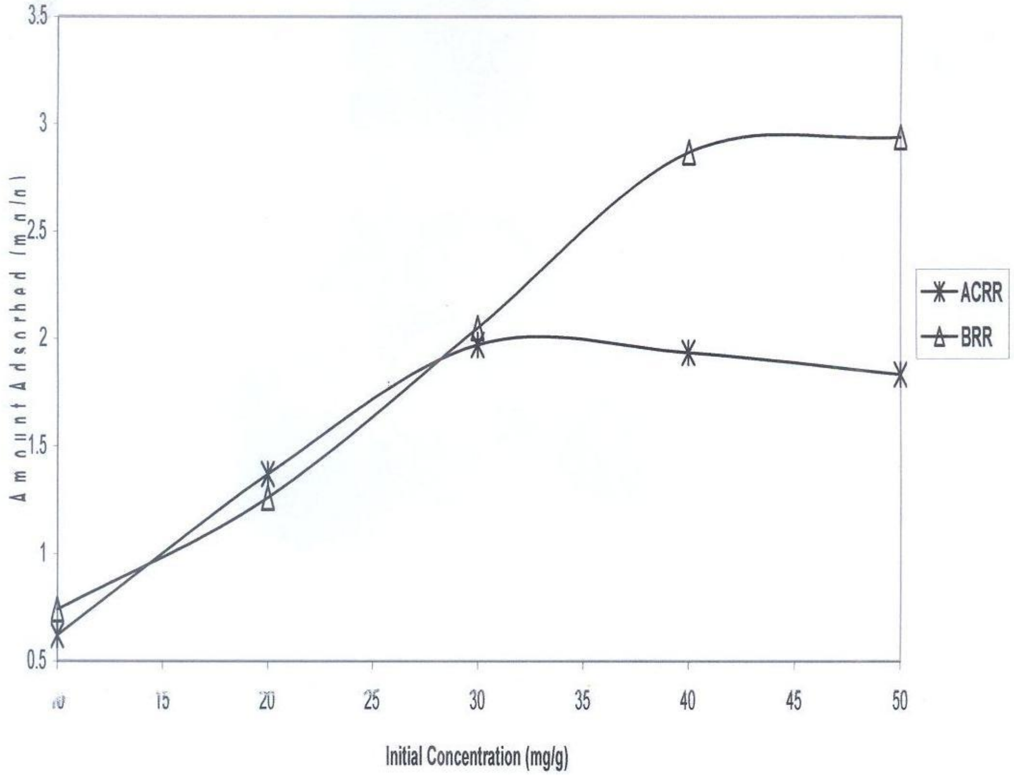


Figure 4: Comparative plots of Effect of Concentration on the adsorption of BG4 on ACRR and BRR using pH Values

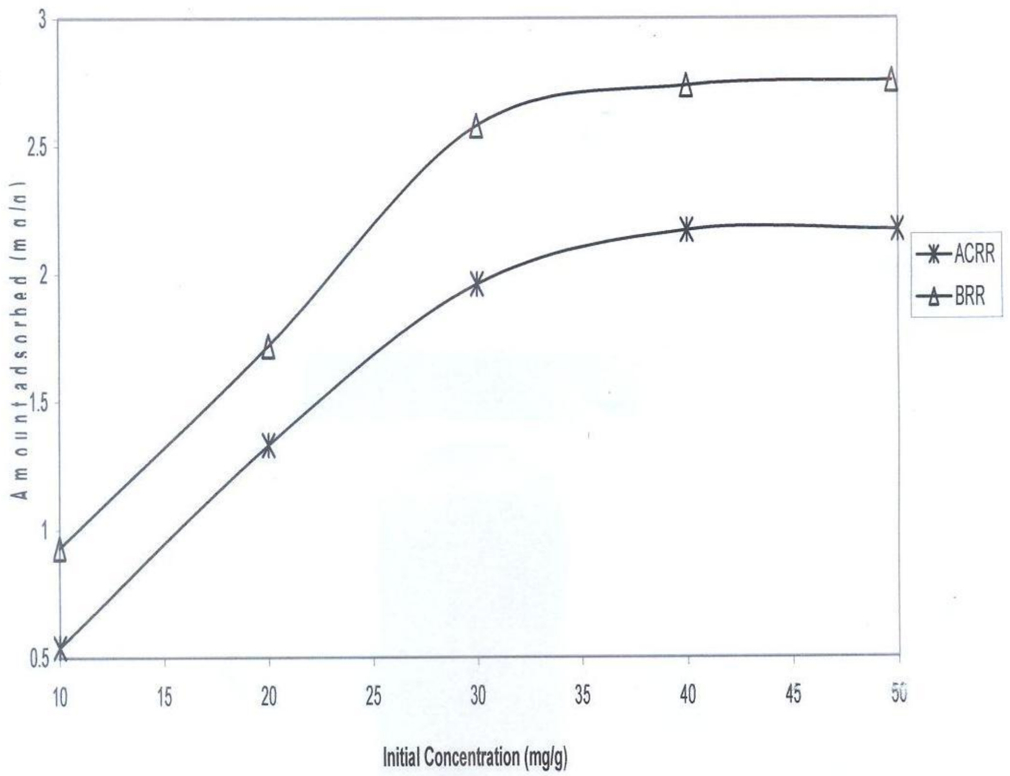


Figure 5: Comparative plots of Effect of Concentration on the adsorption of DB6 on ACRR and BRR using pH Values

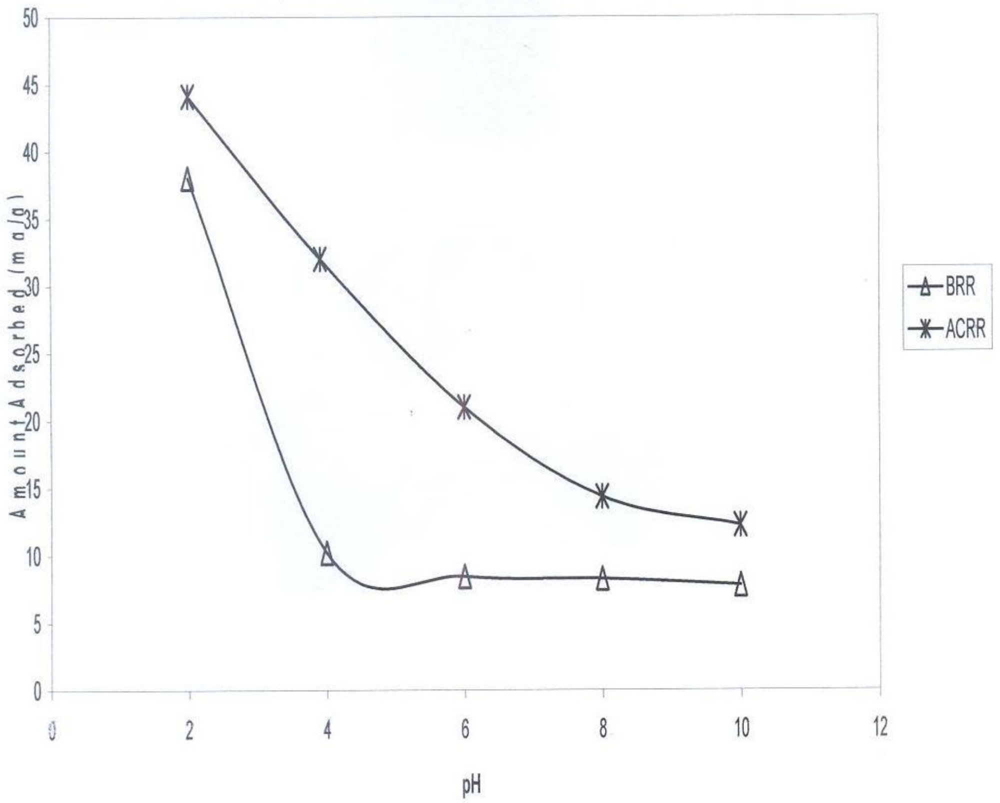


Figure 6: Comparative plots of Effect of pH on the adsorption of DB6 on BRR using pH Values

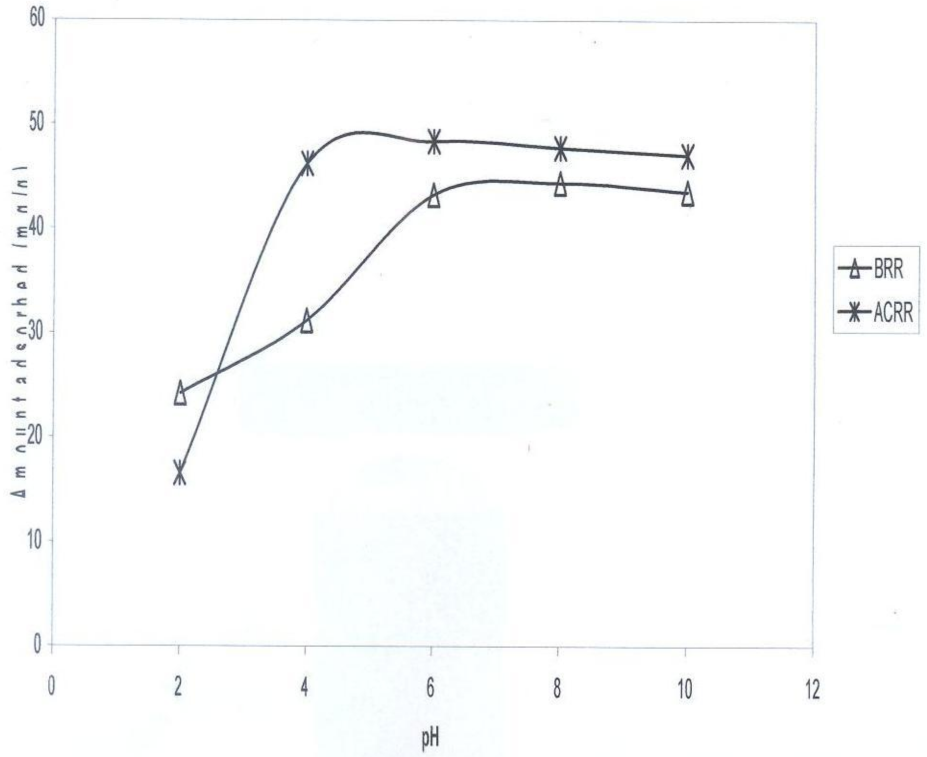


Figure 7: Comparative plots of Effect of pH on the adsorption of BG4 on ACRR and BRR using pH Values

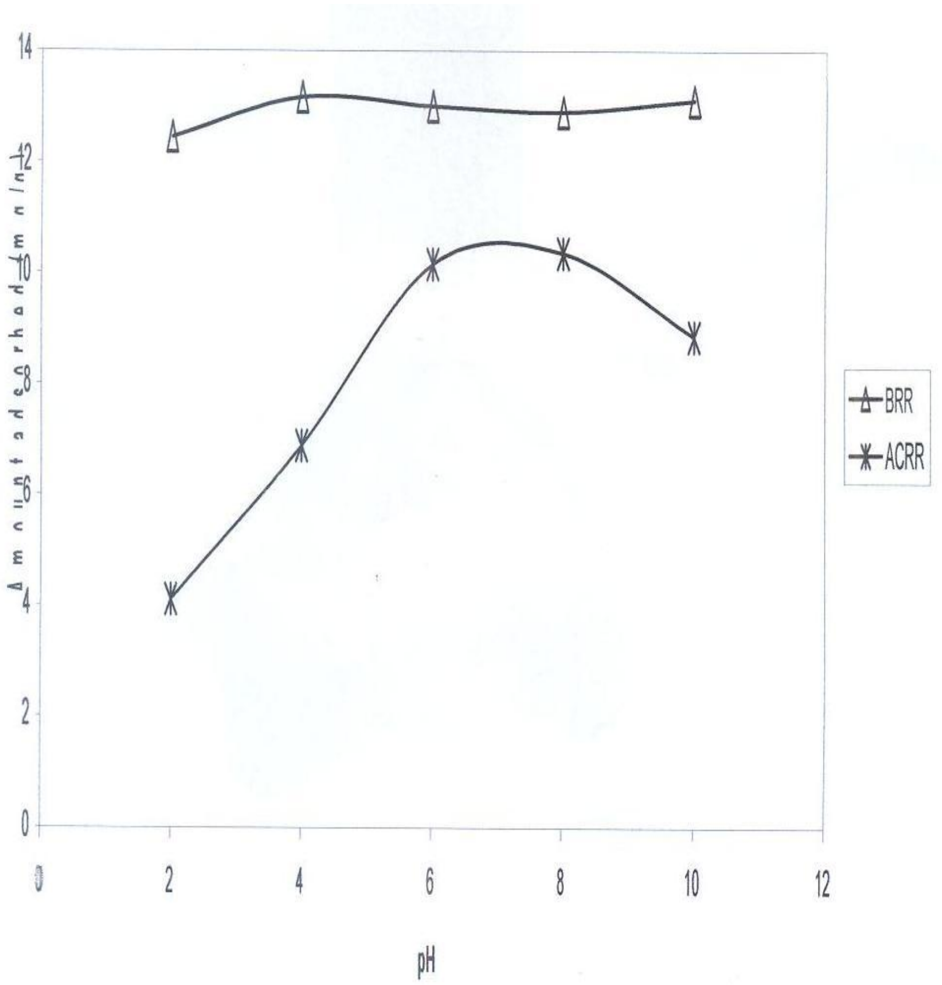


Figure 8: Comparative plots of Effect of pH on the adsorption of DB26 on ACRR and BRR using pH Values

EQUILIBRIUM ADSORPTION STUDIES

Results of the adsorption of dye stuff on the adsorbents as a function of concentration and pH are shown in figure 9-21.The results show that the amount of cationic (BG4) and anionic (DB6) dyes adsorbed increased with increase in concentration of dye until saturation occurred. It was also observed that the adsorption of dispersed dyes (DB26) increased with increase in concentration and no saturation was observed in the concentration range studied. This is an indication that under the prevailing experimental conditions, there was no formation of complete monolayer of DB26 molecules covering the surface of the adsorbent. The biomass (BRR) contains cellulose which in aqueous solution exhibits negatively charged species (Khattri and Singla, 1988). The cationic dyes (DB26, BG4) in aqueous solution adsorb on the surface of negatively charged biomass through electrostatic interaction. The activation of biomass carbon at 900^{o}C exhibits amphoteric properties (Faust, 1992) which showed lower level of adsorption of cationic dyes. Dispersed dyes have very low solubility in aqueous solution (Jones, 1984). Therefore the adsorption of DB26 on the surface of the biomass and carbon might have occurred through physical interaction, i.e. hydrophobic interaction with the hydrophobic part of the cellulose in the biomass. In the case of activated carbon, the presence of surface carbonyl group enhanced adsorption of aromatic compounds with the formation of the donor-acceptor complex involving the π electrons of benzene ring with the partial positive change on the adsorption of low soluble hydrophobic species.

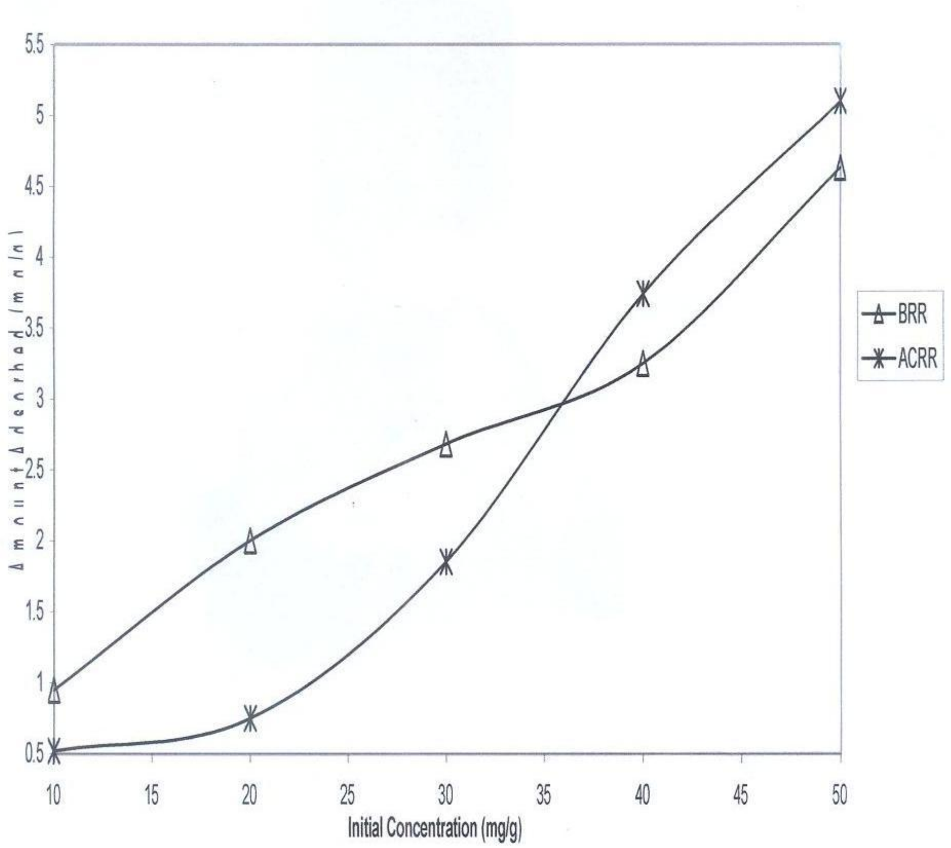


Figure 9: Comparative plots of Effect of Concentration on the DB26 on ACRR using pH Values

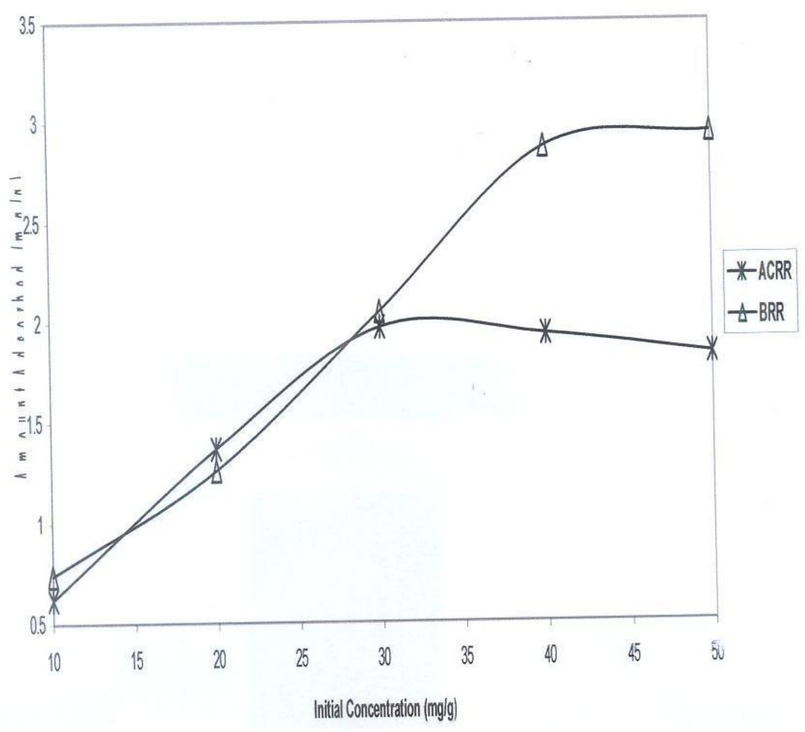


Figure 10: Comparative plots of Effect of Concentration on the adsorption of BG4 on ACRR and BRR using pH Values

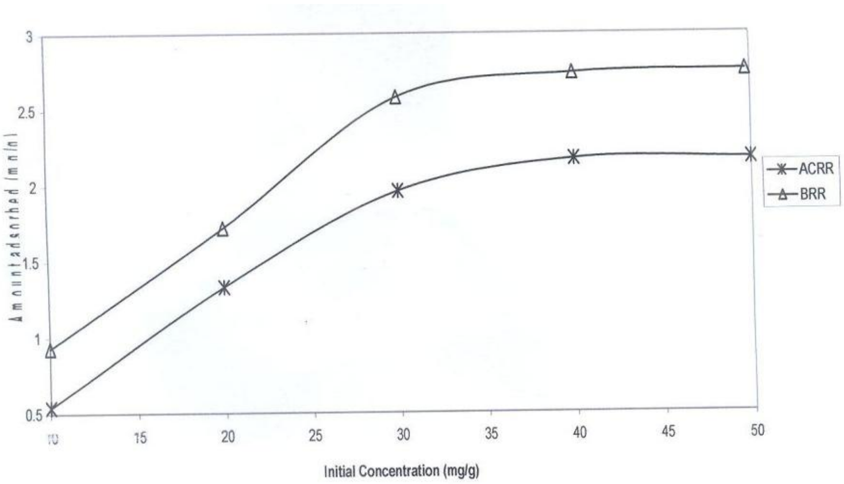


Figure 11: Comparative plots of Effect of Concentration on the adsorption of DB6 on ACRR and BRR using pH Values

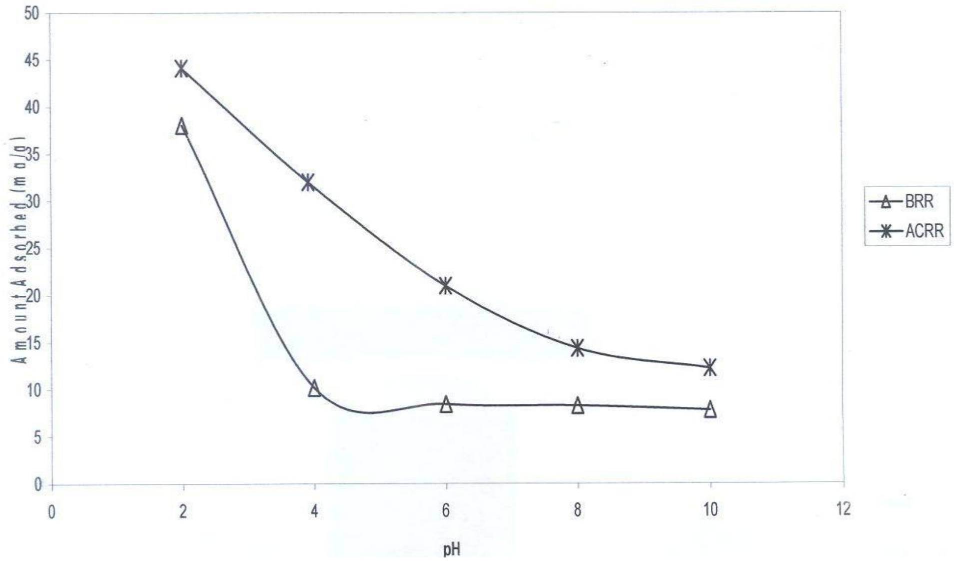


Figure 12: Comparative plots of Effect of pH on the adsorption of DB6 on BRR using pH Values

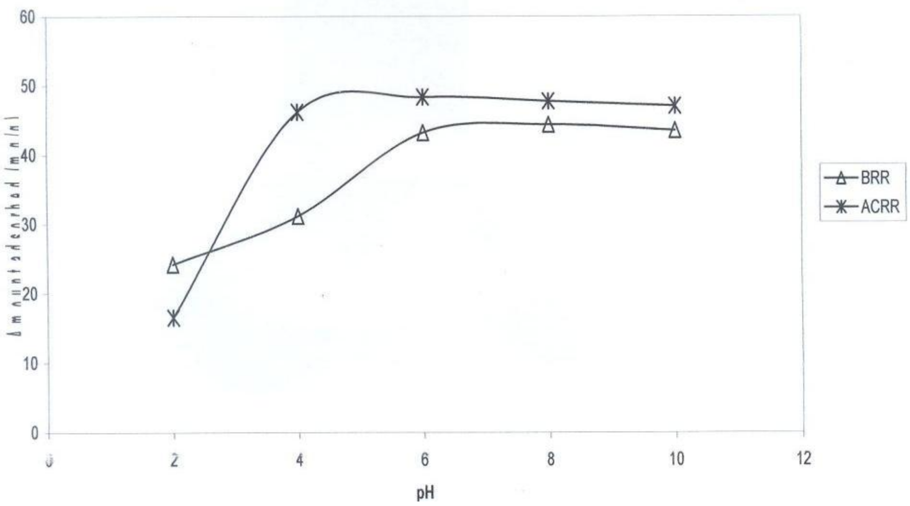


Figure 13: Comparative plots of Effect of pH on the adsorption of BG4 on ACRR and BRR using pH

Values

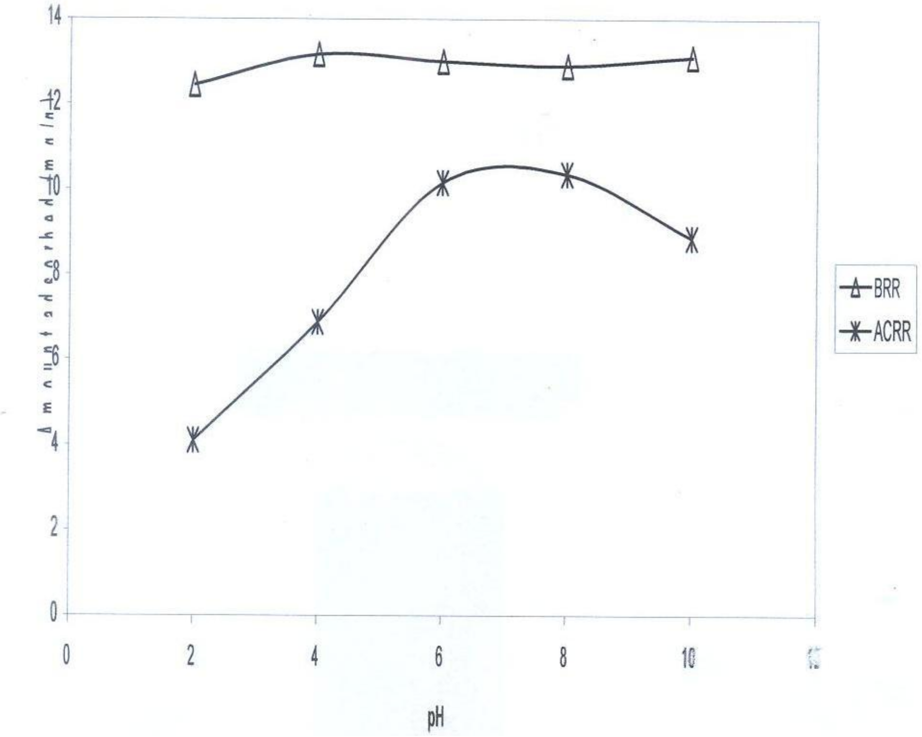


Figure 14: Comparative plots of Effect of pH on the adsorption of DB26 on ACRR and BRR using pH Values

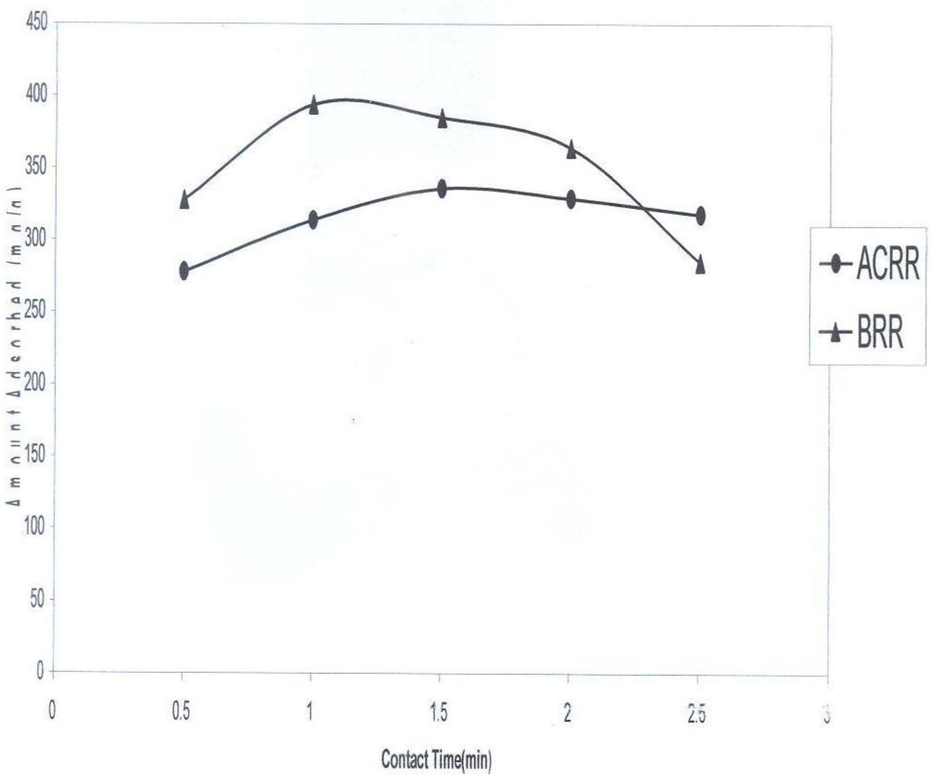


Figure 15: Comparative plots of Effect of Contact time on the adsorption of DB6 on ACRR and BRR using pH Values

The adsorption of the three dyes DB6, BG4 and DB26 on the two adsorbents (BRR and ACRR) was tested by using the Freundlich and Langmuir models (figs 9-21)

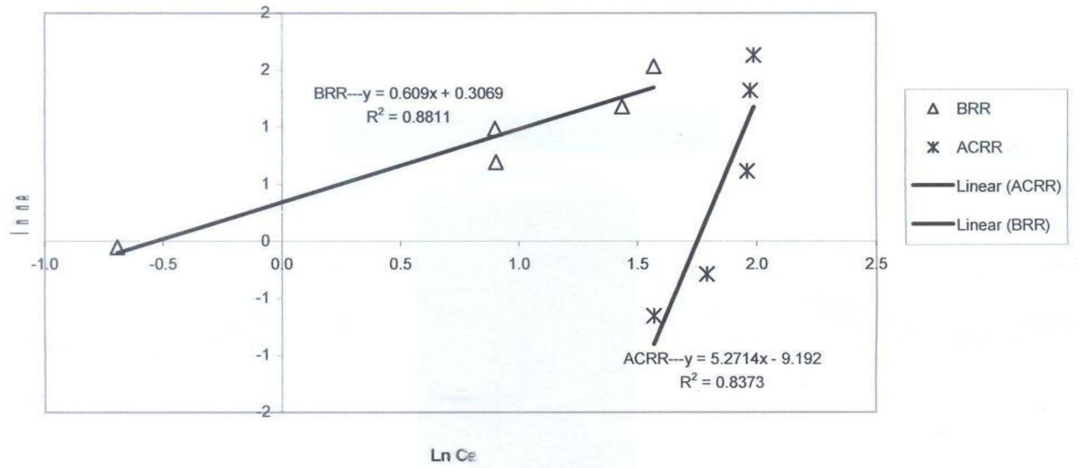


Figure 16: Plots of Freundlich Model for DB26

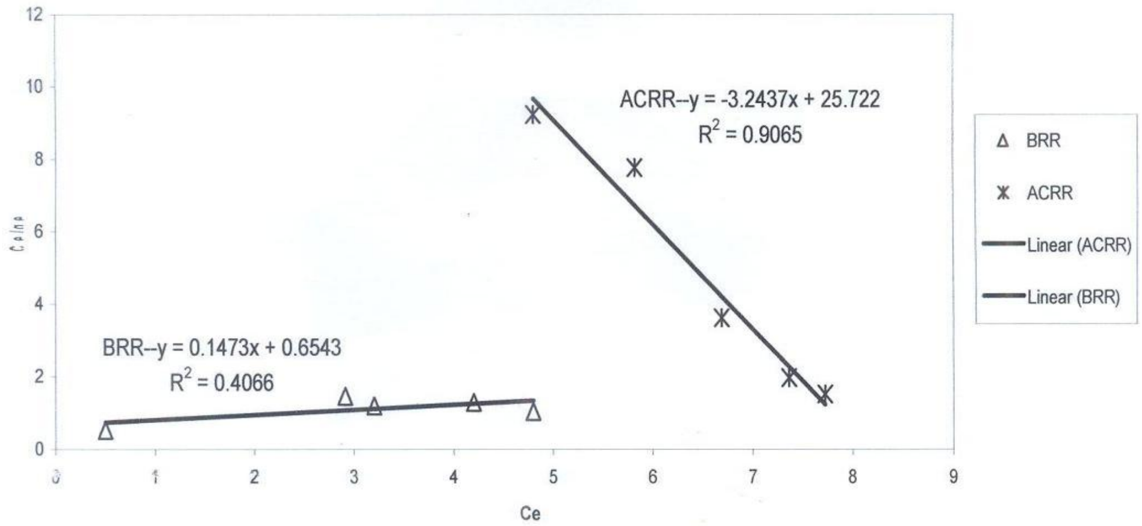


Figure 17: Plots of Langmuir Model for DB26

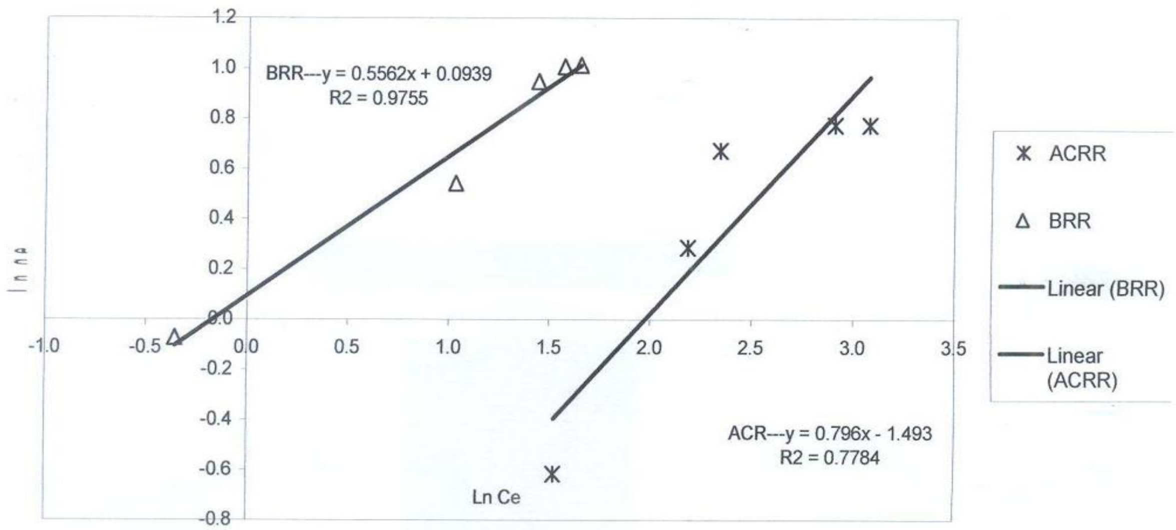


Figure 18: Plots of Freundlich Model for DB6

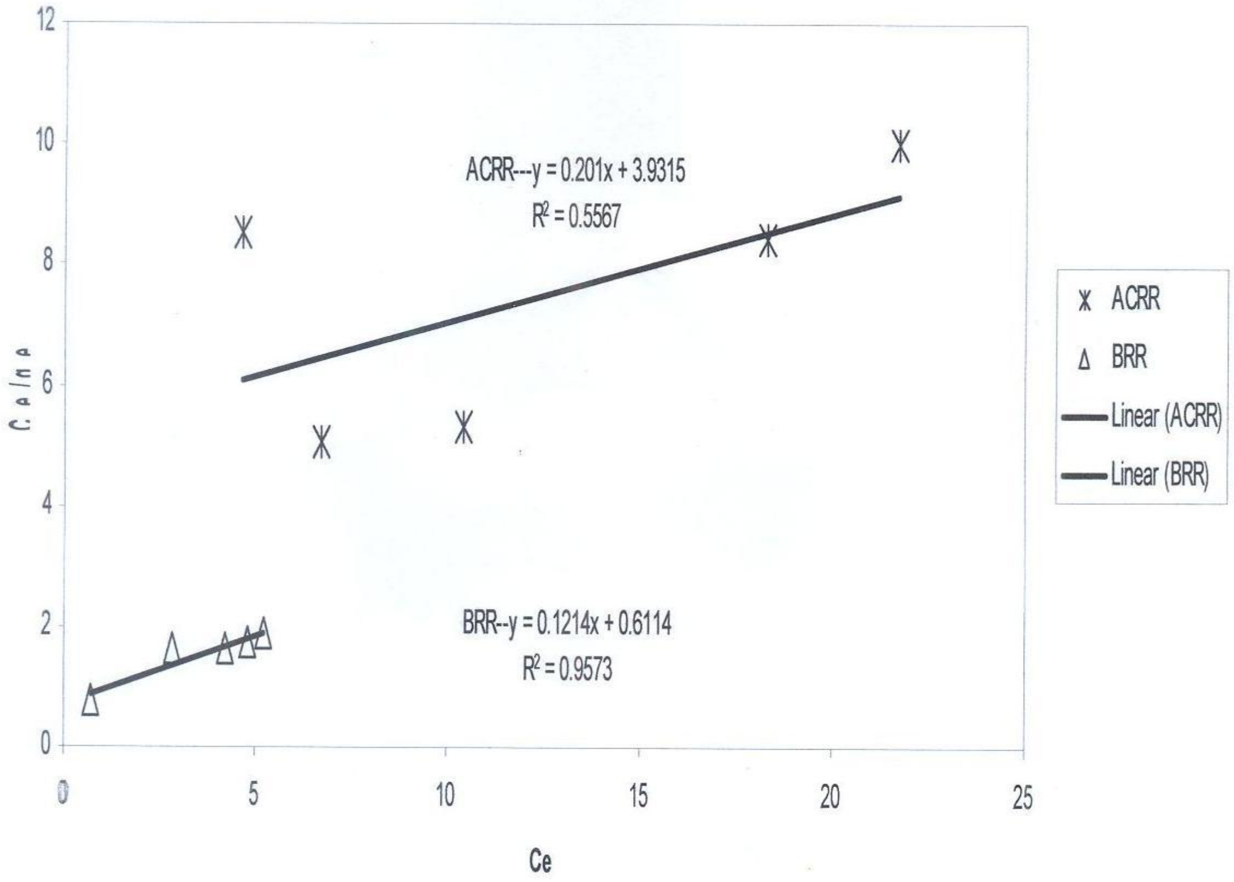


Figure 19: Plots of Langmuir Model for DB6

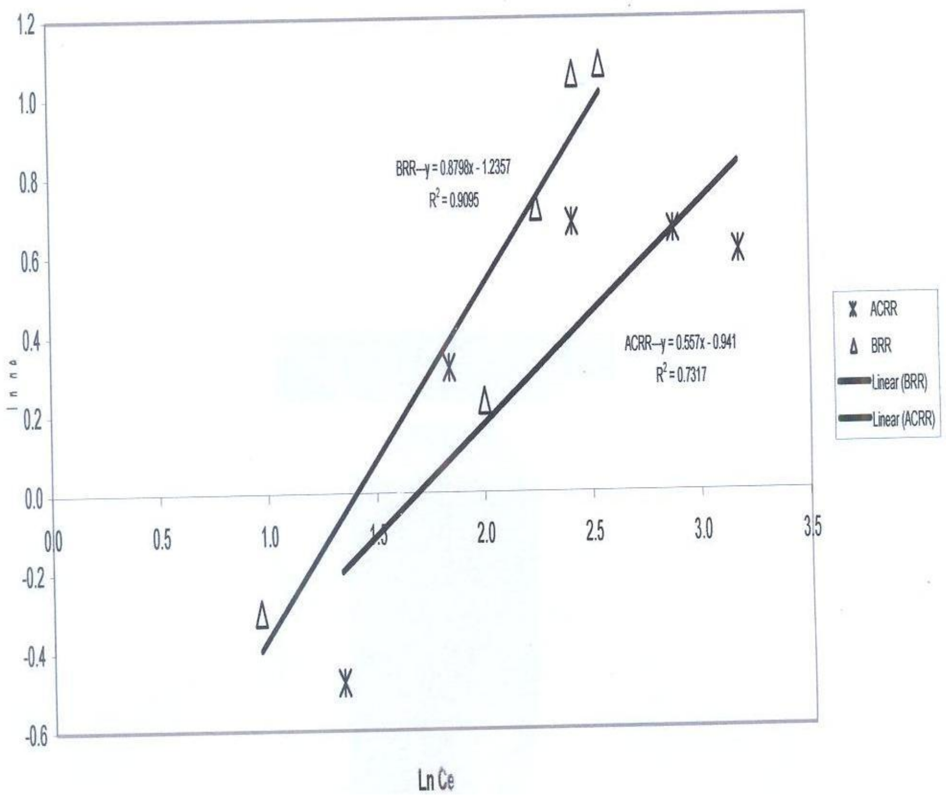


Figure 20: Plots of Freundlich Model for BG4

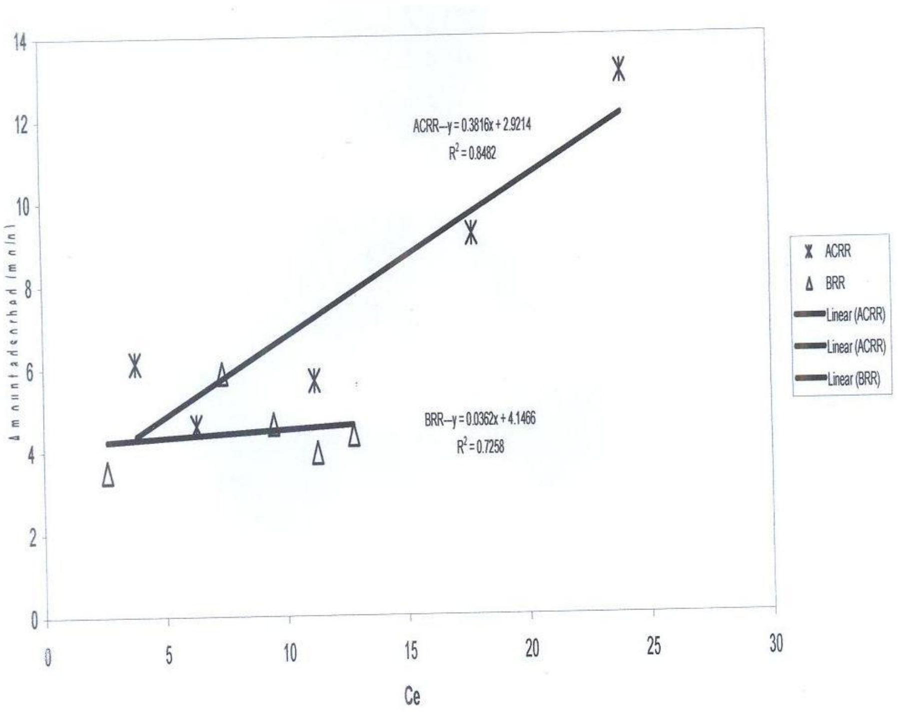


Figure 21: Plots of Langmuir Model for BG4

The various Freundlich and Langmuir constants for all the adsorbate-adsorbent systems calculated are shown in table 4.

TABLE 4: Freundlich and Langmuir Constants for the various Adsorbent/Adsorbate systems showing the R_L^2, R_F^2, K_L, K_F, q_{max} and n values from the isotherms. (The values given are average for different concentration)

Adsorbate	Adsorbent	K_F (mg/g)	K_L (dm3/g)	q_{max} (mg/g)	n	R_F^2	R_L^2
BG_4	ACRR	0.29063	1.30	2.162	1.936	0.9095	0.0258
	BRR	0.39024	1.36	2.6205	1.79533	0.7317	0.8482
DB_6	ACRR	0.1984	29.80	3.237	1.79791	0.9755	0.9573
	BRR	0.22440	25.11	4.9751	1.25628	0.7784	0.2567
DB_{26}	ACRR	0.035	22.51	6.78887	1.64204	0.8811	0.4066
	BRR	0.100102	12.61	1.30829	0.18970	0.8373	0.9065

These values are similar to those obtained by (Jadhav and Vanjara, 2004)

The results for the pH dependence study as shown in shown in figs 8, 9 and 10, revealed that while the adsorption of DB6 and BG4 on both adsorbents change with change in pH of the solution, the adsorption of DB26 on the biomass (BRR) remained fairly constant with changes in pH. However, the adsorption of DB26 on ACRR had shown a strong dependence on pH of the solution (fig 11). DB6 showed higher adsorption levels at lower pH whereas BG4 showed higher adsorption levels at higher pH. This is because with decrease in pH the surface of the adsorbents got protonated. The negatively charged DB6 therefore, showed greater adsorption at lower pH because of positive-negative electrostatic interaction. Positively charged BG4 had lower adsorption at lower pH due to repulsion between positively charged adsorbents and positively charged adsorbate. Adsorption of DB26 on the biomass was not much affected by charge in pH suggesting that the interaction might be hydrophobic in nature.The average values of both Freundlich and Langmuir constants for the various adsorbent dye systems are shown in table 4.The optimum conditions for the adsorption dye stuff on BRR and ACRR based on the experimental results are shown in table 5.

Table 5: Optimum conditions for the adsorption of Crude Oil, Heavy Metalsm, and Dyes on BRR and ACRR.

Parameters	Pollutants	Adsorbents	
		ACRR	BRR
Heavy Metals			
Temperature (°C)	Ni	70	40
	Cd	70	40
	Pb	70	40
Contact Time (min)	Ni	30	15
	Cd	30	15
	Pb	45	30
pH	Ni	7	5
	Cd	5	5
	Pb	7	6
Crude Oil			
		ACRR	**BRR**
Concentration (ppm)		1600	2000
Contact time (min)		2	2
Temperature (°C)		38	30
Dyes			
		ACRR	**BRR**
Concentration (ppm)	Direct Blue 6 (DB6)	2	2
	Basic Green 4 (BG4)	5	6
	Disperse blue 26 (DB26)	5	Adsorption constant with pH change
Contact time (min)	Direct Blue 6	1.5	1.0
pH	Direct Blue 6 (DB6)	2	2
	Basic Green 4(BG4)	5	6
	Disperse Blue 26 (DB26)	5.5	Constant

SINGLE FACTOR ANALYSIS OF VARIANCE (ANOVA)

The summary of results of statistical analysis for the single factor ANOVA applying Microsoft excel is presented in table 6.

Table 6: Analysis of Variance (ANOVA) using the Langmuir Plot values of q_e for the different Adsorbent/Adsorbate Systems Applying the Microsoft Excel at 95% confident level.

DYES: DISPERSED BLUE 26 (DB 26)

ANOVA: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
BRR	5	13.51	2.702	1.89507
ACRR	5	11.96	2.392	3.91117

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.24025	1	0.24025	*0.0828	0.780908	5.317655
Within Groups	23.22496	8	2.90312			
Error	0.0044	7	6.29×10^{-4}			
Total	23.46961	16				

DYES: BASIC GREEN (BG4)
ANOVA: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
BRR	5	9.86	1.972	0.94357
ACRR	5	7.73	1.546	0.32603

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.45369	1	0.45369	*0.7147	0.422451	5.317655
Within Groups	5.0784	8	0.6348			
Error	0.00343	7	4.9×10^{-4}			
Total	5.53552	16				

DYES: DIRECT BLUE 6 (DB6)
ANOVA: Single Factor
SUMMARY

Groups	Count	Sum	Average	Variance
BRR	5	10.73	2.146	0.64458
ACRR	5	8.17	1.634	0.49253

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.65536	1	0.65536	*1.1527	0.314303	5.317655
Within Groups	4.54844	8	0.568555			
Error	0.00335	7	4.79×10^{-4}			
Total	5.20715	16				

*= There is no significant difference between the variables since F is less than F crit **= There is a significant difference since F is greater than Fcrit

The single factor ANOVA results indicate that n significant difference was obtained for the adsorption of the three dye stuff (DB26, DB6) between the two adsorbents BRR and ACRR. This means that BRR can replace ACRR as adsorbent for any of the dyes investigated and statistically, the same level of efficiency can be achieved.

THE SEPARATION FACTORS (S_F)

To find a quantitative interpretation of the adsorbate/adsorbent interactions observed, the favourability or unafavourability of the adsorption system was predicted using an essential feature of the langmuir isotherm called the separation factor (S_F). Table 7 gives the calculated separation factors values for the different dry-adsorbent systems.

Table 7: The calculated separation factors (S_F) values of the different adsorbate/adsorbent systems

Adsorbate	Adsorbent	K_L (dm^3/mg)	Values of S_F	Types of Isotherm	Predominant Adsorption Mechanism
Nil	ACRR	$1.06\text{x}10^{-4}$	1	Linear	Physisorption and Chemisorption
	BRR	$-4.6\text{x}10^{-3}$	1.198	Unfavourable	Adsorption may not be possible
Cd	ACRR	$1.18\text{x}10^{-4}$	1	Linear	Physisorption and Chemisorption

	BRR	$6.51x10^{-3}$	0.813	Favourable	Physisorption
Pb	ACRR	$1.68x10^{-3}$	1	Linear	Physisorption and Chemisorption
	BRR	$8.6x10^{-4}$	0.764	Favourable	Physisorption
BG4	ACRR	$1.3x10^{-3}$	1	Linear	Physisorption and Chemisorption
	BRR	$1.36\ x10^{-3}$	1	Linear	Physisorption and Chemisorption
DB6	ACRR	$2.98\ x10^{-4}$	1	Linear	Physisorption and Chemisorption
	BRR	$2.51\ x10^{-4}$	1	Linear	Physisorption and Chemisorption
DB26	ACRR	2.25 x104	1	Linear	Physisorption and Chemisorption
	BRR	$1.26\ x10^{-4}$	1	Linear	Physisorption and Chemisorption
CRUDE OIL	ACRR	$3.2x10^{-3}$	0.897	Favourable	Physisorption
	BRR	$8.2x10^{-3}$	0.772	Favourable	Physisorption

The interaction between each of the dyes and each of the adsorbents investigated appeared to be a linear relationship. The possible interactive process therefore might have been a mixture of physisorption and chemisorption mechanisms since the S_f values are unity, 1.The results obtained in this study were compared with those of Jadhav and Vanjara (2004), a commercial grade adsorbent. The comparison is shown in table 8.

Table 8: Comparing Freundlich Constants for Adsorption of dyes between Jadhav (2004) and Kinigoma, (2007).

Absorbate	Adsorbent	Jadhav & Vanjara (sawdust)			Kinigoma (bark of *Rhizophora* root)		
		K_F (mg/g)	n	R^2	K_F (mg/g)	n	R_F^2
DB_6	BRR	0.131	0.941	0.982	0.224	1.256	0.778
	ACRR	2.530	2.599	0.947	0.198	1.797	0.975
BG_4	BRR	0.015	0.621	0.945	0.390	1.795	0.731
	ACRR	3.842	2.045	0.879	0.290	1.936	0.909
DB26	BRR	0.375	1.295	0.968	0.100	0.189	0.837
	ACRR	0.410	1.458	0.811	0.035	1.642	0.881

The closeness in the values of Freundlich constants obtained in Kinigoma, 2008 and those of Jadhav and Vanjara, 2004, both using different plant based adsorbents, has that was no remarkable indication difference between the operational efficiency of the *rhizophora* based adsorbents and other established ones.

IV. CONCLUSIONS

[1] The study has shown in comparative terms the effectiveness and efficiency of both biomass and activated carbon of the bark of *rhizophora* root as sorbent materials in uptaking dyestuff as petroleum industry effluent contaminants. This was validated by the level of agreement of the different adsorption constants and favourability factors.

[2] The adsorption of BG4 and DB6 dyes on the biomass and activated carbon adsorbents and also the adsorption of DB26 on the carbon is influenced by change in pH of the solution, where as adsorption of DB26 on biomass is not affected by change in pH of solution.

[3] A single factor analysis of variance (ANOVA) showed that there was no significant difference in the sorption behaviour of the three dyes on both adsorbents.

[4] These novel adsorbents have been found to compared favourably with commercially available grades and can therefore serve as alternatives to the more expensive and imported conventional one.

[5] The results obtained in this study are relevant for the optimal design of dye effluent treatment plant and also for the predication of model parameters of sorbate sorbent interactions.

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Propane A Replacement Refrigerant For Cfcs and Hcfcs

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ABSTRACT : *The importance to protect our world and control global warming, has necessitated this research work. The use of CFCs and HCFCs as refrigerants, attack, deplete the ozone layer and aids global warming. The use of hydrocarbon- propane as a refrigerant with zero; ozone depletion potential (ODP), global warming potential (GWP) less than three. This will ensure a cleaner and safer environment. It will provide a use for propane gas being flared.*

Keywords: *attacks, global warming, protect, ozone layer, safer environment.*

I. INTRODUCTION

The concept of refrigeration is very important and can be described as one of the greatest achievements of scientists in the twentieth century. It has a variety of applications ranging from refrigerating of water, drinks to air conditioning. Mechanical refrigeration has been around since the mid-nineteenth century. The first practical machine was built by Jacob Perkins 1834 (Thevenot, 1979). It was based on using ether as a refrigerant in a vapour compression circuit. Carbon (iv) oxide (CO_2) was also used as a refrigerant in 1866 and ammonia (NH_3) in 1873. Other chemicals used as vapour compression refrigerants include chymgene (petrol, ether and naphtha), sulphur (iv) oxide (R-764) and methyl ether. Their applications were limited to industrial processes. Most food preservation was accomplished by using blocks of ice collected during and stored or manufactured through an industrial process (McQuay, 2002). By the beginning of the twentieth century, refrigeration systems were being used to provide air conditioning in major building projects. The Milam building in San Antonio, Texas was the first high-rise offices to be completely air conditioned (Pauken, 1999).In 1926, Thomas Midgely developed the first CFC (chlorofluorocarbons), R-12. CFCs were non-flammable, non toxic (when compare to sulphur iv oxide) and efficient. Commercial production began in 1931 and quickly found a home in refrigeration. Wills Carrier developed the first centrifugal chiller for commercial use and the era of refrigeration and air conditioning began. Unfortunately. The CFCs and HCFCs are so stable that when discharged to atmosphere the molecules diffuse to the stratosphere before being ultimately decomposed by ultraviolet radiation. It has now been found that the liberated chlorine atoms attack the ozone layer which protects the Earth from that radiation – and moreover by a chain reaction wherein every chlorine atom breaks up about 105 ozone molecules (Rogers and Mayhew, 1992).By the mid 1970s concerns began to surface about the thinning of the ozone layer and whether CFCs may be in part responsible. This led to the ratification of the Montreal protocol in 1987 that required the required the phase out of CFCs HCFCs. (McQuay 2002). In the 1990 global warming arose as the threat to all well being of the planet.

II. MATERIALS AND METHOD

Materials used for this research include mild steel plates guage-22, aluminum sheet, angle iron-2cm, fibre-cork board, copper tubing 0.9mm to 1.0mm, propane R-290, as refrigerant, ¼Hp rating compressor. These materials can be sourced and bought locally from the market.The cabinet unit being the main structure of the freeze carries the other units, therefore it must be constructed to be rigid. First, the angle iron is used to frame the structure length 70cm, height 60cm, and weight 50cm. Then the mild steel plates are used as the main outer plate and the base plate. A recess of dimension (50x25x25) cm, the seating for compressor. The fibre-cork board is then placed inside the main outter plate, before the aluminum plate which is used as the inner plate which is folded round with the copper/capillary tubings-space at 7.00cm from one another.

The inner plate of aluminum and folded copper tubing is attached to the insulator with the use of an appropriate adhesive. The door unit is the most stressed part of the structure being subjected to mechanical opening and closing stress cycle all the time. As a result, the unit is usually the first to show signs of mechanical fatigue/failure before the other structural members. The vulnerability to antique stresses is a function of the height of the unit amongst others.Therefore, the design of the door unit is directed at reducing the height of the unit as mush as possible and its rigidity. The dimension length 70cm, weight 50cm, and thickness 2cm. Double walled with fibre-cork in between the outside mild-steel plate and aluminum plate thickness of insulator cork - 2cmThe copper tubing is connected to the compressor and other refrigeration cycle components – evaporator condenser and expansion value. A simple vapour compression refrigeration system cycle with superheated vapour before compression.

III. REFRIGERANT

A refrigerant can be described as any substance having thermodynamic properties, capable of changing state from liquid to gaseous state and vice-versa with the resultant refrigerating effect and heat rejection at different stages of the process. Another important property which is critical for refrigerants, is its compatibility with the environment.

Refrigeatant Number[a]	Chemical Name[a]	Chemical Formula[a]	Molecular Mass[a]	Safety Group[a]	Atomspheric Lifetime[b] (yrs)	ODP[c]	GWP
11	Trichlorofluoromethane	CCl_3F	137.4	A1	50	1	3800
12	Dichlorofluoromethane	CCl_2F_2	120.9	A1	102	1	8100
22	Chlorodifluoromethane	$CHClF_2$	86.5	A1	12.1	.055	1500
32	Difluoromethane	CH_2F_2	52	A2	5.6	0	650
123	2,2-dichloro-1,1,1-trifluoroethane	$CHCl_2CF_3$	153	B1	1.4	.02	90
125	Pentafluoroethane	CHF_2CF_3	120	A1	32.6	0	2800
134a	1,1,1,2-tetrafluoroethane	CF_3CH_2F	102	A1	14.6	0	1300
245fa	1,1,2,2,3-pentafluoropropane	$CHF_2CH_2CF_3$	134.05	B1	8.8	0	820
290	Propane	$CH_3CH_2CH_3$	44	A3	<1[n]	0	0

Table 1 – Refrigerant properties

Source :

[a]ASHRAE, 1997.ANSI/ASHRAE Standard 34-1997. Designation and Safety Classification of Refrigerants Atlanta, Ga: ASHRAE

[b]1995 IPCC Report HFCs Table 2.9: CFCs and HCFCs Table 2.2 (Houghton et al.,1996)

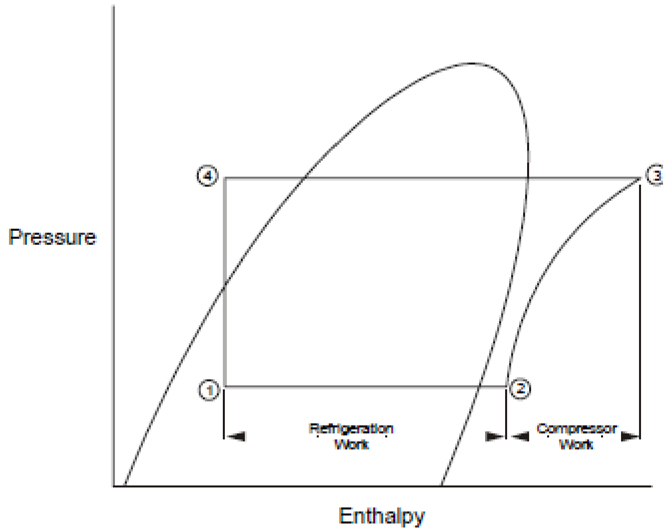
[c]Ozone Secretariat UNEP (1996)

IV. BASIC COMPONENTS OF VAPOUR COMPRESSION CYCLE

The basic components of the vapour-compression cycle include: evapourator, compressor condenser and expansion device. Evapourator this is a heat exchanger that removes the built-up heat from the chilled water/food substance, there-by lowering the water/food substance temperature in the process. The heat is used to vapourize the refrigerant, changing it from liquid to gas (vapour).Compressor, the compressor assembly is made up of a prime mover (typically an electric motor) and a compressor. The compressor raises the pressure and temperature of the refrigerant gas. Condenser similar to the evapourator, the condenser is a heat exchanger. In this case, it removes heat from the refrigerant causing it to condense from gaseous state to liquid. The heat raises the water temperature. The condenser water then carries the heat to the cooling tower where the heat is rejected to the atmosphere. Expansion Device after the refrigerant condenses to a liquid, it passes through a pressure-reducing device. This can be as simple as an orifice plate or as complicated as an electronic modulating thermal expansion valve.

Pressure-Enthalpy Diagram : the Pressure-Enthalpy (P-H) diagram is used to analyze the refrigeration cycle. It is a very important tool for refrigeration, as the various processes are clearly identified in Figure 1. It shows the Pressure-Enthalpy (P-H) diagram for the refrigeration circuit shown in Figure 1. The process for each of the components is indicated. The evapourator process is from point 1 to point 2. As the refrigerant changes from a liquid to gas, the pressure (and temperature) remains constant. The heat is being absorbed as a phase change (latent energy). The refrigeration effect is the change in enthalpy from 1 to 2, simply expressed as Btu/lb. of refrigerant circulated. The line from 2 to 3 represents the compression process. The work is the change in enthalpy from point 2 to 3; times the flow of refrigerant. Simply, Btu/lb. times the lb./min equals compressor power. Compressors end up with the work of compression as heat in the refrigerant. The vertical aspect of the curve shows the rise in refrigerant pressure (and temperature) from 2 to 3. The next process takes place in the condenser. The first section (outside the refrigerant dome) is the de-superheating process. Once the refrigerant is saturated, condensation occurs and the refrigerant changes from a gas to a liquid. Like the evapourator, the line is horizontal indicating constant pressure (or temperature). The final process is the expansion device. This appears as a vertical line from point 4 to 1, indicating the pressure (and temperature) drop that occurs as the refrigerant passes through the Thermal Expansion (TX) valve (McQuay, 2002)

Figure 1 Refrigeration Circuit, P-H Diagram



Required Parameters
Total cooling load,
Refrigerating effect,
Mass flow rate of refrigerant,
Compressor power,
Coefficient of performance of the freeze, and
Volume flow rate of air/heat rejection at the condenser.
Derivative and Calculations
Product Data

Product	= meat and fish products
Relative humidity (R.H)	= 85%
Average density	= 1,060kg/m^3
Storage temperature	= -1.1 to 0.5^{o}C
Cp above freezing point	= 3.7681kj/kgk
Cp below freezing point	= 1.92593kj/kgk
Latent heat (L)	= 290.75kj/kgk

Maximum product load (W_{max}) = Maximum volume occupied X density of the product
Maximum Volume = Volume of freeze – Volume of compressor compartment
= (70 X 60 X 50) – (25 X 25 X 50)
= 210,000 – 31,250
= 178, 750cm^3
= (178,750)/(100)^3
= 0.178750m^3
W_{max} = 0.17875 X 1,060 X 0.4
= 75.79kg

= 76kg

The 0.4 has been used to multiply, because the compartment that is to be cooled is 40% of the volume of the freeze.

Product Load

Product load is given as the sum of : heat given off by the product in cooling from entering temperature , heat given off by the product in freezing, that is latent heat of fusion, and heat given off by product in cooling from its freezing temperature to the final temperature.

Q $= q_1 + q_2 + q_3$
$= MCp(T_2 - T_1) + ML + MCp(T_2 - T_1)$
= (76 X 3.76812(30- - 2.2)) + (76 X 290.75) + (76 X 1.92593 X (-2.2 - -20))
= (76 X 3.76812 X 32.2) + (76 X 290.75) + (76 X 1.92593 X 17.8)
= 9221.34 + 22097 + 2605.40
= 33,923.74kj

Using a freezing point of 13hours for the whole content of the compartment to freeze.
= Q/(13 X 60 X 60)
= 33923.74/(13 X 60 X 60)
= 0.7249kw

Temperature(^oC)	Liquid	Evaporating	Saturated vapour
-20	46.3	400.5	446.8
-10	70.4	388.0	458.4
40	203.1	306.5	509.6

Table 2: Extract of saturated propane enthalpies

Source : Michael, J.M, et al , 8TH September, 2011.

Enthalpies of propane from saturated table of propane for the design:
h_1= 46.3kj/kg, h_2 = 446.8kj/kg , h_3 = 509.6kj/kg, h_4 = 203.1kj/kg

Refrigerating Effect

Refrigerating effect $= h_2 - h_1$
= 446.8- 46.3
=400.5kj/kg

Mass Flow Rate (m)

The mass flow rate of refrigerant is related by the equation
$m(h_2 - h_1)$ = total cooling laod
m = Total cooling load $/(h_2-h_1)$
= 0.7249/(446.8 -46.3)
= 0.7249/400.5
= 0.0018099kg/s

Compressor Power (Pc) $= m (h_3-h_2)$
Pc $= m(h_3-h_2)$
= 0.0018099 (509.6 – 446.8)
= 0.0018099 x 62.8
= 0.11366172kw

1kw = 4/3Hp
? = 4/3 X 0.1137
= 0.15155Hp

For safety, a compressor of ¼ Hp is selected.

Coefficient of Performance (COP)
COP $= (h_2 - h_1)/(h_3-h_2)$
= (446.8 - 46.3)/(509.6 – 446.8)
= 400.5/62.8
= 6.377

Heat Rejection at the Condenser (Qr)
The heat rejected at the condenser Qr $= m(h_3-h_4)$
= 0.0018099 (509.6 – 203.1)
= 0.0018099 X 306.5

= 0.554734kw

V. CONCLUSION AND RECOMMENDATION

From the analysis, it is evident that propane can be used as a refrigerant with good and reliable thermodynamic properties. The utilization of the propane gas, will help control gas flaring from refineries and the Niger-Delta region of Nigeria. Also, an environmentally friendly deep freeze is obtained for the tropics. Again, demand for refrigeration services are on the increase and essential for industrialization and attainment of becoming one of the top twenty economies by 2020. Practices, such as this will help check global warming and eliminate the possibility of endangering lives.

The following recommendations are made:

- More emphasis be laid on the development/learning to enhance refrigeration services in technical schools and tertiary institutions,
- Adequate funding through provision of facilities, equipment and manpower,
- Incentives such as better remuneration should be given to refrigeration workers,
- Giving of soft or interest free loans to entrepreneurs of refrigeration and tax holidays as incentives.

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Effects of Oil Spillage on Groundwater Quality In Nigeria

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Abstract: - The purpose of the study was to ascertain the effect of oil spillage on groundwater quality in the oil producing Niger Delta region of Nigeria. The study was carried out in Abacheke community in Egbema Local Government area, Imo state.Water Samples were collected forquality analysis in boreholes/wells at three locations A, B, C. Locations A and B are areas with history of spillage while C is a location downstream with no history of oil spillage. The following parameters were tested for; physical parameters (temperature and turbidity), inorganic constituents (Conductivity, PH, TDS, DO, BOD, Mg, and P) and organic constituents (Total hydro-carbon)The results showed the some parameters exceeded the WHO permissible levels. Comparatively, Sample C had a lower value of hydrocarbon content (0.6 mg/l) while Samples A and B values were 0.9mg/l and 1.1mg/l respectively.The Turbidityvalue for sample C was 5 NTU compared to values of 14 and 18 NTU from samples A and B respectively. Results of PH test also showed that samples A and B were more acidic (5.56 and 5.98 respectively) than Sample C. The higher level of Turbidity and Total hydro-carbon for samples A and B isan indication of oil pollution which is attributable to incessant spillage. It is therefore necessary that appropriate treatment be carried out on the water samples to avoid adverse health effects.We also recommend that comprehensive groundwater monitoring should be carried out in the Niger Delta area and cleanup exercises carried outwhenever there is an oil spill to prevent infiltration of oil into the ground water.

Key Words: - *Oil, Spillage, groundwater, potable, pollution.*

I. INTRODUCTION

Oil exploration in Nigeria began shortly after independence in 1960. The oil sector has generated vital revenue that has contributed significantly to the country's growth (Anazie 2012). Irrespective of its significant contribution towards the country's economy, one should not lose sight of the fact of the tremendous hazards involved in its operations (Awosika, 1985)[1]

Oil spill is the release of liquid petroleum into the environment, especially marine areas to human activity and is a form of pollution (Vidal, 2003)[2]. It has been a major occurrence in Nigeria. The country recorded about 1020 incidents of oil spillage, which culminated in the loss of about 1,359,715 barrels of crude oil to the waste land and water of Niger Delta (Opafunso and Apena, 2000)[3]. Oil spillage in recent times has been a threat to human life, marine life, wild life and micro-organisms in the soil. It has seriously threatened human existence, especially those in the Niger Delta region of the country. Oil spillage is also a major threat to surface and ground water resources of the affected areas through infiltration and seepage, thereby reducing the quality of the affected resources. Oil spills on land are more readily containable but is also deadly due to infiltration which could percolate the underlying soil layers and thereby contaminating the groundwater (Anderson et al 2005)[4].

The major causes of oil spill in Nigeria are corrosion of pipelines and tankers (accounting for 50% of all oil spills), sabotage (28%) and oil operations (21%) with 1% of the spills being accounted for by inadequate or non-functional equipment (Nwilo et al, 2007)[5]. Many of the oil pipelines have been in place for over 30 years.area UNEP (2006)[6] summed the impact of oil spillage in the Niger Delta as follows; high mortality of aquatic animals, impairment of human health,loss of biodiversity in breeding grounds, vegetation hazards, loss of potable and industrial water resources, reduction in fishing and farming activities, poverty and rural unemployment. Virtually every aspect of oil exploration and exploitation has deleterious effects on ecosystem stability and local biodiversity.

Groundwater is a major source of water to many communities in Nigeria.Prolonged consumption of oil polluted water has adverse effect on the health of the consumers. Water with high level of hydrocarbon content may have negative effect on the kidney and liver of the consumers. Also poor reproductive system, leukemia, increased blood pressure and reduced blood clotting are associated with oil polluted water. It is important to note that groundwater pollution from oil spill is not always amenable to total clean up. It is therefore safer and wiser to prevent its occurrence.

This study was carried out in Egbema Local Government area, Imo state. Oil was discovered in Egbema territory in 1973 when Shell found oil in the area. Shell Petroleum and Development company, Cheveron Nigeria Ltd and Agip oil company Ltd are the major players in the oil extractive industry in Egbema having secured the oil mining licence (OML) covering the entire Egbema land(Abbey and Anthony, 1974)[7]. From 1973 to 2007, twenty incidents of oil spill were recorded in Egbema [8]. This has led to adverse environmental effects. The most profound and adverse impact of oil pollution in Egbema with far reaching implications on all other aspects of our traditional lifestyles and livelihoods had been the total loss of biodiversity and destruction of habitats largely due to soil degradation (Ogboghodo et al, 2004)[9].

The study was focused on assessing groundwater quality in the study area with a view to ascertaining the nature and extent of the impacts of oil spillage.The analysis was based on World Health Organisation standard for potable water.

II. MATERIALS AND METHODS

Studies were carried out in Abachekecommunity in Ohaji/Egbema Local Government Area of Imo State .Three samples A, B, and C were collected at strategic points for quality analysis. Samples.A and B were collected at the downstream section at locations with history of oil spillage while sample C was collected from the upstream section of the study area.Samples A and B were collected from public wells, while Sample C was collected from a public boreholeThe following parameters were tested for;physical parameters (temperature and turbidity), inorganic constituents(Conductivity, PH, TDS, DO, BOD, Mg, and P), and organic constituents (Total hydrocarbon)

Onsite measurement was carried out forPh, temperature, dissolved oxygen. The portablePH meter was used in measuring the level of acidity or alkalinity. Electrical conductivity, which is a measure of the ability of the aqueous solution to carry an electric current, was measured using a digitalconductivity meter. 200 ml of sample was placed in a 250 ml beaker, and the probe was inserted to read the conductivity in µS/cm. Total dissolved solid was estimated (in mg/l) by multiplying the conductivity by factor of 0.55.. The turbidity meter was used to measure turbidity. The cell was rinsed with distilled water and the sample poured to the cell mark and the most stable value read.

Calcium and Magnesium content was determined by heating 25 ml of water mixed with 1 ml concentration of Hydrochloric acid to reduce the original volume to 1/3 the original volume. After cooling 5ml of Ammonium Acetate was added and 2ml of Phenothroline solution was added. The entire solution was now transferred to a 25ml measuring cylinder and sent to spectrophotometer for reading at wavelength of 510 mm. Calorimetric method was adopted for phosphate determination. Stannous chloride solution was used.

The BOD was determined using Winklers solutions, starch indicator, concentrated hydrochloric acid and sodium triosulphate solution. The BOD5 was computed as

$$(DO - DO_5)_. P \qquad 1$$

Where DO = Dissolved oxygen concentration at zero time

DO5 = Dissolved oxygen concentration at 5days incubation period

P = Dilution factor

To determine total hydrocarbon, 1000mls of water was collected from the field and poured into a separatory funnel. 50ml of Xylems was added to it and shaken vigorously before the same quantity was added again. The solution was allowed to settle for about 15mins. Thereafter the oil and xylem (extracted) was collected and sent to Spectrometer for reading.

III. RESULTS AND DISCUSSION

Tables 1- 3 showresultsof tests on physical parameters, inorganic and organic constituents of the samples. The results were compared with WHO guidelines for potable water. `

In case of physical characteristics, Samples A and B with history of oil spillage show high turbidity of 14 NTU and 8 NTU which exceeds WHO maximum value of 5 NTU.(Table 1). The pH values of samples A and B shows that the samples were relatively more acidic compared to sample C. The background level of phosphorus was not found because there is little potential for phosphorus to leach through the soil into the ground. Soil particles have a large capacity to fix phosphorus in forms that are immobile in soil. Most solids filter out soluble phosphorus and water passes through the soil profile into the ground.

The dissolved oxygen levels of samples A and B were quite low and cannot support desired aerobic organisms in the study area. This may upset the ecosystem encouraging development of septic conditions and subsequently produce anaerobic condition in the ground water. On the other hand the dissolved oxygen level of sample C could support aerobic organism in the study site. The difference in the value of dissolved oxygen in Samples A, B and C could be as a result of oil spillage which affected samples A and B locations. The BOD value of sample is also relatively higher than that of samples A and B The high concentration of Total hydrocarbon content (oil and grease) (Table 3) in samples A and B is an indication of oil pollution as a result of the spillage.

IV. CONCLUSIONS AND RECOMMENDATIONS

The effect of oil pollution on ground water was investigated by collecting water samplesfrom boreholes with history of oil spillage These samples were analyzed for physical and chemical properties. Results showedthat the Total Hydrocarbon Content (THC) for the oil polluted sites are higher than the value of THC from the control site where there was no oil spillage. This is a strong indication of pollution. Other indications of oil pollution are low dissolved oxygen levels and pH which exceed WHO Standard. Results of the study showed that the groundwater of the study area is contaminated as a result of oil spillage. The effects on the indigenes may depend on the extent of consumption and their previous health history. If treatment is not considered as soon as possible, there is no doubt that these health problems may cause low life expectancy and affect the productivity of the study area.It is therefore recommended that detailed medical test be carried out in the project area to ascertain the health of the people.

Comprehensive groundwater monitoring should be carried out and adequate treatment should be implemented. The Government should carry out cleanup exercise immediately there is spillage in order to prevent infiltration of oil into the groundwater. Oil spill prevention, containment and countermeasures should be put in place.

Table 1 Physical Parameters

Parameter	Unit	Max permitted level (W.H.O guideline)	Sample A	Sample B	Sample C
Temperature	Celsius	Ambient	25	24.9	25.5
Turbidity	NTU	5	14	8	5

Table 2 Inorganic Constituents

Parameter	Unit	Max. Permitted Level (WHO)	Sample A	Sample B	Sample C
Conductivity	µs/cm	1000	54.4	21.8	292.7
pH		6.5 - 8	5.98	5.56	6.56
TDS	mg/l	600-1000	30	12	161
D.O	mg/l	7-14	3	2	6.5
BOD	mg/l	0.8-5	2.0	2.4	2.668
Magnesium	mg/l	30	4.1	3.0	20
Calcium	mg/l	75	2.8	0.4	13.9
Available Phosphorous	mg/l	0.15	-	-	-

Table 3 Organic Constituents

Parameter	Unit	Max. Permitted Level (WHO)	Sample A	Sample B	
Total Carbon	Mg/l	0.007	0.9	1.1	0.6

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SCA based BASS: Using OMP

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Abstract: - This paper deals with under-determined blind audio source separation, which is solved using sparse representations. The sparse component analysis (SCA) framework is a powerful method for achieving this. First, the mixing matrix is estimated in the discrete cosine transform (DCT) domain by a clustering algorithm. Then a dictionary is learned by an adaptive learning algorithm. Here, the Greedy Adaptive Dictionary (GAD) algorithm is utilized. Using the estimated mixing matrix and the learned dictionary, the sources are recovered adopting l_2-minimization technique called Orthogonal Matching Pursuit (OMP) as the sparse signal recovery method.

Index Terms: - *Blind audio source separation, Sparse component analysis, dictionary learning, sparsity.*

I. INTRODUCTION

Over the past two decades, blind source separation (BSS) has attracted a lot of attention in the signal processing community, owing to its wide range of potential applications, such as in telecommunications, biomedical engineering, and speech enhancement (Hyvarinen et al., 2001; Cichocki and Amari, 2003). BSS aims to estimate the unknown sources from their observations without or with little prior knowledge about the channels through which the sources propagate to the sensors. The instantaneous model of BSS can be described as:

$$X = A\,S \qquad (1)$$

where $A \in R^{MXN}$ is the unknown mixing matrix assumed to be full row rank, $X \in R^{MXT}$ is the observed data matrix whose row vector x_i is the ith sensor signal having T samples at discrete time instants t=1,…,T, and $S \in R^{NXT}$ is the unknown source matrix containing N source vectors. The objective of BSS is to estimate S from X, without knowing A.

Many algorithms have been successfully developed for blind source separation, especially for the exactly or over determined cases where the number of mixtures is no smaller than that of the sources. Independent component analysis (ICA) is a well-known family of BSS techniques based on the assumption that the source signals are statistically independent. However, ICA does not work in the underdetermined case, where the number of mixtures is smaller than that of the sources.

Underdetermined blind speech separation is an ill-posed inverse problem, due to the lack of sufficient observations, i.e. the number of unknown speech sources to be separated is greater than the number of observed mixtures. Several approaches have been developed to address this problem, such as the higher order statistics based method in (Comon, 1998), the sparse representations based technique in (Zibulevsky and Pearlmutter, 2001; Bofill and Zibulevsky, 2001). Good reviews on using sparse component analysis for source separation can be found in (Gribonval and Lesage, 2006; Sudhakar, 2011).

The key idea of sparse signal representation is to assume that the sources are sparse, or can be decomposed into the combination of a small number of signal components. By sparse, we mean that most values in the signal or its transformed coefficients are zero, except for a few nonzero values. These signal components are called atoms or code words, and the collection of all the atoms is referred to as a dictionary. Finding the sparsest representation (i.e. the non-zero coefficients) which best approximates the observation is often an NP-hard problem (Donoho, 2006).

In this work, the observed mixture is transformed by applying short-time DCT and the mixing matrix is estimated by clustering. Also here, sparse coding based on learned dictionary is used to solve the problem of underdetermined blind speech separation. In particular, we propose a novel algorithm in which the BSS model is reformulated to a sparse signal recovery model. As a result, any of the state-of-the-art sparse signal recovery algorithms could be incorporated into this model to solve the underdetermined blind speech separation problem, with various separation performance and computational efficiency. This proposition was motivated by the failure of time domain algorithm called T-ABCD [1], in solving underdetermined BSS cases. It is an ICA framework along with k-means clustering [2], which found good results in determined cases.

II. PROPOSED METHOD

A. *Outline*

1. Apply short-time DCT to the mixture signal in X, for say, taking data frames of duration 25-35ms and an overlap of 10-15ms.
2. Estimate the mixing matrix, Â by K-means clustering of the normalized DCT coefficients.
3. A dictionary, Φ is learned on the transformed mixture signal by Greedy Adaptive Dictionary (GAD) algorithm.
4. Using Â and Φ, separate the sources by sparse signal recovery method, by reformulating the BSS problem into compressive sensing problem.
5. Reconstruction of separated sources by inverting the transform and the time domain signals are finally obtained.

The flow of the method is depicted in fig.1.

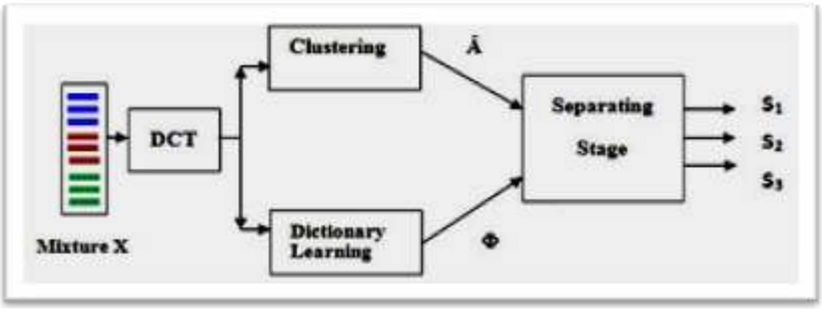

Fig .1 Flow of the proposed method.

B. *Steps in detail*

The transformed coefficients are undergone the three stage processing. It includes the mixing matrix estimation, dictionary learning and the source separation.

i. Mixing matrix estimation

The short-time DCT coefficients obtained in the first step are divided into *k* equal parts. Here *k* is equal to the number of sources and compute the mean values of each part as the initial centers. Run the K-means clustering algorithm to update iteratively the *k* centers until convergence and compute the column vectors of the estimated mixing matrix Â as the final centers.

ii. Adaptive dictionary learning

The dictionary atoms are obtained by using greedy adaptive dictionary (GAD) learning algorithm [3]. These obtained atoms can represent the features of the observed signal. GAD learns the dictionary atoms based on an iterative process using the sparsity index defined as follows:

$$\sigma_j = \frac{\|x_k\|_1}{\|x_k\|_2} \qquad (2)$$

where $\|.\|_1$ and $\|.\|_2$ denote the l_1 and l_2- norm respectively and x_k is the column vector of the matrix containing the short-time DCT coefficients. The sparsity index measures the sparsity of a signal, where the smaller σ_j , the sparser the signal vector x_k. The GAD algorithm begins with the definition of a residual matrix R^d. This is first initialized to the transformed input matrix. The dictionary is then built by selecting the residual vector that has the lowest sparsity index. Then it is normalized and added to the dictionary. Finally, the new residual is computed for all the columns. The process is repeated until the number of obtained atoms reaches a pre-determined value.

iii. Separating sources by sparse signal recovery

In the separating stage, with the estimated mixing matrix Â, the underdetermined blind speech separation problem is formulated as a sparse signal recovery problem [4]. Equation (1) can be expanded as:

$$\begin{pmatrix} X_1 \\ \vdots \\ X_M \end{pmatrix} = \begin{pmatrix} a_{11} & \cdots & a_{1N} \\ \vdots & \ddots & \vdots \\ a_{M1} & \cdots & a_{MN} \end{pmatrix} \begin{pmatrix} S_1 \\ \vdots \\ S_N \end{pmatrix} \qquad (3)$$

where x_i (i=1,…,M) are the mixtures, s_j (j=1,…,N) are the sources, and a_{ij} is the *ij*th element of the mixing matrix A. Rewriting the above equation as follows,

$$\begin{pmatrix} x_1(1) \\ \vdots \\ x_1(T) \\ \vdots \\ \vdots \\ x_M(1) \\ \vdots \\ x_M(T) \end{pmatrix} = \begin{pmatrix} \Lambda_{11} & \cdots & \Lambda_{1N} \\ \vdots & \ddots & \vdots \\ \Lambda_{M1} & \cdots & \Lambda_{MN} \end{pmatrix} \begin{pmatrix} s_1(1) \\ \vdots \\ s_1(T) \\ \vdots \\ \vdots \\ s_N(1) \\ \vdots \\ s_N(T) \end{pmatrix} \qquad (4)$$

where T is the length of the signal, $\Lambda_{ij} \in R^{TxT}$ is a diagonal matrix whose diagonal elements are all equal to a_{ij}. Let b= vec (X^T), f= vec (S^T), where vec is an operator stacking the column vectors of a matrix into a single vector. Equation (4) can be written in a compact form as:

$$b = M\,f \qquad (5)$$

The above equation can be interpreted as a sparse signal recovery problem in a compressed sensing model, in which M is the measurement matrix and b is the compressed vector of samples in f. Therefore, a sparse representation in the transform domain can be employed for f:

$$f = \Phi\, y \qquad (6)$$

where Φ is a transform dictionary and y contains the weighting coefficients in the Φ domain. Combining (5) and (6), we have

$$b = M\,\Phi y \qquad (7)$$

In eq.(7) if y is sparse ,the signal f can be recovered from the measurement b using an optimization process. This indicates that source estimation in the underdetermined problem can be achieved by computing y in (7) using sparse signal recovery (i.e. sparse coding) methods.
Here the l_2 –minimization is adopted to find the sparse solution y. Specifically, OMP (Orthogonal Matching Pursuit) is used here. The orthogonal matching pursuit (OMP) (Pati et al.,1993) was developed to improve the MP (Matching Pursuit) by projecting the signal vector to the subspace spanned by the atoms selected as in MP via the same method. The basic idea of MP is to represent a signal as a weighted sum of atoms using Eq. (8) which involves finding the "best matching" projections of multidimensional data onto an overcomplete dictionary,

$$b = \sum_{i=1}^{k} y_i q_{\gamma_i} + r^{(k)} \qquad (8)$$

where $r^{(k)}$ is a residual after k iterations, and q_{γ_i} is the atom of $M\Phi$ that has the largest inner product with the residual. At stage i, it identifies the dictionary atom that best correlates with the residual then subtract its contribution as follows,

$$r^{(i+1)} = r^{(i)} - y_i q_{\gamma_i} \qquad (9)$$

where $y_i = \langle r^{(i)}, q_{\gamma_i} \rangle$and $\langle , \rangle$ is an inner product operation. Then the process is repeated until the signal is satisfactorily decomposed. However, as opposed to MP, OMP maintains full backward orthogonality of the residual at each step when updating the coefficients:

$$b = \sum_{i=1}^{k} y_i q_{\gamma_i} + r^{(k)}, s.t. \langle r^{(k)}, q_{\gamma_i} \rangle = 0 \qquad (10)$$

As proven in (Pati et al., 1993) the necessary number of iterations for OMP to converge is no greater than the number of atoms in the dictionary, while MP does not possess this property. The eq. (6) can then be written as:

$$\begin{pmatrix} s_1(1) \\ \vdots \\ s_1(T) \\ \vdots \\ s_M(1) \\ \vdots \\ s_M(T) \end{pmatrix} = \begin{pmatrix} D_1 & & \\ & \ddots & \\ & & D_M \end{pmatrix} \begin{pmatrix} y_1(1) \\ \vdots \\ y_1(T) \\ \vdots \\ y_M(1) \\ \vdots \\ y_M(T) \end{pmatrix} \quad (11)$$

where $D_1,...,D_M$ are identical dictionaries, $S_1,\dots,S_M$ are the sources recovered and $y_1,\dots,y_M$ are the sparse solutions. Finally, the estimates of separated sources are obtained by inverting the transform.

III. RESULTS AND DISCUSSION

The proposed algorithm was tested for various types of speech and music signals. For objective quality assessment three performance criteria defined in the BSSEVAL toolbox [4] was used to evaluate the estimated source signals. These criteria are the signal to distortion ratio (SDR), the source to interference ratio (SIR) and the source to artifacts ratio (SAR) [5], defined respectively as:

$$SDR = 10\log_{10}\frac{\|s_{target}\|^2}{\|e_{interf} + e_{noise} + e_{artif}\|^2} \quad (12)$$

$$SIR = 10\log_{10}\frac{\|s_{target}\|^2}{\|e_{interf}\|^2} \quad (13)$$

$$SAR = 10\log_{10}\frac{\|s_{target} + e_{interf} + e_{noise}\|^2}{\|e_{artif}\|^2} \quad (14)$$

The experimental results are shown in the table 1.

TABLE 1 Separation performance measures

Sl.no.	**Mixture**	**SIR** (dB)	**SAR** (dB)	**SDR** (dB)
1.	I am_female_30s	0.0001	-79	0
	Poem _male	0.42	-44	-24.6
2.	Henry_theater_male	-3.16	-29	-44
	Poem _male	-165	-169	-156
3.	Music _signal_guitar	2.46	-28.6	-49.5
	Male _speech	0.00	-29	-26

The sources for the test are taken from [7]. The computational efficiency is improved when compared to STFT based and predefined dictionary based methods [6]. In general, separation performance highly depends on the mixing process. In this context, the accuracy of estimated mixing matrix is challenging.

The frame wise processing of data tremendously reduces the computation time whereas DCT provides good compression, so that less number of samples are undergone processing. The results are promising, even for this higher rate of compression. Also, the adaptive dictionary learns atoms with much faster rate compared to K-SVD [8].

IV. CONCLUSIONS

A multi-stage system for underdetermined blind speech separation using sparse coding with adaptive dictionary learning is presented. Numerical experiments have shown the competitive separation performance by the proposed method. The proposed method builds a new framework for underdetermined BSS, and offers great potential to accommodate the sparse signal recovery and adaptive dictionary learning algorithms to the source separation problems. This study has also shown the benefit of using learned dictionaries for underdetermined BSS, and the advantage of using the frame wise processing to improve the computational efficiency. Moreover, the framework of the proposed method provides a friendly structure to test the performance of other dictionary learning and signal recovery algorithms, specifically l_1 minimization techniques, in source separation applications in the future.

V. ACKNOWLEDGMENT

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Framework for The Integrated And Validated Model of Data Warehouse

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Abstract: - A Data warehouse has its own set of challenges for security. Organizational data warehouse are often very large systems. Once we have extracted and loaded the data from heterogeneous sources we need to integrated the data as it seems to similar but coming from the different sources. Validation is required at all the design phases of the development of the data warehouse. With the rapid development and implementation of the data warehouse, security problems arise in populating a warehouse with the enterprise data. For the periods many researchers work on the designing phases of the data warehouse but no research gathers the causes of the security issues. There are some malicious attempts and the vulnerabilities occurring at the levels of abstraction. In this paper we identified the malicious attempts and the vulnerabilities at validation phase through conceptual level modeling and propose the framework of the integrated and validated model of data warehouse.

***Keywords*: -** *Data warehouse, designing,modeling approaches, proposed model,security issues, validation*

I. INTRODUCTION

Data warehouse is integrated databases that is designed, organized and honed for retrieval and analysis of data use to support management decision making process [1]. Data warehouse contains the wide variety of data that an organization personnel can use to gain a better understanding of their conditions. A Data warehouse comprises the data that is subject oriented, integrated, time variant and non volatile.Data warehouse development Process conducted in an iterative form after the initialization of business requirements. Then it specifies the cyclical planning , Design, construction, testing and validation and then implementation [2]. The basic view of the development of data warehouse is shown in fig:1. In this paper, we are focusing on the validation process of the development cycle of data warehouse. Validation process helps to reconcile and validate the information before it enter for the implementation. It provides the resistance for the intruded information having some vulnerabilities from the external sources.

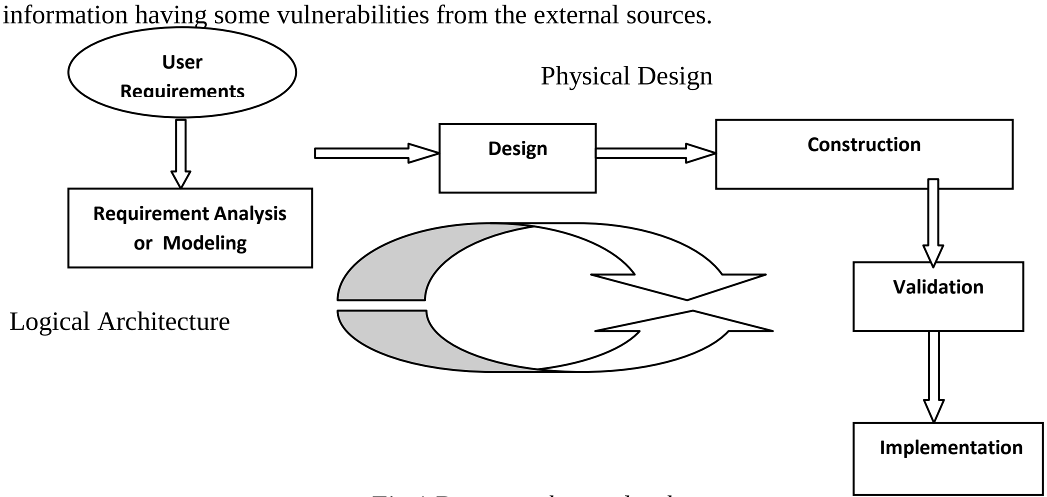

Fig.1 Data warehouse development process

Also there are some existing malicious acts at the same process of development that reduces the functionality and growth of the data warehouse environment [3]. So there is a need of security at the desired phase. To secure the personnel information, primary requirement i.e. CIA, business information, decision making information, usage, decisions and technical information. Some of the techniques at the various design faces can be use to provide the security which is mandatory for the development of the data a warehouse.
Section 2 focuses on the existing approaches on securing the data warehouse. Section 3 explains the dimensional modeling of data warehouse. Section 4 explains multi-dimensional modeling concept with the basic approaches. Further section 5 specifies the security issues. Section 6 explains the framework of the integrated and validated model of data warehouse. Section 7 has conclusion.

II. EXISTING APPROACHES ON SECURING THE DATA WAREHOUSE

This is done with the literature survey of the modeling approaches use to design the secure data warehouse. E.Soler faces on the requirement analysis for the data warehouse which includes the security requirements of the data warehouse by using the MDA approach [4]. A frame work for the requirement analysis upto the conceptual design face is proposed by Ariham Sarkar [5]. Here, the complexity arise in the development of the data warehouse as it is not supported the security of the data warehouse. The access control and audit model explains the security rules and authorization rules at the conceptual level only [6].
In automated data validation and data migration security the validation check of the existing data maintains the integrity of the data [3]. This validation can be done by the mapping and transformation methods. Validation is must at all the design phases upto the physical levels.

2.1 Dimensional Modeling

Dimensional modeling is a design concept used by many data warehouse designers to build their data warehouse [7].All data is contains in two types of table i.e fact table and dimension table.

Table	*Description*
1.Fact Table	• Stores the measures of the business and point to the key value. • Collection of related data items. • Consisting of measure s for the process of decision making.
2.Dimension Table	• Categories each item in a data set into non over-lapping region. • Contains master data with detailed information in a structure.

Dimensional Modeling is a model of tables and relations optimizing for decision support system also constituted to

1. Remove redundancy.
2. Facilitate retrieval of individual records.
3. Optimize OLTP.

2.2 Multidimensional Modeling

Multidimensional modeling is an integrated aspect of OLAP. It involves the analysis of selected facts or measures of the business area. Multidimensional modeling is a prominent factor in interactive analysis of large amount of data for decision making purpose. Basically multidimensional modeling is the foundation of the data warehouses [8]. In this section we are providing the brief reference of the most relevant models done before by the authors.

The dimensional fact model by Golfarelli et al.[9]. The multidimensional conceptual model by Enrico Franconi et al.[10]. The starER model by Tryfona et al.[11]. The model proposed by Abello et al.[12]. These approaches for multidimensional modeling considers security as an important issue but do not solve the problem of security at all stages of data warehouse development.

III. SPECIFIC SECURITY ISSUES

3.1 Malicious attempts

In the data ware house these attempts gains unauthorized controls of some ones computer [13]. These activities includes the personification of the unauthorized user which gains the access by :

a) Spoofing
b) Scanning
c) Masquerade
d) Snooping
e) Impersonalization
f) Tunneling
g) Scavenging
h) Denial of service(DOS)
i) Distributed Denial of Service(DDOS)
j) Password Cracking
k) SourceRouting.

3.2 Vulnerabilities

It is a junction of three classes a system susceptibility, attacker access, attacker capability to exploit the flaw. The vulnerabilities which spoil the behavior of data warehouse are as follows [18]:

a) Dual security engines:- Generates the complexities of security administration in data warehouse environment.
b) Interference attacks:- Posing out direct and indirect attacks.
c) Availability factors:- Deals with the confidentiality and integrity of data warehouse.
d) Human Factors :- Include the accidental and intentional acts.
e) Insider threats:- advisory who operates inside the trusted computing base, basically a trusted adversary.
f) Outsider threats:- outsider parties poses as unethical insiders.

IV. FRAMEWORK FOR THE INTEGRATED AND VALIDATED MODELFOR DATA WAREHOUSE

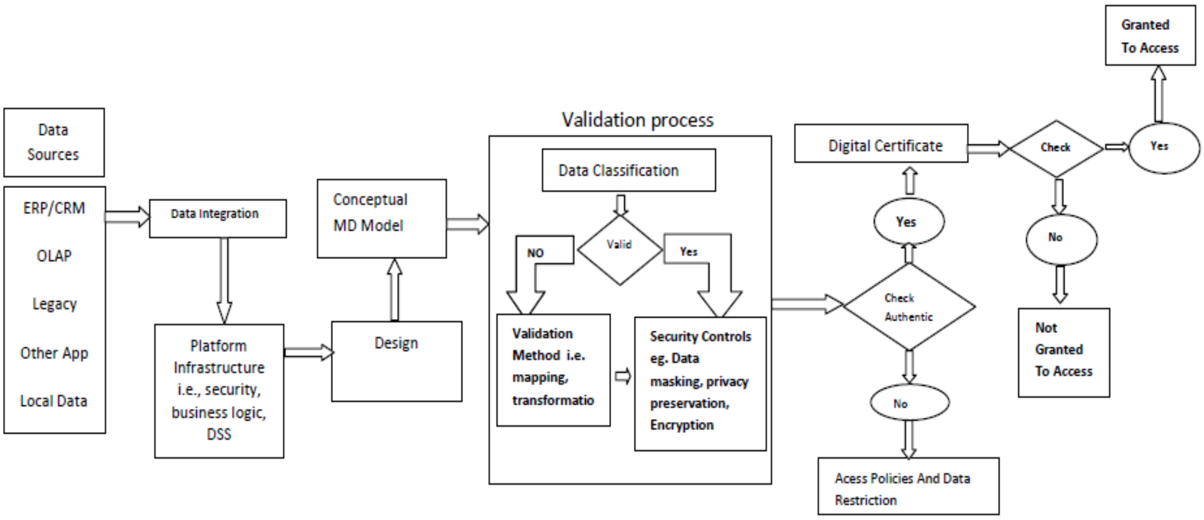

Fig: 2 Proposed model

4.1 Elaboration of the proposed model:

In this approach, the data integration is done as the data comes from the heterogeneous sources(ERP, OLAP, legacy, other applications, local data). To run the environment many issues comes into the picture like schema integration, redundancy, inconsistencies [14]. To maintain the integration of the system some of the tools are running in scenario naming as data scrubbing and data auditing tools. After the integration of the data, a platform infrastructure is built which includes the security, business logic and the decision support system. It is done at the requirement analysis phase. It manages the archieve data of different formats i.e., structured and unstructured [15]. To meet the requirement a standard platform is built in a particular behavior of the data warehouse environment. To maintain the consistency of the platform infrastructure, a regular format is fixed in a manner.

Data warehouse needs to be designed at the next level of the development process. It is the conceptual level designing. Many authors proposes there design at the conceptual level. In the conceptual muldimensional model, the specific OLAP applications has been discusses with the summarized features [16]. Modeling the requirements is the prominent factor in designing the model.

When the designing of the modeling is done, there is a need of validating the process. Validation of the process is required at each level of abstraction(conceptual, logical, physical). Validation helps to reconcile and validate the information before it enter for the implementation[3]. It provides the resistance for the intruded information having some vulnerabilities from the external sources. For validation, first we need the classification of the data to satisfy the security requirement i.e., CIA [17]. The classification of the data is catagories as *Publicly* which is the least sensitive data and can access by the end users, *Confidential* which is moderately sensitive data and those users can access this data who are in need to run their work, *Top-Secret* which is the most sensitive data and the limited users can access that data [18]. Validation check needs to be done after the classification of the data. If the validation check is negative then apply the validation methods to go for the same. Existing validation methods are mapping the data and the transformation rules [3]. If the validation check is positive then the *Security Controls* must apply to the system:

4.2 Security Controls:

1. ***Data Masking***:
2. it is the process of protecting the real data from the unconditional theft. Unlike encrypted data, masked information maintains it's usability for activities like software development and testing [19]. Techniques used for masking are Mutation, Generation, Algorithmic, Loading, Customization.
3. ***Privacy preservation***: needs of ensuring that the privacy and confidentiality needs are fulfill and proper level of data details are exposed not exposing all the details [20]. Privacy preservation is helpful to reduce the possibility of identifying sensitive information. By this method user can utilize the essential details not need to see all the background details as in the case of data abstraction.
4. ***Encryption***: it is the conversion of data into a form which is not understood by the unauthorized person.

After the validation process implementation check the authenticity, if the result is negative then apply the access policies and data restriction. By the access policies the protection of the data is done with the corresponding access rules [13]. Auditing rules cal also be use to do the same and by this the trust can be generated. And if the result is positive then we go for the digital certification of the user. *Digital certificates* are the digital file by which the identity of the user can be verified [21]. If the evaluation through the digital certificates are true then the user is granted to access the data and if it is false then the user is not able to access the same.

The basis of the data warehouse security is to understand the nature and value of the data. Proper classification is also required for implementing the access policies. The primary thing considering is the classification of data(ontology) that supports the other parameters. The classification includes the metadata that indicates semantic classification parameters. The access policies and restriction must be defined based on data to the user roles. Data integration and validation needs to run in parallel with all level of abstraction in the designing phase of data warehouse.

V. CONCLUSION

Data integration and validation is required at the different levels of abstraction throughout the whole implementation process. The proposed framework will fit for any kind of data development process and it works on the refinement process. The benefit of this model is to reduce the risk of security failures at all the stages of data warehouse development.

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Object Tracker Using Fmcw System And Image Acquisition

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Abstract: - This paper discusses the design and implementation of FMCW systems and tracking an object by using the data given by these systems followed by image acquisition. It concludes with an overview of the effects of oscillator phase noise and reflected power on the performance of these systems.

Keywords: - *frequency modulated continuous wave, radar, range resolution, phase noise, image acquisition.*

I. INTRODUCTION

Frequency Modulated Continuous Wave (FMCW) systems operate using the homodyne principle, i.e., a CW in which the oscillator serves as both the transmitter and local oscillator. The CW signal is modulated in frequency to produce a linear chirp which is radiated toward a target through an antenna. The echo received (T_b) seconds later is mixed with a portion of the transmitted signal to produce a beat signal at a frequency (f_b), this is proportional to the round-trip time Tp.

II. METHODOLOGY

FMCW (Frequency Modulated Continuous Wave) should be generated and transmitted using a transmitter. When an obstacle is present in the path of the transmitted signal, the wave hits the obstacle and retraces back with some phase difference, the reflected signal is received using a receiver and phase shift of the received wave is calculated. These waves are recorded in (.wav) and are further processed. MATLAB reads these .wav files and sort out triggered pulses, group of pulses to process in three modes of operation Doppler vs. time, range vs. time, SAR imaging.

1. **Determining the Beat Frequency:**

For an analytical explanation the change in frequency (W_b) with time can be described as

$W_b = A_b.t.$

Substituting into standard equation for FM and simplifying we obtain

$V_f\,(t) = Ac \cos\,[Wc\ t + A_b/2\ t^2].$

A portion of the transmitted signal is mixed with the returned echo by which time the transmit signal frequency will be shifted from that of the received signal because of the round trip time T_p. The first cosine term describes a linearly increasing FM signal (chirp) at about twice the carrier frequency with a phase shift that is proportional to the delay time Tp. This term is generally filtered out either actively or more usually in radar systems because it is beyond the cut-off frequency of the mixer and subsequent receiver components. The second cosine term describes a beat signal at a fixed frequency which can be obtained by differentiating the instantaneous phase term.

For a chirp duration of Tb seconds, the spectrum of the beat signal will be resolvable to an accuracy of 2/Tb Hz assuming that $T_b >> T_p$. It is common practice to define the resolution bandwidth of a signal $\delta\ f_b$ between its 3dB points, which in this case fall within the $1/T_b$ region centered on f_b.

The rate of change of frequency (chirp slope) in the linear case is constant and equal to the total frequency excursion Δf divided by the time Tb. The beat frequency is then given by

$F_b = 0.636\ A_b\ T_p = \Delta f\ T_p / T_b$

The round trip time T_p to the target and back can be written in terms of the range as

$T_p = 2R/C$
Substituting the value of T_p we get
$F_b = \Delta f\, 2R / T_b\, C$

III. RANGE RESOLUTION

The range resolution, δR, can be obtained by substituting the frequency resolution δf_b, as follows
$R = T_d\, C\, f_b / 2\Delta f$
$\delta R = T_d\, C\ \ \delta fb / 2\Delta f$
As $\delta f_b \approx 1/T_d$
$\delta R = C/ 2\Delta f$

For closed-loop linearization where an almost perfectly linear chirp is generated, it is no longer practical to try to optimize the bandwidth. In this case the resolution degrades with range in a predictable way, with the resolution determined by the chirp bandwidth at close range, and by the linearity thereafter.

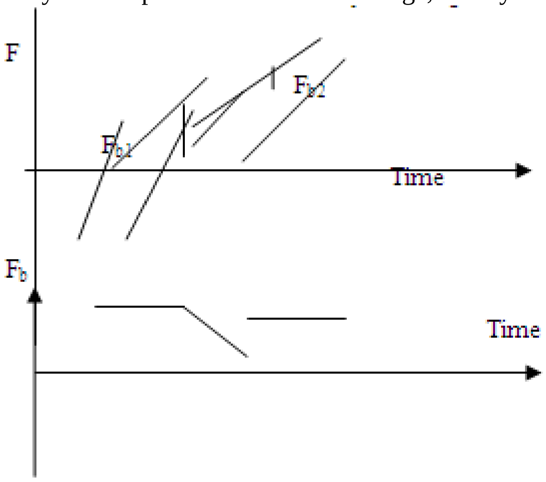

Fig.1,Graph showing Frequency difference

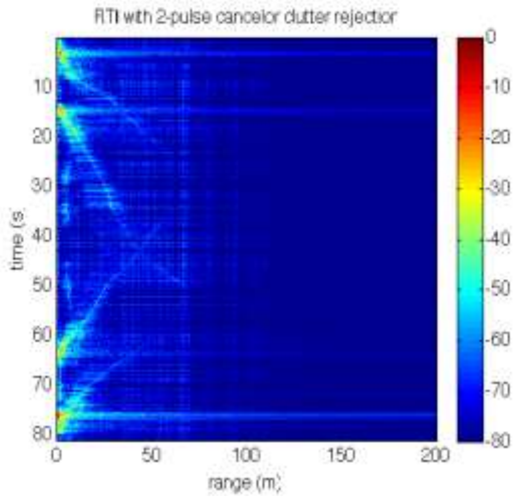

Fig.2 RTI with 2-pulse cancelor clutter rejector

IV. IMPROVING RANGE RESOLUTION

To improve the range resolution a number of practical methods of linearising the chirp signal have been considered. A common method uses the programmed correction stored in a lookup table which is then clocked through a digital to analog converter (DAC). The VCO temperature must either be held constant or different lookup tables must be used to accommodate variations in the oscillator characteristic. It uses an analog multiplier to produce a quadratic voltage that is added to the linear ramp to perform the correction.

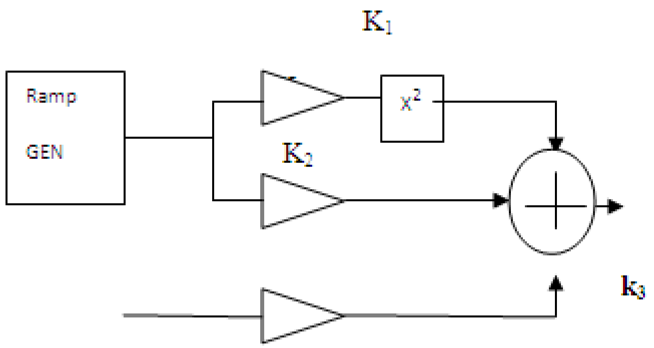

Fig.3. Quadratic ramp generator

In essence all a FMCW does is mix a portion of the transmitted signal with the received signal to produce a beat signal, the frequency of which is proportional to the range. A delay-line discriminator performs the same function using an electrical delay-line rather than the genuine round-trip delay to a target and back.

Block diagram:

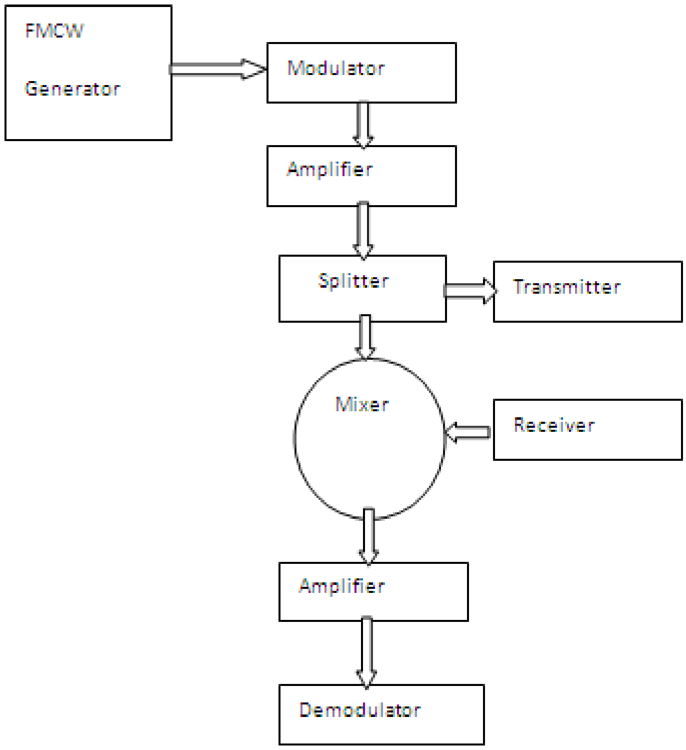

Fig.4 Quadratic frequency chirp correction circuit using an analog multiplier chip

Phase Noise around the Target:

Phase Noise around the Target Phase noise fringes also appear around any received target, and if the target is large they leak into the adjacent range bins. This results in a blurring of edges in image and can even result in smaller targets being completely swamped. Noise must be removed from the image.

Fig.5. Noise around the target

Features of the system:

1. Coherent FMCW architecture
2. Records files in .wav format
3. Bandwidth of 2.4GHz.
4. Three modes of operation Doppler vs time , range vs time , SAR imaging.

V. CONCLUSION

This paper shows that FMCW principle is straight forward and can be used for tracking purpose. Careful implementation of this system is very beneficial and accurate results can be obtained. This type of systems will be very useful to track the objects in remote areas.

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Effect of Unsupported Area of Composite Plates Subjected to Quasi-Static Indentation

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Abstract: E-glass/Epoxy composite circular plates clamped circumferentially were subjected to quasi-static indentation at the center of the specimen with a ball indenter. Damage pattern on surface of the laminated plates with varying degrees of fiber orientation and different unsupported areas was studied. Damage was quantified in terms of the area of opacity of the damaged region. Results obtained on 3 mm thick laminates with a hardened spherical ball indenter of 8.32 mm diameter indicated that damage was directly proportional to the angle θ and inversely proportional to unsupported areas of the specimen plate. Most internal damage was confined to the surroundings of the indentation point.

Keywords: *a) Epoxy resin; b)E-glass fiber; c)Filament winding; d)laminate; e)Indentation; f)delamination*

I. INTRODUCTION

Composite materials have wide spread structural applications in Aeronautical, Automotive, and Ship Building and Aero space industry. The volumes on the above sectors as well as the applications areas have been steadily increasing in recent days due to their obvious advantages of high specific stiffness and strength. The damage mechanisms in composites such as delamination fiber breaks and matrix cracking play an important role in every absorption. Prediction of damage assessment is a rather difficult area due to the complexities involved in measuring the energy absorbed in each of the above damaged mechanism. In this context damage inflicted in composite structures subjected to low velocity impact has been very important. This investigation was taken up in the above context. Damage in any composite structure is progressive and cumulative. Damage occurs during manufacturing processes as well as in service usage. These include low velocity impact by hand tools, collision between two structures during assembly etc. Such localized impacts cause local damage but an induced degradation in their strength and are liable to grow under continued usage. The size and type of damage depends on various parameters like Geometry of support, size, projectile diameter and angle of incidence. Extensive studies are taking place in the foreign object damage response of the composite structures. It was found that the damage in composite materials due to Quasi – Static indentation is similar to the one caused by low velocity impact. Several investigators have experimentally studied the damage due to Quasi – Static indentation and characterized the damage. The aim of this research work is to investigate the influence of fiber orientation in the damage of composite laminate, subjected to quasi-static indentation. Damage in the composite laminates results from the interaction between different failure mechanism like matrix cracking, fiber-matrix debonding, delamination between the successive layers and fiber breakage. However in quasi-static indentation mostly the damage may result due to delamination between the layers. For this purpose, static tests were conducted on the composite laminate loaded at the centre by a spherical stainless steel indenter. All the tests were stopped at fixed values of the indenter displacement. Composite laminates with different fiber orientation were supported on a circular steel frame. The intensity of the damage caused is observed by the optical light microscope. Apart from the damage the force carrying capacity is also influencing the angle between the fibers and the depth of indentation increase with the increase in the angle between the fibers. Freitas et al [1] have carried out a numerical study to examine the failure mechanisms in composite specimens subjected to impact loading. Results show that the numerical evaluation of impact with a linear static finite element analysis is not very accurate, but it gives meaningful insights on the major mechanisms of failure. Metals show visible damage caused by impact mainly on the surface of the structures, but for composites the damage is hidden inside the member when subjected to low velocity impact [2]. Wu and Chang [3] studied ballistic impact response of monolithic fibers reinforced composite laminates, where they found that the contact force is dependent on the mass of the projectile, but it has no influence on the amount of the absorbed energy, which is found to be dependent on the initial energy of the impactor. While zhou and Greaves studied damage resistance and tolerance of glass fiber reinforced plates with different thickness [4]. Williams and Vaziri [5] used damage mechanics principles along with matrix and fiber failure criteria ot model damage in low velocity impact. They developed material subroutines for LS DYNA. Load deflection curves and damage patterns compared well with experimental results. Liu [6].carried out an experimental study to obtain the perforation threshold of laminated composite plates with different thickness and bending stiffness. Results show that thickness is more efficient than bending stiffness on the perforation threshold Chen and Sun [7] developed a finite element program to analyze the impact response of composite laminates under biaxial in-plane loads using the program; they solved three cases of in-plane loading. i.e., tensile loading of three times the critical buckling loads of the plate. Compressive loading of 75% of the same critical load, and no initial in-plane loading. N. Rajesh et al studied the behavior of woven glass epoxy laminates were subjected to low velocity impact loading at different energy levels have been investigated using standard instrumented falling weight test, the results shown that the dynamic response of these systems depends on the elastic properties of the fiber materials [8].Ramazan Karakuzu et al. experimented the behavior of glass/epoxy composite plate with different fiber orientations with different impact energies with different masses and observed the following conclusions like the contact force increases by increasing fie angle, the lower impactor mass with higher impact velocity causes greater contact forces, the lower mass with higher velocity causes higher deflection while the lower energy with lower velocity and lower mass with lower energy cause lower deflection. Higher plate thickness cause higher contact force and lower deflection. But contact force and deflection rates decrease y increasing the plate thickness. The overall delaminations area increases by the increasing impact energy; however it does not significantly change by increasing the fiber orientation. The overall delamination area decreases by increasing the plate thickness [9].By this time a number studies have been carried out in this direction, but most of them are concerned with low velocity impact [10].Static tests were carried out on SiC/SiC composite plate loaded at the centre by hemispherical indenter with a fixed displacement and also with complete penetration using various circular support and different indenter diameters. Damage assessment was made using micrograph and post-indentation tensile strength [11].

II. EXPERIMENTAL PROCEDURE

2.1 Material:

E-glass/epoxy composite plates were prepared using a drum winding machine. Laminae were carefully laid up on the surface of the die plate molding tool to a pre-determined layup sequence. After closing the mould with the punch plate and spacers, the assembly was subjected to curing at 160^0C. Laminated composite plates were obtained after curing and trim to the required size.

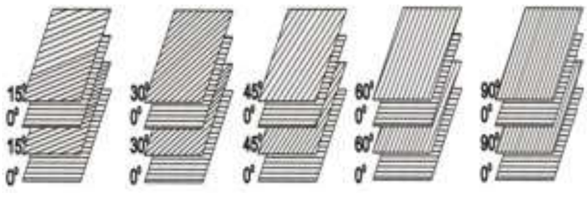
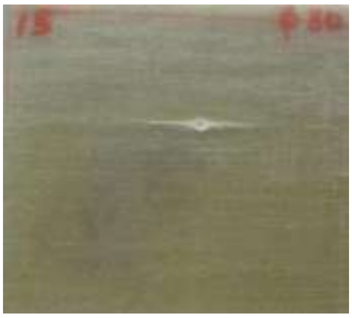


Fig-1: layup sequence of laminae

2.2. Experimental procedure:

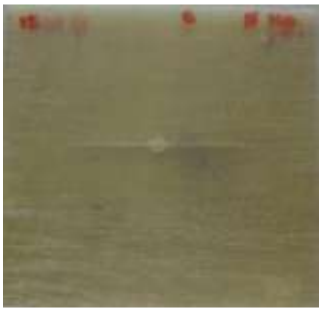
Quasi-static Indentation tests were conducted on a universal testing machine to various specimen plates with different ply orientations and unsupported area placed on a steel supporting frame. A cover plate with a central circular hole of different sizes was placed on top of the composite laminate to obtain different unsupported areas and clamped rigidly using bolts and nuts. The complete assembly along with composite laminate was placed on the bottom support of the testing machine. A spherical stainless steel ball of radius 4.16mm was used for indentation on the composite laminate. The tests were conducted under controlled indenter displacement δ (0.1mm/minute) up to 4mm. Load on the laminate at the central point (P) was quantified with the help of 20kN load cell of the UTM. The load - displacement data were obtained for the chosen ply orientations and unsupported areas of the laminate. From the load displacement curve, stiffness K was evaluated. unsupported diameter=60mm, 80mm, 100mm.

($0^0/15^0$)

TOP

($0^0/15^0$)

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TOP

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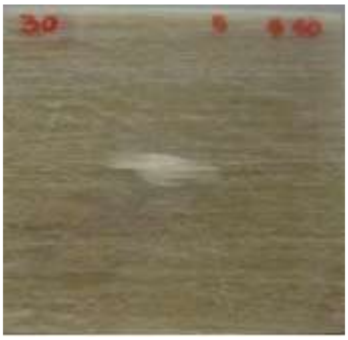 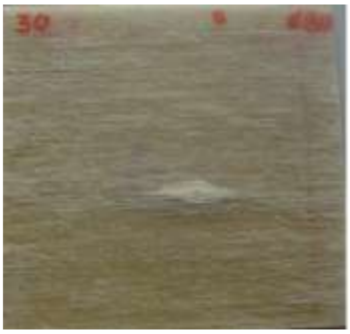 

BOTTOM

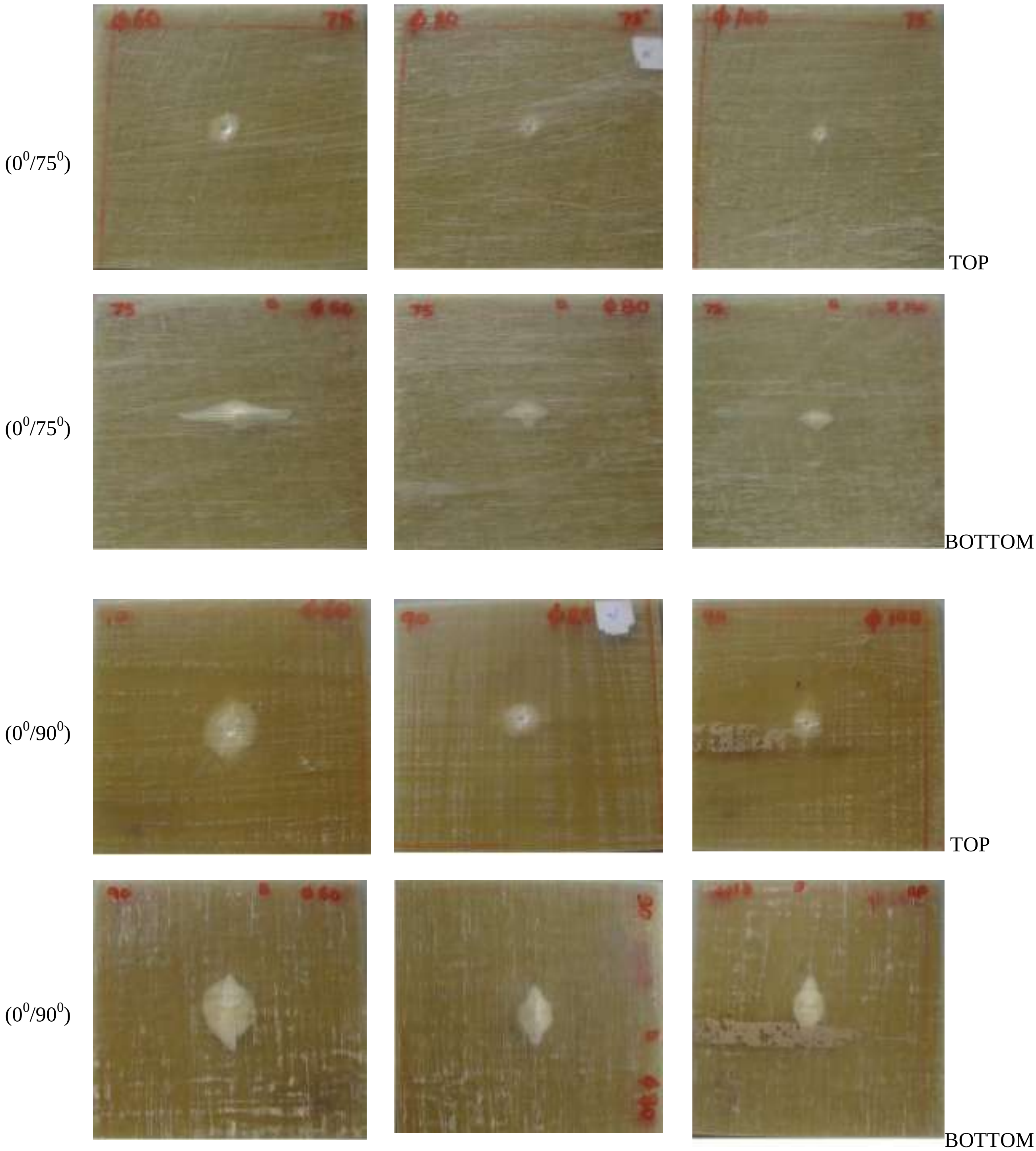

Fig-3: Laminates after indentation

III. RESULTS

3.1 Load-displacement

The load-displacement curves for the specimens indented until the indenter displacement reached a maximum of 4mm was shown in Figs: 4 to 10. These were linear in nature and the apparent damage area on both sides of the specimen was increased with the increase in fiber orientation θ. The load P was proportional to fiber orientation of the laminates. The maximum load when $\theta=15^0$, 30^0, 75^0, 90^0 for unsupported circular diameter of 60mm was 3.3, 3.86, 4.3, 5.52 kN respectively. It was very clear that as the fiber orientation was increasing the load bearing capacity was also increasing. The same trend followed for the unsupported area diameters 80mm and 100mm with decrease in load at the end of 4mm indenter displacement. Irrespective of fiber orientation it was also observed that for small unsupported area diameters the load was higher than large unsupported diameters for the specimen configurations.

3.2 Stiffness - Fiber orientation

K_0 was calculated using the slopes of P-δ curves in different configured specimens and observed that K_0 depends on fiber orientation θ. It shows a non linear relationship with increasing values of K_0 with θ. The global stiffness reflects the ability of the plate to withstand a central load without any loss of stiffness despite some local damage at the point of indentation. There is a progressive increase of K_0 for values of θ from 15^0, 30^0 75^0 and 90^0 and also increases in these values with the decrease in unsupported area diameters as shown fig.11

3.3 Central deflection - Indenter displacement

Under the action of a normal load at the midpoint on a circular plate clamped circumferentially, the deflection at any point of the plate was a function of indenter displacement. The deflection-indenter displacement curve was linear with increasing values of indenter displacement**.** It was observed that the deflection at centre of the plate was directly proportional to indenter displacement and unsupported area diameter as shown in fig.12 to 18.

3.4 Damage development/Apparent damage area - fiber orientation

Composite plate photographs after indentation shown in fig.3 provide a means of quantifying damage area of the indented specimens. The damage on the indented side is a hemispherical cavity with a small convex deformation observed on the back side of the specimens due to compression phenomenon on indented side and tension on back side of the specimen. The size of damage on back side of the specimen was more than the indented side as shown. The photo images disclose that, damage was directly proportion to fiber orientation θ on both the sides, with the damage on the back face being higher than that in the front face. The apparent damage was due to the combined effect of one or more phenomenon like, matrix cracks, fiber-matrix debond and delamination between the angled plies. It was assumed that for small indentation depths, there would have not any fiber breakage. Matrix cracks may take place on the top laminae of the laminate which might be subjected to compression and will result localized buckling. Bottom laminae are in a state of tension and lead to debond or fiber fracture. The mechanism of damage for the top laminae would be matrix crack whereas for the bottom laminae would be delamination.

3.5 Spring back - fiber orientation

Spring-back was defined as the difference between depth of indentation at the centre point at the instance of downward indenter traverse of 4mm and the measured depth of indentation at the same point after the indenter has been retracted back. Experimental results showed that spring back was directly proportional to unsupported area of the laminate and fiber orientation.

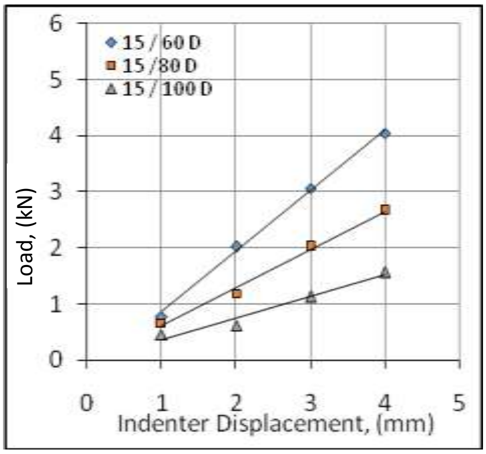

Fig-4: Load vs. Indenter displacement

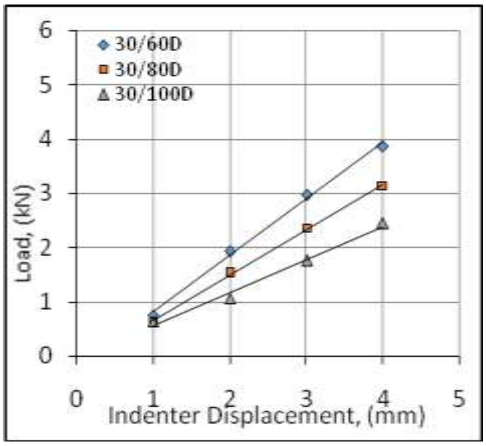

Fig-5: Load vs. Indenter displacement

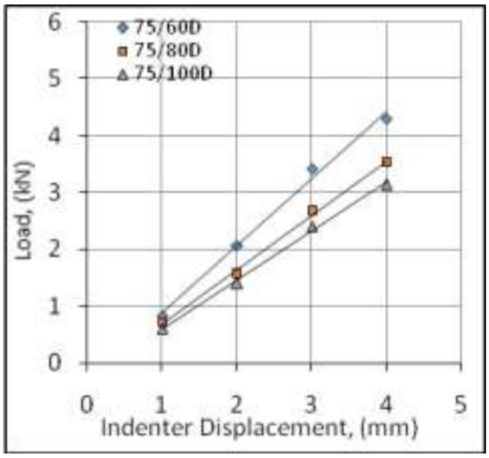

Fig-6: Load vs. Indenter displacement

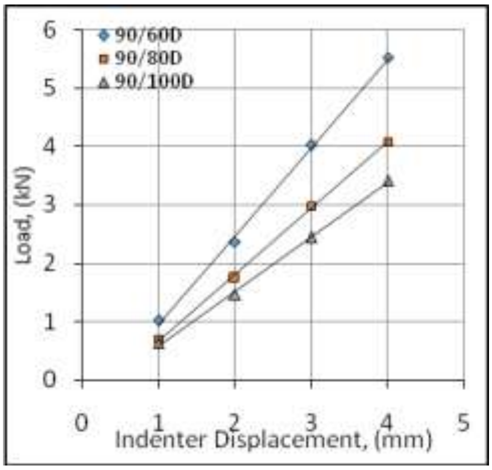

Fig-7: Load vs. Indenter displacement

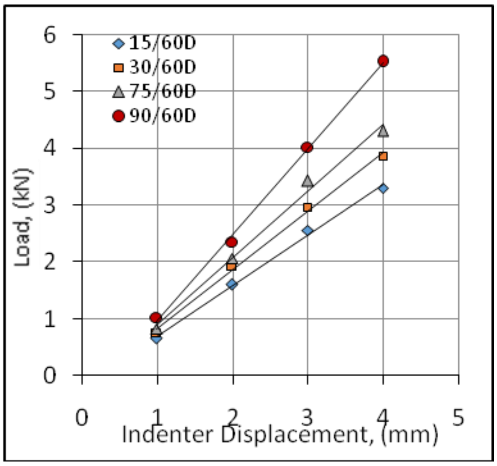

Fig-8: Load vs Indenter displacement

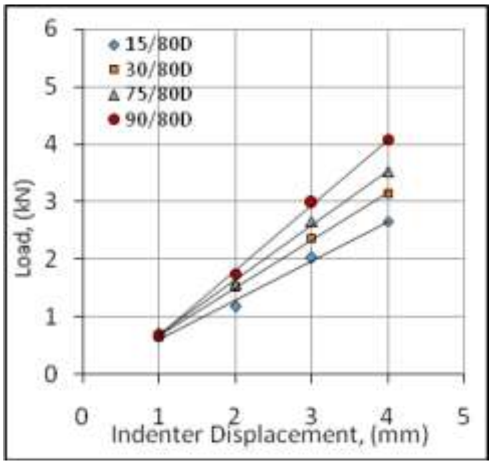

Fig-9: Load vs Indenter displacement

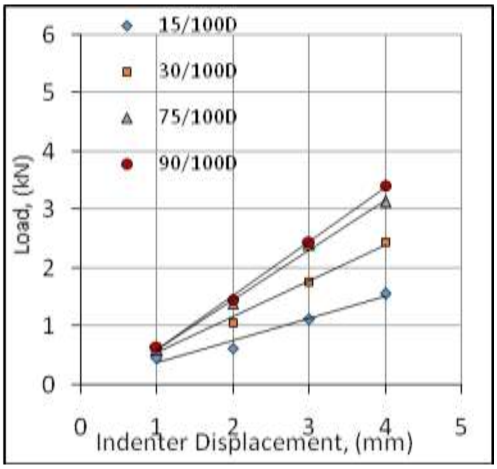

Fig-10: Load vs. Indenter displacement

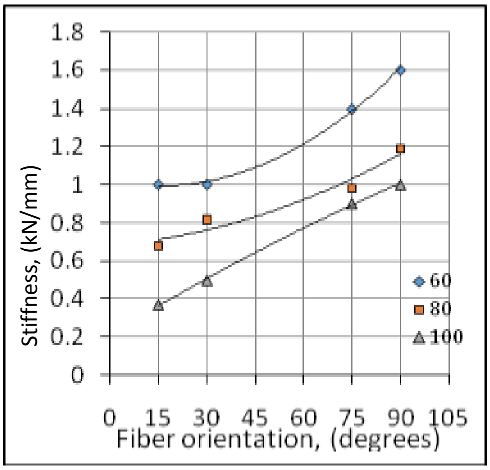

Fig-11: Stiffness vs. fiber orientation

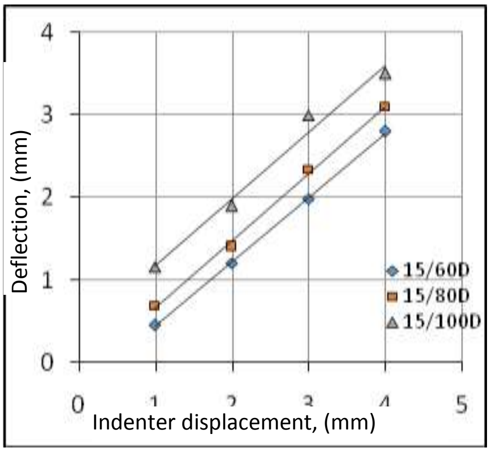

Fig-12: Deflection vs. Indenter displacement

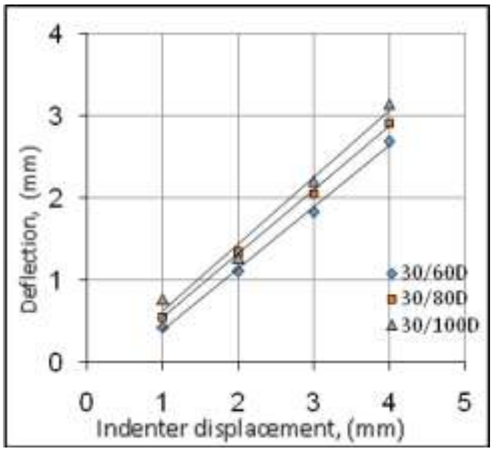

Fig-13: Deflection vs. Indenter displacement

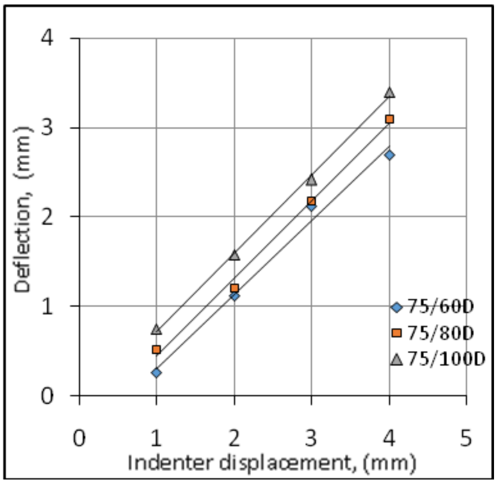

Fig-14: Deflection vs. Indenter displacement

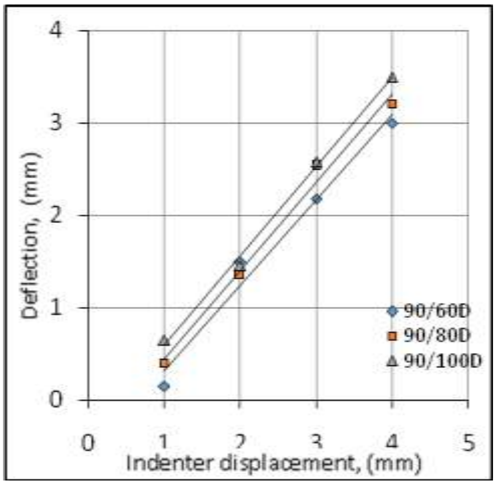

Fig-15: Deflection vs. Indenter displacement

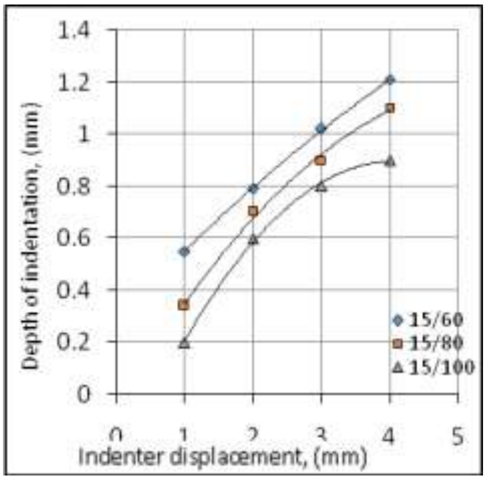

Fig-16: Indentation vs. Indenter displacement

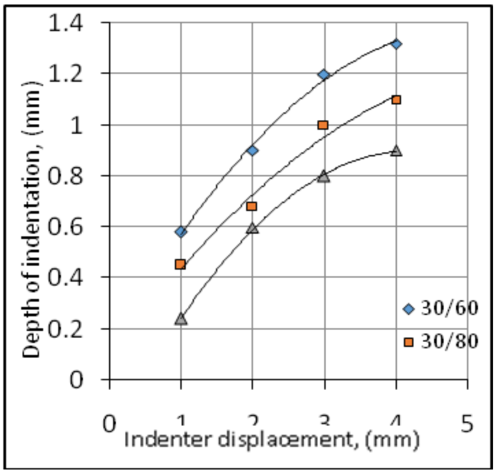

Fig-17: Indentation vs. Indenter displacement

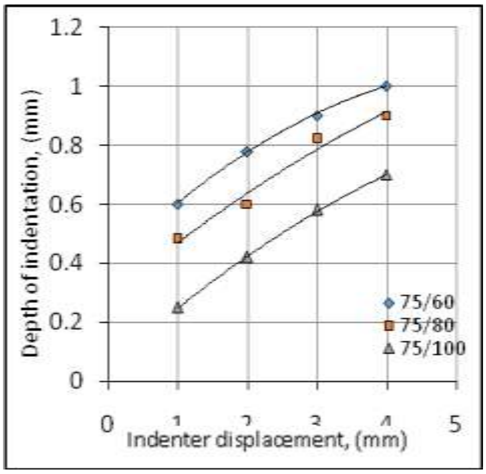

Fig-18: Indentation vs. Indenter displacement

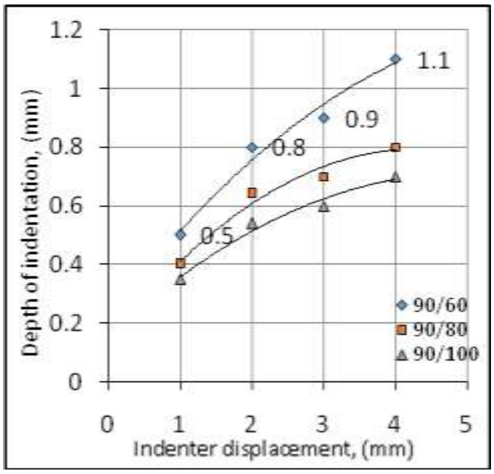

Fig-19: Indentation vs. Indenter displacement

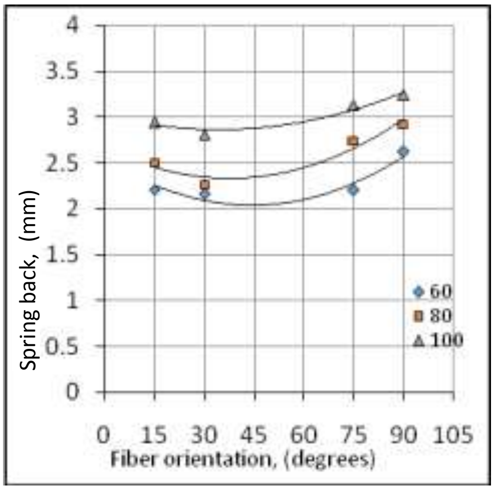

Fig-20: Spring back vs. fiber orientation

IV. CONCLUSION

The size of damage increased with the indenter displacement for given fiber orientation and unsupported area. The damage area was increased with the increase in fiber orientation. Stiffness of specimen for all the values of fiber orientation was gradually increasing with the increase in fiber orientation. It was also observed that for small unsupported area diameters of the specimens, the load was higher than large unsupported area diameters. There is a progressive increase in stiffness values from 15^0, 30^0 75^0 and 90^0 and also increase in these values with the decrease in unsupported diameters of the specimens. The deflection at centre of the plate was directly proportional to indenter displacement and unsupported area diameter of the specimen. Due to increase in stiffness, there was an increase in depth of indentation with decreasing values of unsupported area diameter. Compression phenomenon on indented side and tension on back side of the specimen a led to small convex deformation on the back side of the specimens. Spring back was directly proportional to unsupported area of the laminate.

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Application of magnetized fly ash based soil conditioner for the improvement of soil fertility and paddy productivity

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Abstract: - Use of fly ash as soil conditioner has been established as a safe method of recycle and reuse of enormous quantity of fly ash produced by thermal power plants. In this investigation, fly ash was magnetized and magnetized fly ash - *Biosil* - was tested for its potency in a field trial experiment on paddy crop. Recommended doses of fertilizers (RDF) were fortified by *Biosil* at different doses (kg/ha) namely 150, 300, 450, 600, 750 and 900, keeping RDF and vermicompost (VC) as controls. All doses of *Biosil*, especially 450 kg/ha to 900 kg/ha, improved the soil fertility and paddy productivity over and above RDF control and VC control as compared to conventional very high doses (10% to 100%) of fly ash used by other authors. Trend of improvement was in the order: *Biosil*+RDF>VC>RDF. *Biosil* fortification improved the effect of RDF on soil fertility and crop productivity to the best level in the treatments. Thus, it is evident that the magnetization has improved the potency of *Biosil* as Soil conditioner. VC showed better results than RDF. It is, thus, recommended that further field trials with the integrated treatment of *Biosil*, RDF and VC will be helpful in improving the paddy crop productivity and soil fertility on sustainable way.

Keywords: - *Fly ash, Magnetization, Soil conditioner, Paddy, Soil fertility*

I. INTRODUCTION

Amount of fly ash produced per year in India and elsewhere, where coal based thermal power plant is the principal source of energy, is enormous (Joshi and Lothia, 1997). India is the largest producer of FA followed by China, USA, W. Germany and UK. The dumping on land of accumulated fly ash has covered and deteriorated significant area of precious land resource in these countries. This has resulted in serious environmental pollution of air, water and soil apart from public health impacts (Carloon and Adriano, 1993).
The peculiar structure and richness of micronutrients has made the fly ash as reusable resource. The research on reuse of fly ash invented a potential large scale utilization in two fields namely construction sector for making cement and bricks and as soil conditioner in agriculture (Central Electricity Authority, New Delhi, December, 2011) for improvement of quality and fertility of soil and improvement of crop productivity and yield (Garg et al., 1996; Kalra et al., 1997; Gupta et al., 2002; Prem Kishor et al., 2010; Singh et al., 2011).

Lot of research is still needed to improve the agricultural use of fly ash soil conditioner, with respect to improvement of quality of fly ash, and its optimum use with respect to type of soil and crop. This investigation is aimed at improvement of fly ash soil conditioner through magnetization of fly ash and its use in improvement of paddy crop which is the staple crop of the majority of world population.

II. MATERIALS AND METHODS

The fly ash was securely collected from the hopper of thermal power plant and was magnetized to produce novel soil conditioner Biosil. It was applied in July 2011 (rainy season) to paddy fields at Jabalpur, India having black soil. Biosil at different doses (kg/ha) namely 150 (T1-150), 300 (T2-300), 450 (T3-450), 600 (T4-600), 750 (T5-750) and 900 (T6-900), each dose along with recommended dose of fertilizer (RDF) (120:60:40 kg NPK/ha), was added to different plots in the agricultural field before transplantation of paddy seedlings. The control plots of RDF control (T7-RDF) and vermicompost (VC) control (T8-VC) .were also maintained. Paddy variety WG132100 was selected as rice cultivar. The soil in the field was subjected to excessive dispersion during puddling, resulting into drastic change in their pore size distribution.

A total of eight treatments over 24 plots (8x3=24) were arranged in a completely randomized design and each treatment was carried out in three replications. The gross and net plot sizes were 6mx3.6 m and 5.6 m x 3.2 m respectively. The distance between plots was kept at 1.0 m and the distance between replications were kept at 1.5 m.

The powder form of Biosil was applied at the rates given above one week prior to flooding and mixed mechanically by ploughing within 15 cm depth of the surface soil. The basal RDF dose applied into soil two days before rice transplanting was given as: nitrogen (50% dose), phosphorus (100% dose), potash (100% dose). Each dose of top dressing fertilizer (nitrogen 25%) was added after one and two months of transplanting. Water level was controlled at around 5-7 cm depth during the cropping season and rice was harvested 150 days after transplantation.

Soil was collected from the test field from 30 cm depth from three places before sowing and after harvest, air dried, sieved (<10mm) and analyzed for physico-chemical properties viz. pH, electrical conductivity (EC), bulk density (BD), available nitrogen (N), available phosphorus (P), available potassium (K), available sulphur (S) and available zinc (Zn) (Jackson, 1973). The results were averaged and presented. The observations on the crop were recorded at pre-harvest at 30, 60 90 days after transplantation (DAT) and at maturity in November 2011 on plant population - number/sq m, plant height (cm), number of tillers/sq m, number of leaves/sq m, and leaf area/sq m. Similarly post-harvest observations on the crop have been made on number of effective tillers/sq m, length of panicle (cm), no of grains/panicle, test weight (g), grain yield (kg/plot) and straw yield (kg/plot).

III. RESULTS AND DISCUSSION

Project site

Jabalpur from Madhya Pradesh, India has humid subtropical climate. Summer starts in late March and lasts up to June. May is the hottest month with average temperatures reaching upto and beyond 45 ^{0}C. Summer is followed by monsoon season, which lasts until early October, with a total precipitation of nearly 55 inches (1386 mm). Winter starts in late November and last until early March. They peak in January with average daily temperature near 15 ^{0}C.

Magnetized fly ash

Fly ash, upon being subjected to controlled magnetic field, exhibits remarkable magnetic movement. This magnetic movement causes nutrients in soil to be attracted to roots of plants, facilitating assimilation by the plants of the nutrients in the soil, to which magnetized fly ash is added. Particle size distribution showed dominance of small sized particles. The finer fractions (<0.25 mm) varied from 52.24% to 65.32%, as the magnetic properties are concentrated in small fraction of particles. Analysis of Biosil indicated 0.10-0.32% moisture content, 0.85-1.16 g/cubic cm bulk density, 40.1 to 55.6% water holding capacity, pH (7.3-7.9), electrical conductivity (0.27 to 0.36 dS/m), available macronutrients (ppm) (nitrogen 95-130;phosphorus 65-90; potash 72-98) and available micronutrients (ppm) (iron 10.2-22.2; zinc 0.8-3.2; manganese 1.5-4.2; boron 0.76-1.20; molybdenum 0.76-1.20; copper 40-109; zinc 47-136; and manganese 100-700). The major constituents of the fly ash were found to be silica (SiO_2) (60.1 to 68.8%) followed by total aluminium (20.6 to 27.5%) and total iron (4.3 to 8.7%). These characteristics of Biosil indicate that Biosil fortification to soil as soil conditioner will help in improving drainage and porosity of soil, pH of acidic soil, improvement of micronutrients in deficient soil, mitigating boron deficiency of soil.

Improvement of soil properties

The soil of experimental field before the transplantation of paddy seedlings was observed to be clayey in texture (Table I) (however with excess clay) and with ideal Electrical conductivity & pH; medium organic carbon & potassium; medium-low nitrogen and low phosphorus as per the guidelines for rating the soil fertility indicators in India (Table II) and also the guidelines given by Utah State University in cooperation with U.S. Department of Agriculture (Table III). This low content of P in the Jabalpur soil is in conformity with the report (Chandy, 2013) that medium black soils of semi-arid regions have a medium fertility level with respect to phosphorus. The reason for medium-low N is the medium organic carbon content of soil. Soil organic carbon has role in improving and maintaining soil fertility, structure, stability, nutrient retention & restricting soil erosion (Singh, 2008).

The initial soil quality and soil quality after harvest of paddy crop are shown in Table IV. Biosil+RDF treatments improved Initial pH of soil from initial 7.1 to 7.3 in T3-450 and higher treatments, electrical conductivity (EC) from 0.31 dS/m to 0.35 dS/m in T5-750 and higher treatments, organic carbon (OC) from 0.64% to 0.68% in T6-750 treatment onwards and effectively reduced the bulk density (BD) from 1.46 g/cc to

1.40 g/cc which is optimum for black soil (USDA-NRCS Soil Quality Test Kit Guide). Thus, Biosil treatments improved the physical quality of soil with respect to pH, EC, bulk density and organic carbon, an essential macronutrient, in the soil. The vermicompost (VC) and recommended dose of fertilizers (RDF) also improved the soil nutrients. Vermicompost improved the nitrogen content of soil from 372 to 378.25 kg/ha (1.68% increase), phosphorus content from 17.45 to 17.93 kg/ha (2.75% increase), potassium content from 297 to 303 kg/ha (2.02% increase), sulphur from 9.1 to 9.5 kg/ha (4.4% increase), and zinc from 1.3 to 1.45 kg/ha (11.54% increase). Similarly, RDF improved the nitrogen content of soil by 372 to 372.5 (0.13% increase0, potassium content by 297 to 297.25 kg/ha (0.08% increase), sulphur content from 9.1 to 9.13 kg/ha (0.33% increase) and zinc from 1.30 to 1.38 kg/ha (6.15% increase). Percent Increase/Decrease in Soil Parameters in Optimum Dose of Biosil at 90 DAT over initial value, RDF control and VC control are shown in Figure 1. The trend of improvement was RDF > Biosil+RDF for pH and EC and VC > Biosil+RDF for OC and BD.

In vermicompost control, pH remained unchanged at 7.1. Similar observation is made by Sharma et al., 2013 who observed soil pH maintained or declined in all in Integrated Nutrient Management Treatments as compared to the initial value, which may be ascribed to the formation of organic acids due to the decomposition of organic manure and crop residues.

Similar improvement in soil quality have been observed by other authors but with very high doses of fly ash such as change in soil pH at 10 t/ha fly ash application (Gautam et al., 2012; Tekade et al., 2013), Reduction in bulk density (Kalra et al., 1998; Kene et al., 1991), increase in electrical conductivity (Tekade et al., 2013; Matsi and Keramidas, 1999,), and improvement in soil pH, conductivity, available phosphorus, organic carbon and organic matter with increased application rate of fly ash (Sarkar et al., 2012; Sarangi et al., 2001).

Biosil Treatment with RDF showed improvements in macronutrients over initial value namely nitrogen from 372 to 376 kg/ha (1.28% increase), phosphorus from 17.45 to 17.85 kg/ha (2.29% increase), potassium from 297 to 301 kg/ha (1.35% increase), sulphate from 9.1 to 9.48 kg/ha (4.18% increase) and zinc from 1.30 1.45 kg/ha (11.54% increase). Vermicompost and RDF also improved the soil nutrients (Table IV) with the trend of improvement as Biosil+RDF > VC > RDF. This indicates that Biosil fortification to RDF improved the results of RDF on soil fertility to the best level in all the treatments. Thus, vermicompost and Biosil were effective in improving the soil fertility and were capable of optimizing bulk density, and mobilizing organic carbon, nitrogen, phosphorus, potassium, sulphur and zinc. Biosil doses ranging from 600 kg/ha to 900 kg/ha were found to be suitable as soil conditioner (Table V). Better results were recorded by some authors with higher doses of fly ash. Jala (2005) observed a distinct increase in the concentrations of N, P, K, S, in soil plus fly ash mixtures after trial with concomitant increase in fly ash percentage. RDF was more effective in improving EC and pH of soil, while Biosil+RDF and vermicompost were effective in improving other soil parameters.

Improvement of paddy growth and productivity

The results on paddy growth and productivity are summarized in Table VI. The treatment T6-900 i.e. Biosil 900 kg/ha along with RDF was observed to be optimum for all the plant growth and productivity parameters. 90 DAT was sufficient for full development of plant height and leaf area/m^2. Number of leaves increased rapidly in first 30 days and then shows gradual decline. Yield attributes and yield components were maximally developed at maturity. The trend of enhancement was similar for all the parameters that is Biosil+RDF followed by vermicompost and then by RDF. Therefore, it is recommended that the combined treatment of Biosil, RDF and vermicompost would be beneficial in improving the paddy growth and productivity. The T6-900 treatment gave maximum values of different parameters such as 47.40 q/ha grain yield, 97.47 q/ha straw yield, 19.33 g test weight, 173 grains per panicle, 32.7 cm length of panicle, 273 number of effective tillers/m^2, and leaf area index of 5.49.

All the doses of Biosil along with RDF showed significant superiority with respect to all plant growth and productivity parameters over RDF alone except lower dose of 150 kg/ha Biosil with RDF. Percent increases in all parameters in T6-900 treatment over T7-RDF control and T8-VC control on 90 DAT are shown in Figure 2. The growth and productivity parameters increased by 8.66% to 34.97% over RDF control (showing enhancement of the effect of RDF due to Biosil fortification) and by 4.15% to 25.26% over VC control in T-900 treatment. On the other hand, addition of vermicompost alone proved to be equally good to 100% RDF alone and lower dose of Biosil (150 kg/ha) with RDF.

IV. CONCLUSION

It is thus concluded that the magnetization of fly ash has increased tremendously the inherent power of fly ash and showed improvement in soil quality and fertility as well as in crop growth and productivity at a very low concentration of 900 kg/ha Biosil as compared to conventional higher rate of applications of fly ash i.e. 10% to 100% to the soil. These improvements have been achieved by higher mobilization of nutrients and making them more available to the paddy under the influence of Biosil. Biosil fortification to RDF also improved the individual impact of RDF on soil fertility and crop growth and productivity (Figure 1 and 2). Considering the better results of vermicompost over RDF, it is recommended that the integrated treatment of Bioslil with RDF and vermicompost will be highly beneficial to improvement of crop productivity and for maintenance of soil fertility for longer period.

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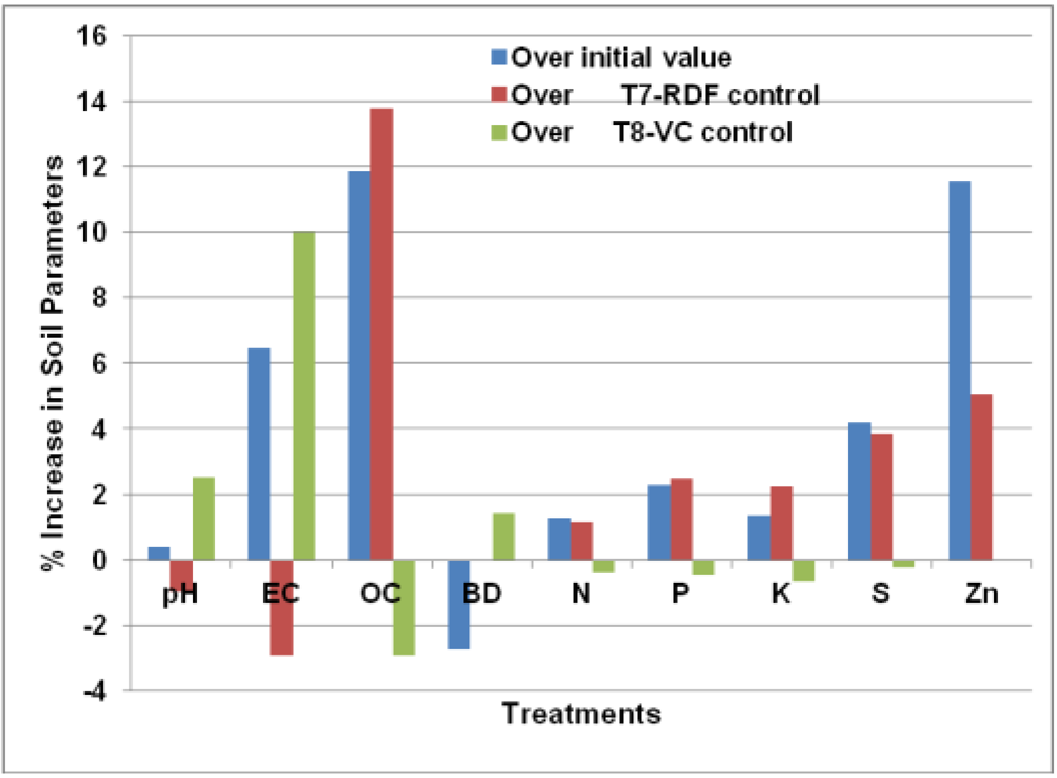
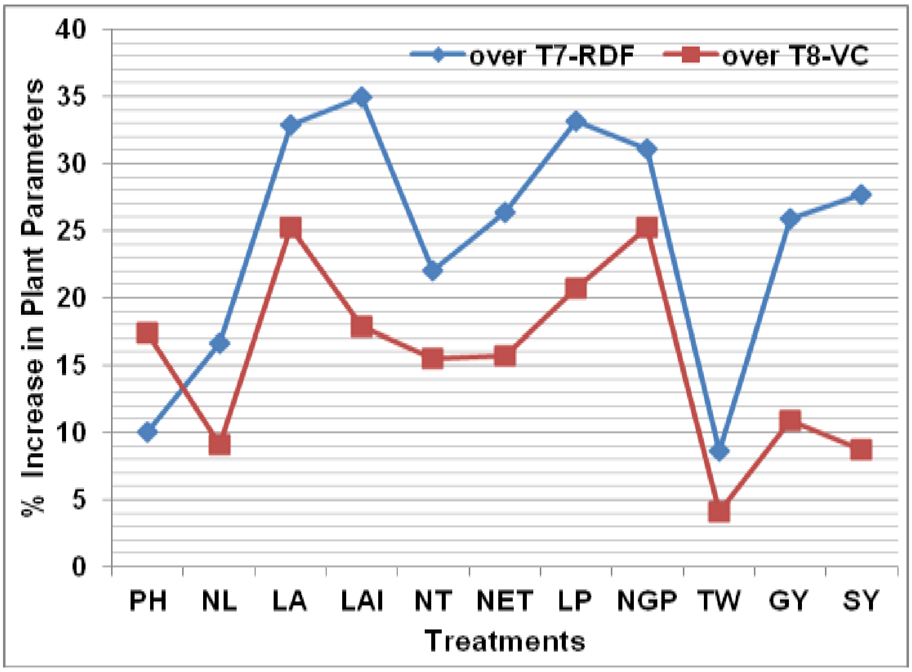


(EC: electrical conductivity; OC: organic carbon; BD: bulk density)

Figure 1: Percent Increase/Decrease in Soil Parameters in Optimum Dose of *Biosil* at 90 DAT



[PH: plant height; NL: number of leaves/sq m; LA: leaf area; LAI: leaf area index; NT: number of tillers/sq m; NET: number of effective tillers/sq m; LP: length of panicle (cm); NGP: number of grains per panicle; TW: test weight (g); GY: grain yield (q/ha); SY: straw yield (q/ha)]

Figure 2: Percentage Increase in Plant Parameters at Optimum *Biosil* Dose at 90 DAT

Table I: Qualitative ratings of soil nutrients in experimental fields before transplantation

Description	*Sand %*	*Silt %*	*Clay %*	*Texture*	*EC dS/m*	*pH*	*OC (%)*	*Available plant nutrients (kg / ha)*		
								N	P	K
Nutrient Content	25.18	19.18	55.64	Clayey	0.31	7.1	0.59	372	17.45	297
Quality ratings	Ideal	Ideal	Unacceptable	Acceptable	Ideal	Ideal	Medium	Medium low	Low	Medium

EC: electrical conductivity; OC: organic carbon; N: available nitrogen; P: available phosphorus; K: available potassium

Table II: Soil fertility classification followed in Maharashtra & some other states

Soil fertility level	***Organic carbon (%)***	***Available N (kg/ha)***	***Available P_2O_5 (kg/ha)***	***Available K_2O (kg/ha)***
Very High	>1.00	>700	>80.0	>360
High	0.81-1.00	561-700	64-80	301-360
Medium	0.61-0.80	421-560	48-64	241-300
Medium Low	0.41-0.60	281-420	32-48	181-240
Low	0.21-0.40	141-280	16-32	121-180
Very Low	<0.20	<140	<16.0	<120

Source: Tandon (2005)

Table III: Guidelines category of soil parameters for the growth of crops

Category	*Soluble Salts (EC) (dS/m or mmho/cm)*	*pH*	*Sand (%)*	*Silt (%)*	*Clay (%)*	*Texture Class**	*Organic Matter (%)*	*% Coarse fragments (>2 mm in diameter)***	*Sodium Adsorption Ratio (SAR)**
Ideal	<3	5.5 to 7.5	<70	<70	<30	L, SiL	≥2.0	≤ 2	<3 for any texture
Acceptable	<4	5.0 to 8.2	<70	<70	<30	SCL, SL, CL, SiCL	≥1.0	2.1 to 5.0	3 to 7 (SiL, SiCL, CL) 3 to 10 (SCL, SL, L)
Un-acceptable	>4	<5.0 or >8.3	>70	>70	>30	LS, SC, SiC, S, Si, C	<1.0	➢ 5.0	➢ 10 for any texture

Source: Utah State University Cooperation with the U.S. Department of Agriculture under Cooperative Extension Work (AG/SO-02, 2002) [S: Sand; Si: Silty; C: Clay; L: Loam; LS: Loamy Sand; SL: Sandy Loam; SCL: Sandy Clay Loam; CL: Clay Loam; SiCL: Silty Clay Loam; SC: Sandy Clay; SC: Silty Clay; SiC: Silty clay; SiL: Silty loam]

Table IV: Effect of different treatments on soil properties along with initial status of soil

Treatment	Soil pH	E.C. (dS/m)	Organic Carbon (%)	Bulk Density (g/cc)	Available Plant Nutrients (kg/ha)				
					N	P	K	S	Zn
Initial Status	7.30	0.31	0.59	1.46	372.00	17.45	297.00	9.1	1.30
T1-150	7.30	0.33	0.64	1.45	373.25	17.40	296.25	9.1	1.40
T2-300	7.30	0.33	0.64	1.44	373.00	17.45	296.50	9.1	1.40
T3-450	7.30	0.33	0.65	1.44	374.75	17.50	297.50	9.28	1.43
T4-600	7.30	0.33	0.66	1.43	374.00	17.60	299.00	9.30	1.43
T5-750	7.33	0.33	0.66	1.42	375.5	17.83	299.50	9.43	1.45
T6-900	7.33	0.33	0.66	1.42	376.75	17.85	301.00	9.48	1.45
T7-RDF	7.40	0.34	0.58	1.42	372.50	17.45	297.25	9.13	1.38
T8-VC	7.15	0.30	0.68	1.40	378.25	17.93	303.00	9.50	1.45
SEm ±	0.07	0.01	0.03	0.02	21.52	0.95	4.89	0.47	0.09
Coefficient of Determination (R^2)	0.69	0.38	0.85	0.94	0.83	0.86	0.96	0.94	0.90
Correlation Coefficient (R)	0.83	0.61	0.92	- 0.97	0.91	0.93	0.98	0.97	0.95

SEm: Standard Error around mean; CD: Critical Difference; EC: electrical conductivity

Table V: Summary of the results on effects of treatments on soil characteristics

Parameters	*Optimum Treatments*	*Trend of enhancement*	*Correlation Coefficient*	*% Increase over initial value*	*% increase over T7-RDF control*	*% increase over T8-VC control*
pH	T5-750	RDF>BS+RDF	0.83	0.41	-0.95	2.52
EC	T1-150	RDF>BS+RDF	NaN	6.45	-2.94	10.00
OC	T4-600	VC>BS+RDF	0.92	11.86	13.79	-2.94
BD	T5-750	VC>(BS+RDF)=RDF	-0.97	-2.74	0.0	1.43
N	T6-900	VC>BS+RDF>RDF	0.91	1.28	1.14	-0.40
P	T6-900	VC>BS+RDF	0.93	2.29	2.47	-0.45
K	T6-900	VC>BS+RDF	0.98	1.35	2.25	-0.66
S	T6-900	VC>BS+RDF>RDF	0.97	4.18	3.83	-0.21
Zn	T5-750	VC=BS+RDF>RDF	0.95	11.54	5.07	0.0

BS: *Biosil*; RDF: recommended dose of fertilizers; VC: vermicompost; EC: electrical conductivity; OC: organic carbon; BD: bulk density

Table VI: Optimum dose of Biosil with RDF and comparison of the results of treatments on plant growth and productivity

Parameters	*Optimum treatment*	*DAT for maximum development*	*Trend of Enhancement*	*Maximum Value*
Plant height	T6-900	90 DAT	BS+RDF>VC>RDF	82.33 cm
Number of leaves	T6-900	Rapid in 30 DAT then taper gradually	BS+RDF>VC>RDF	793 leaves/m2
Leaf area/m2	T6-900	90 DAT	BS+RDF>VC>RDF	27444/m2
Leaf Area Index	T6-900	60 DAT	BS+RDF>VC>RDF	5.49
Number of Tillers/m2	T6-900	60 DAT	BS+RDF>VC>RDF	287 tillers/m2
Number of Effective tillers	T6-900	Maturity	BS+RDF>VC>RDF	273/m2
Length of panicle	T6-900	Maturity	BS+RDF>VC>RDF	32.70 cm
Number of grains per panicle	T6-900	Maturity	BS+RDF>VC>RDF	173 grains/ panicle
Test weight	T6-900	Maturity	BS+RDF>VC>RDF	19.33 g
Grain yield	T6-900	Maturity	BS+RDF>VC>RDF	47.40 q/ha
Straw yield	T6-900	Maturity	BS+RDF>VC>RDF	97.47 q/ha

DAT: days after transplantation; BS: *Biosil*; RDF: recommended dose of fertilizers; VC: vermicompost

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THE CRYSTAL UNIVERSE?... *(A New theory on "Atom and element")*

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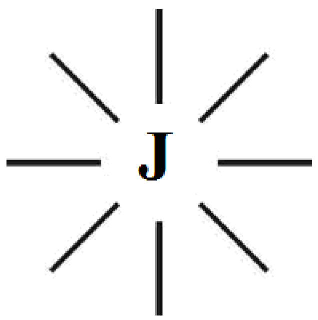
Abstract: **-** A Scientific research in this article focus that the "**Material Universe**" which accommodates Various Planets, Comets, Asteroids, life organisms shall be considered as "**SINGLE CRYSTAL HOUSE**" deriving soul from "**WHITE ELEMENT**" (or) "WHITE IONS" and free from "**ATOM**". It is focused that "**BLACK CRYSTAL**" shall be considered as the absolutely perfect body exist in the early Universe and material Universe shall be considered as the integral part of black crystal.

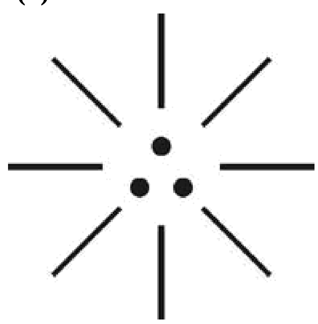
It is further focused that Billions of billions various matters having different "**Molecular Structure**" evolved in "**Three Nuclear Age**" due to impact of **"Fission", "Fusion"** action shall be considered arranged, within the Single crystal house in "**three dimensional** pattern say horizontal, vertical and lateral layers under three domain.

(i)



(White Crystal House)

(ii)



(Three Crystal Domain)

This research further focus that the entire Universal matters pertain to various "**genus and species**" shall be considered derived from fundamental "**WHITE ELEMENT**". In proto Indo Europe Language the white cell shall also be called as "**THEE**". THEE shall also mean the fundamental white matter made of "**White element**" formed near "**White Hole**" region of universe exist under "**Endothermic reaction**" environment in the early universe.

i. *"**ATOM**" is like "**SEED**"*
 ***ELEMENT** is like "**TREE**"*
ii. ***ATOM** is like "**SPECIES**"*
 ***ELEMENT** is like "**GENUS**"*
iii. ***ATOM** is like "**EXOTHERMIC**"*
 ***ELEMENT** is like "**ENDOTHERMIC**"*
iv. ***ATOM** is like byproduct of "**FUSION**"*
 ***ELEMENT** is like byproduct of "**FISSION**"*
v. ***ATOM** is like "**BABY**"*
 ***ELEMENT** is like "**INFANT**"*

-Author

Key Words: -
a) Philosophy of "**Black crystal**"
b) Philosophy of "**White crystal**"
c) Philosophy of **White cell**
d) Chemical symbol of **White crystal**
e) Molecular symbol of **White crystal**
f) Philosophy of **Crystal Nucleus**
g) Philosophy of **Crystal planet**
h) Philosophy of **Crystal comet**
i) Philosophy of **Crystal ions**
j) Philosophy of **Crystal family**
k) Philosophy of **Crystal star**
l) New definition for Atom and Element **model**

I. INTRODUCTION

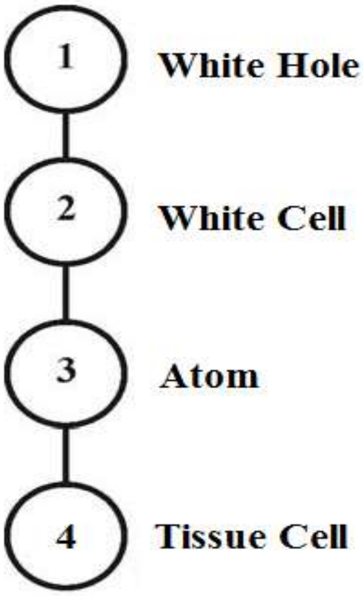
Scientific study shows that currently there are about **118** identified elements and arranged in order based on Valence and Nucleus mass in periodic Table.

Current theory focus that "**ATOM**" is made up of subatomic particles and atoms can be "**split**" into particles. Where as "**ELEMENT**" is considered as basic substance which can't be simplified further. In other words the smallest unit of element is considered as made of single Atom. If so what is the exact difference between "**ATOM**" and "**ELEMENT**"?... can we say "Atom" is the smallest unit of Element?… Then how can be a scientific explanation that Element can't be simplified when Atom could be further split into sub atomic particles?...

It is focused that the global level scientists still could not exactly clarify for the following.

1. **What Element is made up?...**
2. **How exactly Atom differs from Element?...**
3. **How exactly Atom differs from Cell?...**
4. **What is the source of Element and Cell?...**

It is emphasized that "**Element**" shall be considered as the "**Natural Product**" derived from the source of "**WHITE CELL**". The philosophy of **white hole region**, white crystal formation, "Atom" and "Tissue cell" formation stage shall be described below.



*"The formation of various atoms right from Hydrogen, Carbon, Nitrogen, ozone to heavy weight thorium, Uranium, Biological Tissue cell shall be considered as species matters derived from "**White crystal cell**".*

-Author

II. HYPOTHESIS AND NARRATION

a) Philosophy of "Black Crystal"?...

Case study shows that the universe is believed to have been formed **13.7 billion years** ago from molecular cloud of star dust particles supported by "**Big Bang theory**". The big bang theory is based on cosmological principal which states that the Universe is homogeneous.

If so…

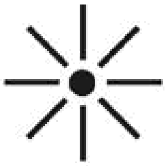
i) **What does mean molecular star dust cloud?...**

ii) **What does mean star dust?...**

iii) **Where did the Energy come from for driving force?...**

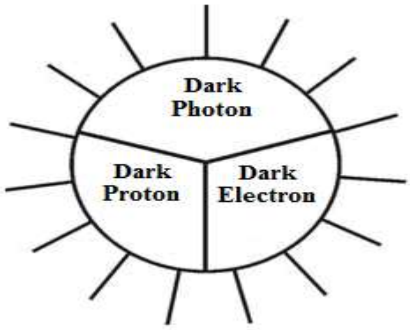
It is hypothesized that "**BLACK CRYSTAL**" shall be considered as the source of Energy exist under "**Super Endothermic**" environment having infinity level of "**ENTHALPY**" and Zero level of "**ENTROPY**". The black crystal shall also be called in Proto Indo Europe language "**AKKI-e**". Akki-e shall mean "**DARK FROZEN FLAME**". The philosophy of black crystal shall be represented with "Logo" as below:

(i)



(Black Crystal)

(ii)



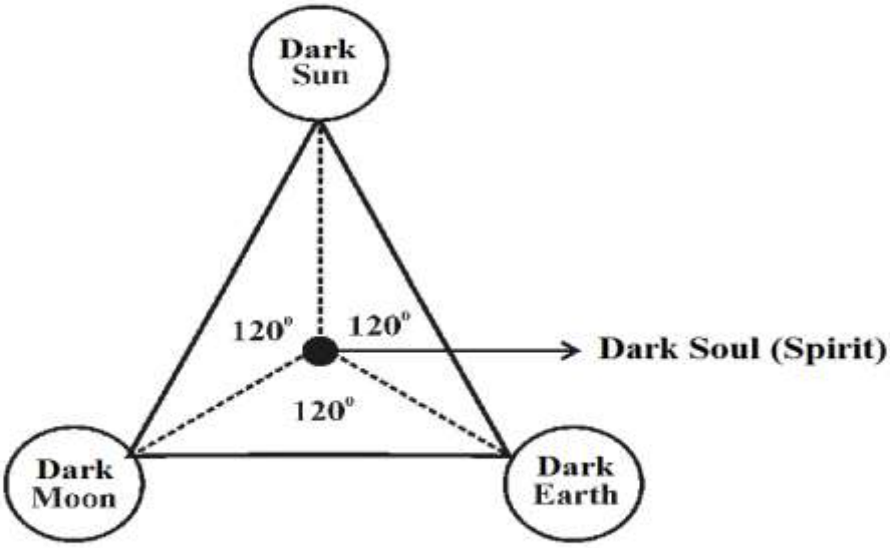
(Dark Cell)

It is further focused that during the course of time (called as Expanding universe) the Black crystal undergoes "**Growth**" due to slow change in environment condition. During the Growth of black crystal billions of dark cells shall be considered evolved which are responsible for formation of various species to fundamental dark crystal. The so called "**BLACK BODY**" stipulated in modern astrophysics shall be considered as species to fundamental black crystal.

b) Philosophy of structure of "Black crystal"?...

The black crystal must have definite structure?... If so what is the structure?

It is hypothesized that the Black crystal shall be considered like a closed "**TRIPOD**" like structure concentrically connected to a '**knot'** called "**Dark soul**" (or) "**Spirit**". The "**Plane**" of black crystal shall be considered as integral part of "**Dark Sun**", "**Dark Earth**", "**Dark Moon**" as described below:



(MODEL BLACK CRYSTAL)

c) Philosophy of "Dark cell"?...

It is hypothesized that during the course of "**cell growth**" billions of dark cell particulars shall be considered formed in different layers with defined "**crystalline structure**". In proto Indo Europe language the dark particulars shall be called as "KARI THIRI". **Kari thiri** (Akkie) shall mean Dark Radiation. The "**Akkie particles**" shall be understood in modern Astrophysics as "**Anti-neutrinos**", "**Neutrinos**".

The philosophy of "**Kari thiri**" composed of billions of sub particles under "**three domain**" shall be called as "**Dark cell**".

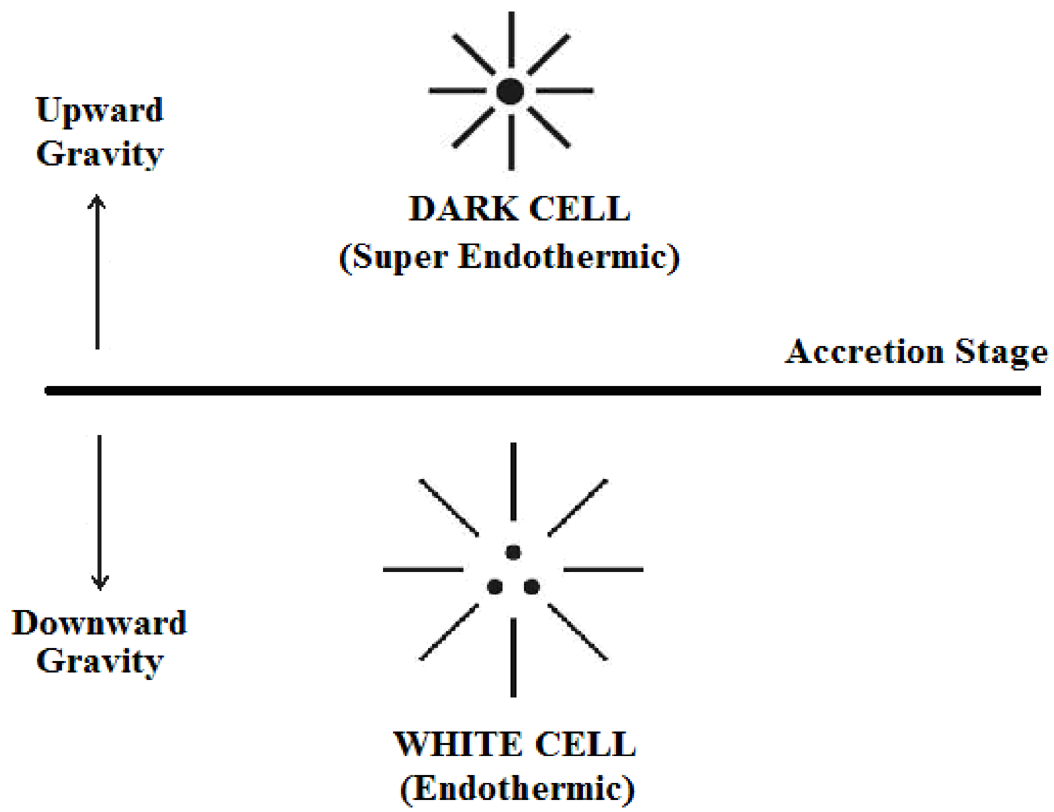
The philosophy of Dark cell shall be called modern scientific term as "**SUPERNATURE**" and the source of Energy for formation of "**molecular star dust**" cloud described n "**Big Bang Model theory**". Further the entire Dark cells shall be considered as under the strong "**Gravitational Force**" of "**Dark soul**". It is further focused that the "**Dark cell**" shall be considered as exist under "**Strong Endo thermic**" environment and absolutely free from "**Hydrogen**", **Carbon**" "**Nitrogen**", "**Ozone**" which shall be considered as "**1st generation**" "**natural atoms**".

d) Philosophy of "Accretion"?...

Case study shows that the philosophy of word Accretion has wider meaning in Biology, Astronomy and Finance Management. In general Accretion refers to the growth or increase by gradual accumulation of additional layers or matters. In biological term accretion refers to "**Biological Fission**" that the coming together and cohesion of matters under in fluency of "**gravitation**" to form larger bodies. The Accretion increased the "**Mass**" of the matter under influence of "**gravity**". In Astronomy Accretion refers to an increase in the mass of celestial object by the collection of interstellar gases and objects by gratify.

It is hypothesized that the "**Accretion**" shall be considered as just like "**ignition**" which begins "**Chain reaction**" of Dark cell of "**Black Crystal**" to become "**White cells**" consists of Higher mass of "**White cells**". In other words Accretion shall be considered as the stage of "**Super nature Fission**" to become the stage of White Crystal under "**Downward gravity**" which exists under lower level of Endothermic environment compared to Dark cells (Akkie particles) exist under still higher endothermic environment.

The philosophy of "**Super nature Fission**" shall be described as below:



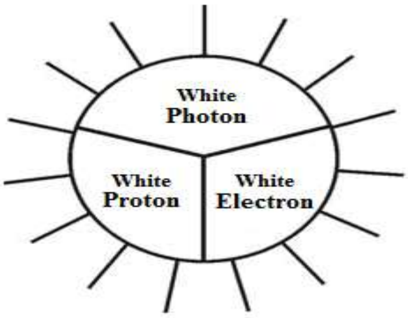
In Biological view the super nature fission shall be viewed like the stage of becoming "**Zygote**" from "**Embryo**" and ultimately becoming "**INFANT**" (White crystal) in three stage of Trimester. In Astronomy it shall be referred to the stage of becoming "**Anti-neutrinos**" from Dark crystal cell" and ultimately becoming "**Neutrinos**" (White crystal) in three stages of "**Proto Nuclear evolution**". Further the stage of "Neutrino Radiation" also called as "**J-RADIATION**" exist under "Zero" (or) low "Entropy" compared to the stage of "**Electromagnetic Radiation**" (EMR) exist under still "higher level of Entropy" compared to "J-Radiation" (Zero Entropy).

*"The "**J-Radiation**" shall be considered like "**Dawn of morning Light**" from "**Dark light**" (Akkie) comprised of Billions of "**Crystalline rays**" consists of fundamental particles white photon, white electron, white proton. The J-Radiation shall also be called as "**White spectrum**" (called in Proto Indo Europe language Mukil).*

- ***Author***

e) Philosophy of White cell?...

It is hypothesized that the smallest unit of crystalline ray shall be called as "**White cell**" (zero mass). the white crystal comprise of billions of white rays under three fundamental domain shall also be called as white matter.

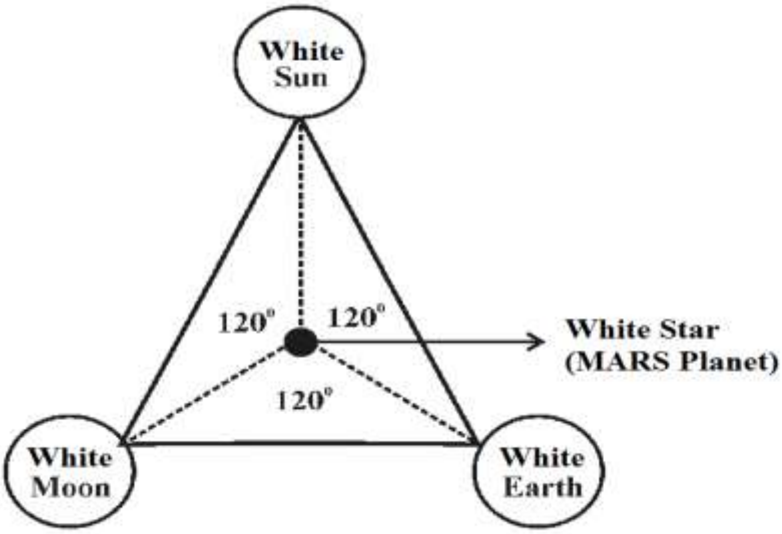


(WHITE CELL)

f) Philosophy of white star?...

It is hypothesized that the source of "**Light**" shall be considered as "**White star**". In astronomical term the white star shall be considered as "**MARS PLANET**" (White hole region). The Sun, Earth, Moon shall be considered as three domain of "**White ions**" (crystal ions) as described below:

i) "**Mars**" is **white star** (white element)
ii) "**Sun**" is "**White photon**" (Neutral ion)
iii) "**Earth**" is like "**White Electron**" (Anion)
iv) "**Moon**" is like "**White proton**" (Cation)



(MODEL J-SOLAR)

It is hypothesized that MARS planet shall be considered as star rather than planet and shall be called as "**mother of stars**". Further in the expanding Universe different species stars shall be considered evolved which led to three fundamental galaxies as described below:

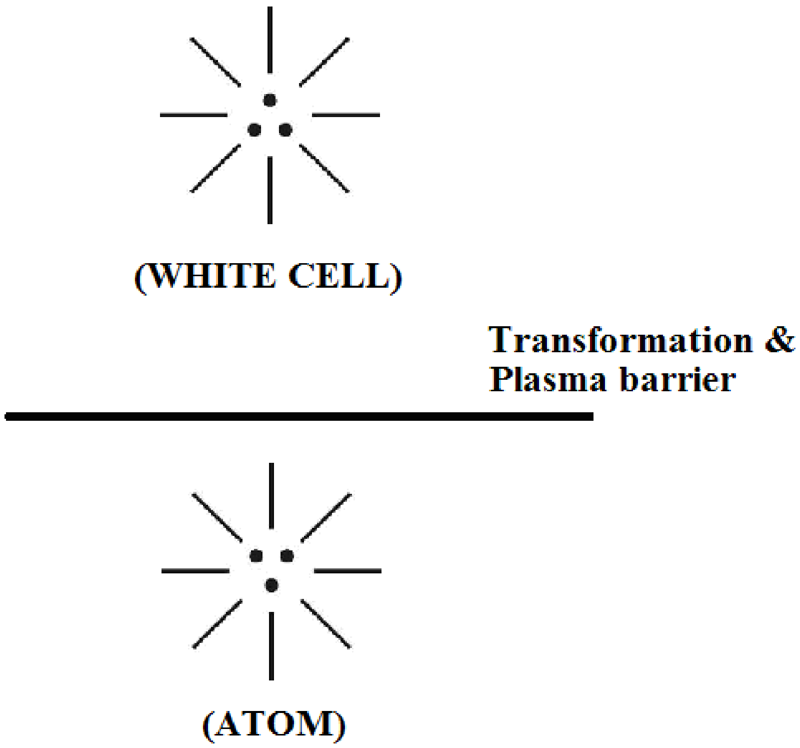
i) Blue galaxy (composed of blue MARS, blue SUN, blue EARTH, blue MOON)
ii) Green galaxy (composed of green MARS, green SUN, green EARTH, green MOON)
iii) Red galaxy (composed of Red MARS, Red SUN, Red EARTH, Red MOON)
iv) Current Red galaxy (composed of Brown MARS, Brown SUN, Brown EARTH, Brown MOON)

*"The "**White star**" shall also be called as mega star of "**Milky Universe**" contain 'infinity level" of "**white energy**". The mega star shall also be called as "**J-SOLAR**" surrounded by **SUN, EARTH, MOON**"*

… Author

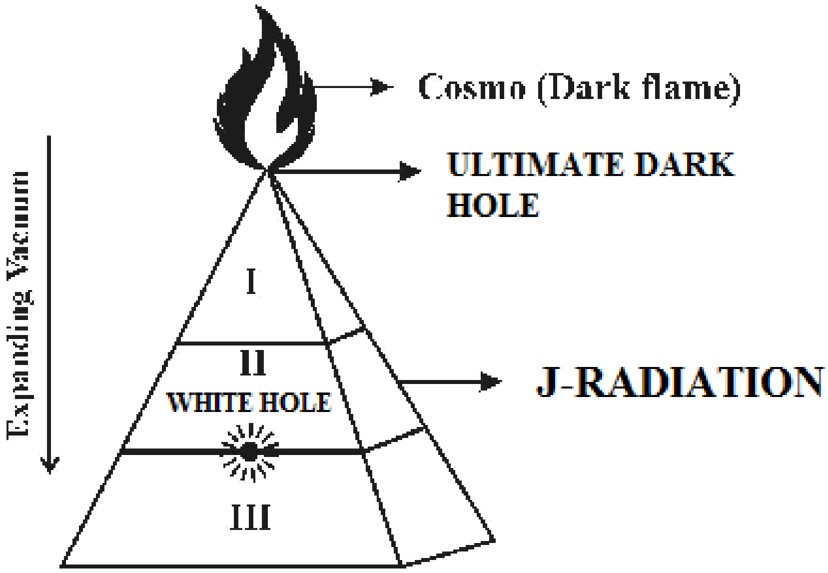
g) Philosophy of origin of ATOM?...

It is hypothesized that during the 'expanding universe" the "**White crystal**" undergoes "**Plasma stage**" and become "**ATOM**" and "**higher mass white energy**". Alternatively the plasma stage shall be considered like "**Fission of white crystal**" and produces Atom and higher mass white energy. The white energy produced considered made "**chain Reaction**" for production of various species crystals called "**Blue Crystal**", "**Green Crystal**" "**Red Crystal**" in three nuclear age and produced three generations of crystal matters.



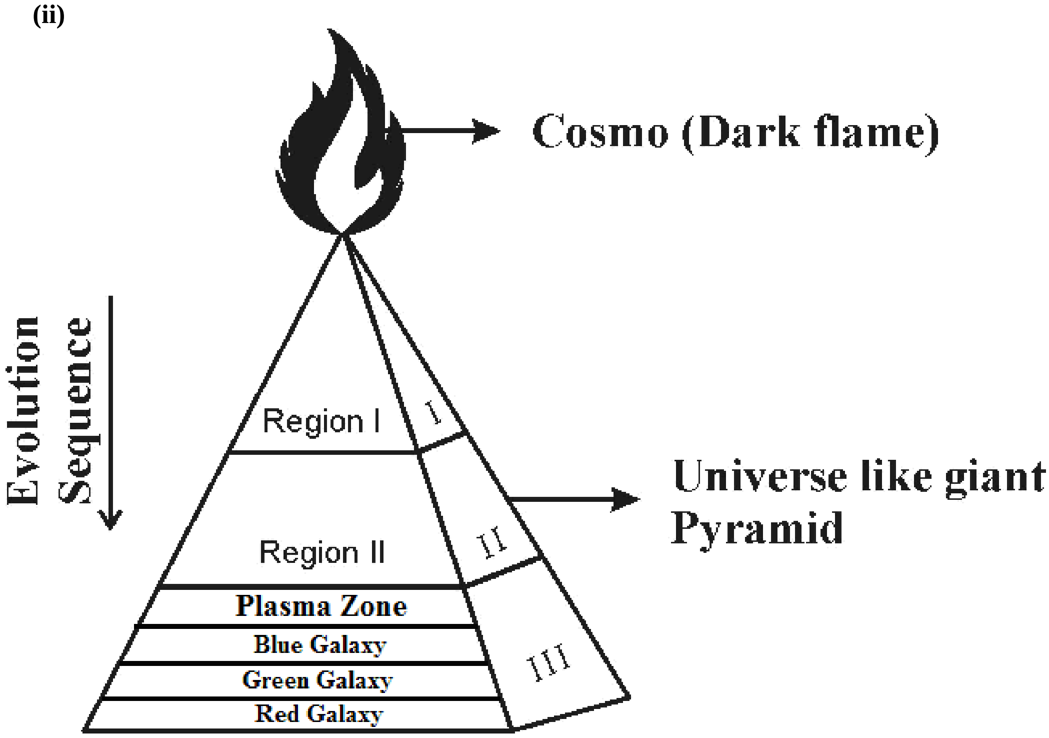
It is focused that various comets, asteroids, meteorites shall be considered as species of three generation plasma crystals and various planets, matters shall be considered as the species of three generations Blue, Green, Red crystals. The three crystal universe shall also be considered as "**three galaxies**" classified under three families of **γ, β, α** emitting **UV RF, IR** radiations in the respective regions of "**Crystal Universe**". It is focused that UV, RF, IR regions shall be considered existing in different "**EXOTHERMIC REACTION**" environment i.e. UV is at lower exothermic, RF at moderate exothermic, IR at higher exothermic.

(i)



(MODEL COSMO UNIVERSE)

(ii)



3G GALAXY

"The '**ATOM'** shall be considered as exist under Exothermic reaction environment with higher level entropy compared to "**ELEMENT**" (white crystal) exist under Endo thermic reaction with Zero level Entropy"

… Author

h) Philosophy of white Hydrogen?...

It is hypothesized that "**white hydrogen**" shall be considered as "**Plasma stage**" of "**White crystal**" or semi element under transformation. In Biological term it shall be considered as "**prokaryotes**" and "**Hydrogen Isotopes**" shall be considered as "**Eukaryotes**" and other Biological cell like "**Stem cell**". It is focused that all kinds of cells shall be considered as evolved from '**White energy**' formed during "**Fission of white crystal**". Similarly all matters shall be considered evolved from "**White hydrogen**" "**Blue hydrogen**", "**Green hydrogen**", "**Red Hydrogen**" under fundamental three domain of atoms **"Carbon", "Nitrogen", "Ozone"** in three "**CNO CYCLE AGE**".

i) Philosophy of three energy level?...

It is hypothesized that the matters produced in "**three different region of galaxies**" shall be considered having different energy level due to impact of varied Exdo, Exothermic reaction level and Enthalphy Entropy level based on characteristics of varied pressure, density, temperature – equilibrium level of matters with different level of Reflectivity, permittivity, permeability under three environment of **UV, RF, IR**.

i) White Galaxy - Infinity level (J-Radiation)
ii) Plasma Galaxy_ Say 90% level (White energy)
iii) Blue Galaxy _ Say 70% level (Blue Energy)
iv) Green Galaxy _ Say 50% level (Green Energy)
v) Red Galaxy _ Say 40% level (Red Energy)
vi) Current Red Galaxy- Say 30% level (Brown Energy)

It is focused that the varied energy level from higher level to lower level shall be considered due to slow and consistent changes from endothermic reaction environment to exothermic reaction environment.

j) Philosophy of Element and Atom?...

i) Hydrogen is Element?...
ii) Carbon is Element?...
iii) Nitrogen is Element?...
iv) Ozone is Element?...
v) Uranium is Element?...

No… No… No…

The philosophy of Element shall be considered as composed of only ions of photon, electron, proton billions of elements shall be considered derived from "**White crystal**" and exists under three domain. Atom, higher mass tissue cells considered descended from "**White Element**" (White crystal).

The Uranium Gold, Platinum, Indium shall be considered as "atoms" derived from three domain of fundamental atoms, "**CARBON, NITROGEN, OZONE**".

k) Philosophy of CRYSTAL STAR?...

The philosophy of "**crystal star**" (White star) shall be considered as "**mother**" of crystal elements and atoms undergoes "**Fission**" and "**Fusion**" to produce billions of matters in the material universe. In proto Indo Europe language "**Crystal Star**" shall be called as "**THAI-e**". Further fission and fusion shall be called in Proto-Indo-Europe language as **THIRI, ERI**.

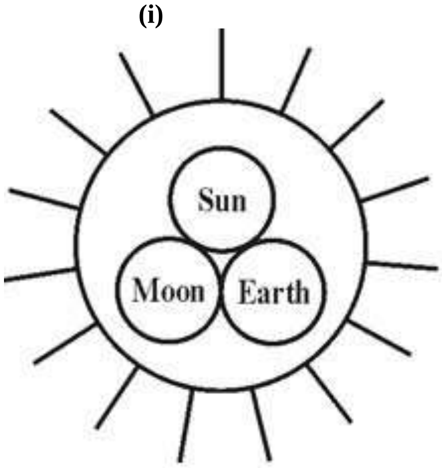
THAI-e
(Crystal Star)

l) New definition for Atom and Element model?...

It is focused that the Philosophy of element and atom having in built energy and having genetically opposite in characteristics. It is focused that various cell, atom shall be considered as produced due to systematic action of decay, annihilation of element, atom.

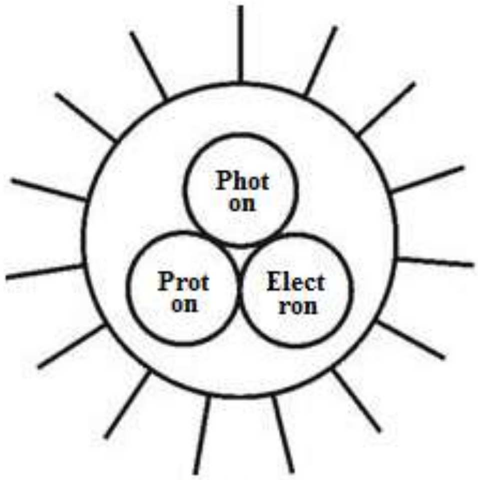
i) Dark Cell -> White Cell + white Energy (J-Radiation)
ii) White Cell -> Element + Energy (Hydrogen plasma)
iii) Element -> Atom + Energy (Electromagnetic Radiation)
iv) Atom -> Atom isotope + Energy (γ, β, α)

(i)



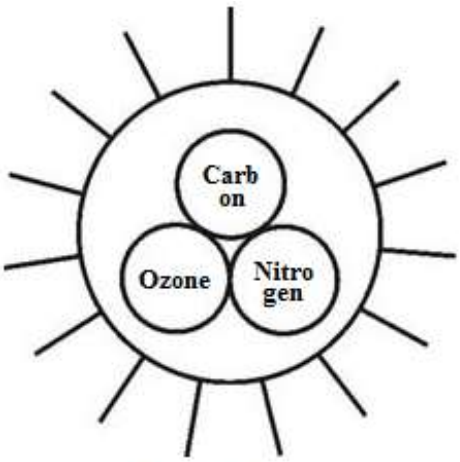
(J-SOLAR)

(ii)



(Model Element)

(iii)



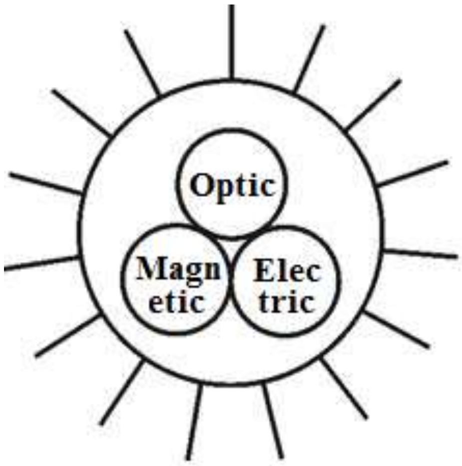
(Model Atom)

m) New Definition for Energy Model?...

Case study shows that "**Matter**" is considered as substance having mass and occupies the space. Similarly Energy is considered as something which does work. If so how exactly "**Matter**" differs from "**Energy**".

i. **Energy has any structure as Matter?...**
ii. **Energy has any Nuclei?...**
iii. **Energy possess any atoms?...**

It is hypothesized that "**Energy**" shall be considered as integral par of "**Cell**" and "**Atom**" and acts a "**SHIELD**". As such a "**Cell**" covered with "**Shield**" shall be called as "**Tissue matter**" and "**Atom**" covered with shield shall be called as "**Atomic matter**". The Energy acts as shield shall be considered as composed of fundamental THREE-IN-ONE "**Energy parameters**" "**OPTIC**", "**ELECTRONIC**", "**MAGNETIC**". As such the Philosophy of "**Energy**" shall be modeled as below. Further the least unit of **energy mass** shall be called as "**FUEL CELL**".



(FUEL CELL)

It is focused that the optic, Electric, Magnetic parameter of Energy considered having definite structure (varied angular displacement from 180° to 0° with respect to vertical axis either with upward or downward gravity). The "**J-RADIATION**" shall be considered as having 90° displacement with respect to vertical axis (Near white hole region of the Universe).

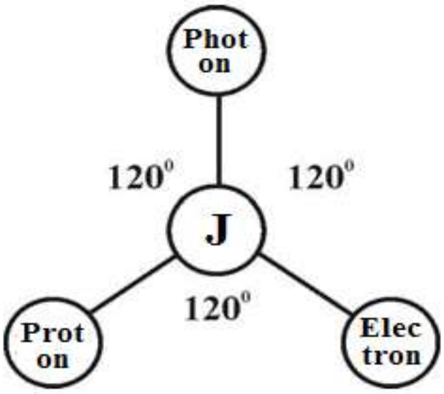
It is further focused that the whole universe is considered composed of Billions of various energy exist under "**three domain**" of optic, Electric, Magnetic parameters with varied angular displacement in three nuclear age influenced by downward gravity.

i. J-Radiation - Angular displacement of "90°" with respect to vertical axis under neutral gravity
ii. 1st generation Energy - Angular displacement of "120°" (γ family) with respect to vertical axis under downward gravity.
iii. 2nd generation Energy- Angular displacement of "150°" (β family) with respect to vertical axis under downward gravity
iv. 3rd generation Energy- Angular displacement of "160°" (α family) tending towards 180° with respect to vertical axis under downward gravity

n) Human is element (or) Atom?...

It is hypothesized that human cell shall be considered as "**ATOM**" covered with "**Energy shield**". Human shall be considered as the "**excited stage**" of "**Element**".

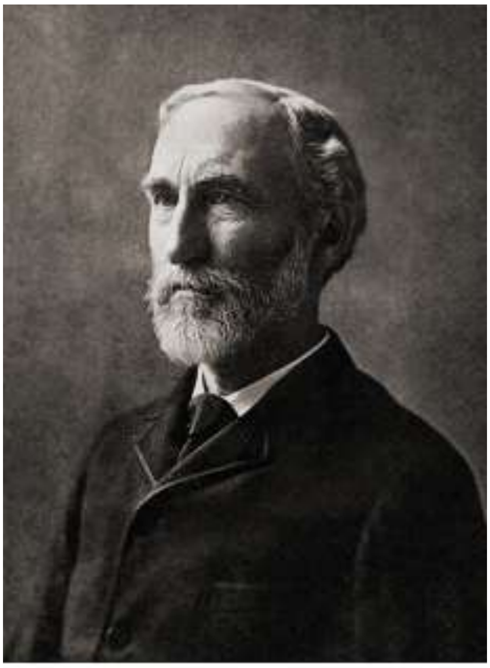
The "**Energy shield**" of human shall be considered as "**HUMAN SOUL**" concerned with the "**HEART BEAT**" of Human. In other words the "**ENERGY SHIELD**" of human shall be considered as the source of **Human heart beat**. The Philosophy of human soul shall be described as below.



(HUMAN SOUL)

o) Case study on Gibbs Contribution?...

Case study shows that JOSIAH WILLARD GIBBS (February 11, 1839 – April 28, 1903), American scientist, who made important theoretical contribution to physics, chemistry, mathematics.



(Josiah Willard Gibbs)

His work on application of thermodynamics was instrumental in transforming physical chemistry into rigorous detective science. Further his research contribution to Nuclear Area, shall be considered as fundamental base for understanding about nuclear behavior of universe. **Albert Einstein** called him as "**Great mind of America**".

p) Case study on crystal?...

Case study shows that crystal is considered as a piece of Homogenous solid substance having a natural geometrically regular form with systematically arranged faces. In biological term crystal shall mean having "**common descendent**". Further case study show that "**crystal growth**" is a solid material whose constituent atoms, molecules or ions are arranged in an orderly repeating pattern in all three spatial dimensions.

q) Case study on Timeline of Crystal:

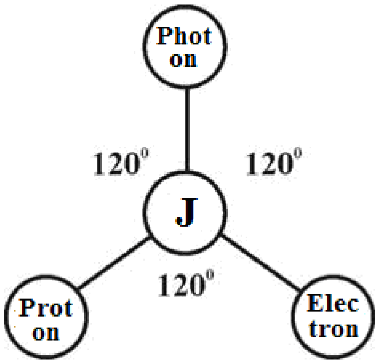
i) 1896 - Uranium gives of unknown radiation
ii) 1896 - Thorium gives off similar radiation (Marie Curie)
iii) 1905 - Albert Einstein formulates special theory of Relativity which explains the phenomenon of radioactivity as "Mass Energy" equivalence
iv) 1932 - Discovery of Neutron
v) 1932 - Nuclear Fission experiment with radiochemical.
vi) 1942 - First Self sustaining Nuclear Chain reaction
vii) 1952 - First Hydrogen Bomb Test
ix) 1954 - First Nuclear Power plant began in USSR.

Atomic Energy is not simply a search for new energy but more significantly a beginning of human history in which faith in knowledge can vitalize man's whole life.

-David Lilienthal (1949)

III. CONCLUSION

The philosophy of **white crystal** shall be considered liked a "**Global Parliament**". The members of the house shall be considered as existing like **atoms** within the house for creating useful action of **FISSION, FUSION** for betterment of mankind and for creating **PEACE.**



(VELLAI MALIKAI)

i) **Rajya Saba** is like "**Common Sense**" (Proton)
ii) **Lok Saba** is like "**Intelligence**" (Electron)
iii) **Supreme Court** is like "**Wisdom**" (Photon)
iv) **White Crystal** is like "**President**" (Element)

IV. PREVIOUS PUBLICATION

The philosophy of origin of first life and human, the philosophy of model Cosmo Universe, the philosophy of fundamental neutrino particles have already been published in various international journals mentioned below. Hence this article shall be considered as **extended version** of the previous articles already published by the same author.

[1] Cosmo Super Star – IJSRP, April issue, 2013
[2] Super Scientist of Climate control – IJSER, May issue, 2013
[3] AKKIE MARS CODE – IJSER, June issue, 2013
[4] KARITHIRI (Dark flame) The Centromere of Cosmo Universe – IJIRD, May issue, 2013
[5] MA-AYYAN of MARS – IJIRD, June issue, 2013
[6] MARS TRIBE – IJSER, June issue, 2013
[7] MARS MATHEMATICS – IJERD, June issue, 2013
[8] MARS (EZHEM) The mother of All Planets – IJSER, June issue, 2013
[9] The Mystery of Crop Circle – IJOART, May issue, 2013
[10] Origin of First Language – IJIRD, June issue, 2013
[11] MARS TRISOMY HUMAN – IJOART, June issue, 2013
[12] MARS ANGEL – IJSTR, June issue, 2013
[13] Three principles of Akkie Management (AJIBM, August issue, 2013)
[14] Prehistoric Triphthong Alphabet (IJIRD, July issue, 2013)
[15] Prehistoric Akkie Music (IJST, July issue, 2013)
[16] Barack Obama is Tamil Based Indian? (IJSER, August issue, 2013)
[17] Philosophy of MARS Radiation (IJSER, August 2013)
[18] Etymology of word **"J"** (IJSER, September 2013)
[19] NOAH is Dravidian? (IJOART, August 2013)
[20] Philosophy of Dark Cell (Soul)? (IJSER, September 2013)
[21] Darwin Sir is Wrong?! (IJSER, October issue, 2013)
[22] Prehistoric Pyramids are RF Antenna?!... (IJSER, October issue, 2013)
[23] HUMAN IS A ROAM FREE CELL PHONE?!... (IJIRD, September issue, 2013)
[24] NEUTRINOS EXIST IN EARTH ATMOSPHERE?!... (IJERD, October issue, 2013)
[25] EARLY UNIVERSE WAS HIGHLY FROZEN?!... (IJOART, October issue, 2013)
[26] UNIVERSE IS LIKE SPACE SHIP?!... (AJER, October issue, 2013)
[27] ANCIENT EGYPT IS DRAVIDA NAD?!... (IJSER, November issue, 2013)
[28] ROSETTA STONE IS PREHISTORIC "THAMEE STONE" ?!... (IJSER, November issue, 2013)
[29] The Supernatural "CNO" HUMAN?... (IJOART, December issue, 2013)
[30] 3G HUMAN ANCESTOR?... (AJER, December issue, 2013)
[31] 3G Evolution?... (IJIRD, December issue, 2013)
[32] God Created Human?... (IJERD, December issue, 2013)
[33] Prehistoric "J" – Element?... (IJSER, January issue, 2014)

[34] 3G Mobile phone Induces Cancer?... (IJERD, December issue, 2013)
[35] “J” Shall Mean “JOULE”?... (IRJES, December issue, 2013)
[36] “J”- HOUSE IS A HEAVEN?... (IJIRD, January issue, 2014)
[37] The Supersonic JET FLIGHT-2014?... (IJSER, January issue, 2014)
[38] “J”-RADIATION IS MOTHER OF HYDROGEN?... (AJER, January issue, 2014)
[39] PEACE BEGINS WITH “J”?... (IJERD, January issue, 2014)
[40] THE VIRGIN LIGHT?... (IJCRAR, January issue 2014)
[41] THE VEILED MOTHER?... (IJERD, January issue 2014)
[42] GOD HAS NO LUNGS?... (IJERD, February issue 2014)
[43] Matters are made of Light or Atom?!... (IJERD, February issue 2014)
[44] THE NUCLEAR “MUKKULAM”?... (IJSER, February issue 2014)
[45] WHITE REVOLUTION 2014-15?... (IJERD, February issue 2014)
[46] STAR TWINKLES!?... (IJERD, March issue 2014)
[47] “E-LANKA” THE TAMIL CONTINENT?... (IJERD, March issue 2014)
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Numerical solutions of second-orderdifferential equationsby Adam Bashforth method

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Abstract:- So far, many methods have been presented to solve the first-order differential equations. Not many studies have been conducted for numerical solution of high-order differential equations. In this research, we have applied Adam Bashforthmulti-step methods to approximate higher-order differential equations. To solve it, first we convert the equation to the first-order differential equation by order reduction method. Then we use a single-step method such as Euler, Taylor or Runge-Kutta for approximation of initially orders which are required to start Adam Bashforth method. Now we can use the proposed method to approximate rest of the points. Finally, we examine the accuracy of method by presenting examples.

Keywords:- high-order differential equations, Adams Bashforth multi-step methods, order reduction

I. INTRODUCTION

Differentialequations arevery useful indifferent sciencessuch asphysics, chemistry, biology and economy. To learn more aboutthe use of theseequationsin mentioned sciences, you can see theapplication of theseequationsinphysics[1,8,6,7,12], chemistry in [16,2,15], biology in [5,4] and economy in [10]. Considering that most of the time analyticsolution of such equations and finding an exact solution has either high complexity or cannot be solved, we applied numerical methods for the solution. Due to our subject which is solving the second-order differential equations, we will refer to some solution methods which have been proposed in recent years by other researchers to solve the equations. In 1993, Zhang presented a solution method for second-order boundary value problems [20]. In 2000, Yang introduced quasi-approximate periodic solutions for second-order neutral delay differential equations[17]. In 2003, Yang presented a method for solving second-order differential equations with almost periodic coefficients [18]. In 2005, Liu et alobtained periodic solutions for high-order delayedequations [9]. In 2005, Nieto and Lopez used Green's function to solve second-order differential equations which boundary value is periodic [11]. In 2006, Yang et al also applied Green's function to solve second-order differential equations [19]. In 2008, Pan obtained periodic solutions for high-order differential equations with deviated argument [13]. In 2011, Lopez used non-local boundary value problems for solving second-order functional differential equations [14]. It should be noted that most of these equations have piecewisearguments. Other parts of this paper are organized as follows. In the second part, we willreview therequired definitionsandbasic concepts. In the third section, we will propose the basic idea for solve insecond orderdifferential equations. In thefourth section, we will provideexamplesfor further explanation ofthe method and in fifth section; it will end with results of discussion.

II. REQUIRED DEFINITIONS AND BASIC CONCEPTS

Definition 2.1. [3]the general form of a second-order differential equation is as follows:

$$\frac{d^2y}{dt^2}+p(t)\frac{dy}{dt}+q(t)y=R(t) \qquad (3-1)$$

Or it can be more simply stated as below:

$$y''+p(t)y_0'+q(t)y=R(t)$$

In which, p (t), q (t) and R (t) are functions of t and without any reduction in totality, the coefficient of y'' is equal to 1 because also in another way, this coefficient will already convert to one for y'' with dividing by coefficient of y''.

Note: Ifine theequation (3.1) the value ofR (t) is 0, then the equationiscalledahomogeneousequation.

Definition 2.2. [3]we say that the function of $f(t,y)$ with variable of y on series of $D \subset R^2$is true in Lipshitz condition. If a fix such $L > 0$exists with this property that when

$(t,y_1),(t,y_2) \in D$,

(3-2) $$|f(t,y_1) - f(t,y_2)| \leq L|y_1 - y_2|$$

We consider the fix L as a Lipschitz fix for$f$.

Definition 2.3. [3]we say that the set of $D \subset R^2$is convex. If, whenever $(t_1, y_1), (t_2, y_2)$belongs to D , the point of $((1-\lambda)t_1 + \lambda t_2\,,\ (1-\lambda)y_1 + \lambda y_2)$which $0 \leq \lambda \leq 1$belongs to D per eachλ.

Theorem2.1.[3] Suppose that $f(t,y)$is described on a convex set of $D \subset R^2$. If a fix such $L > 0$ exists that per each $(t,y) \in D$,

$$|\frac{\partial f}{\partial y}(t,y)| \leq L$$

Then f according to the variable of y on D in lipschitz condition is true with L fix lipschitz.

Theorem3.2. [3]suppose that $D = \{(t,y) a \leq t \leq b, -\infty < y < \infty\}$and $f(t,y)$ are contiguous on D. when f is true in lipschitz condition according to the variable of y on D, then problem of initial value of $y(a) = \alpha$, $a \leq t \leq b$ and $y' = f(t,y)$ have unique solution of $y(t)$ per $a \leq t \leq b$.

Definition 3.4. [3]a multi-steps technique to solve the problem of initial value.

(3-3) $$y' = f(t,y), \qquad a \leq t \leq b, \qquad y(a) = \alpha$$

It is a technique that its' differential equation is to find the approximation of w_{i+1} in the network point of t_{i+1} which can be shown by below equation in which m is an integer greater

(3-4) $$w_{i+1} = a_{n-1}w_i + a_{m-2}w_{i-1} + \cdots + a_0 w_{i+1-m} + h[b_m f(t_{i+1}, w_{i+1}) + b_{m-1} f(t_i, w_i) + \cdots + b_0 f(t_{i+1-m}, w_{i+1-m})]$$

Per each $i = m-1, m, \ldots, N-1$ in which the initial values of

(3-5) $$w_0 = \alpha_0, w_1 = \alpha_1, w_2 = \alpha_2, \ldots, w_{m-1} = \alpha_{m-1}$$

$$h = {(b-a)}/{N}$$

Are determined and as typical

When $b_m = 0$, we call it explicit or open method and in the equation (3-2) it gives the value of w_{i+1} explicitly based on predetermined values. When $b_m \neq 0$, we call it implicit or close method, because w_{i+1} appears in both sides of (3-4) and it can be determined only with an implicit method.

III. THE MAIN IDEAFOR SOLVINGSECOND-ORDERDIFFERENTIAL EQUATIONS

We consider the differential equations as following in which t is an independent variable and y is a dependant variable.

(4-1) $$\frac{d^2y}{dt^2} = f(t, y, \frac{dy}{dt})$$

Now to solve such equations, we act as follows:

(4.2) $$\frac{dy}{dt} = p$$

According to the equation (2-3), we convert the relation (1-3) to two first-order differential equation as follows:

(4.3) $$\frac{dy}{dt} = p = f_1(t, y, p)$$

(4.4) $$\frac{dp}{dt} = p = f_2(t, y, p)$$

Then we use Adam Bashforth's two-steps, three-steps and … method to solve the equations (4-3) and (4.4).

Suppose that the initial condition for (4-3) and (4-4) are given as below:

(4.5) $$y(t_0) = y_0,\ y'(t_0) = p(t_0) = p_0$$

Now, if we want to use n-step Adam Bashforth method for n= 2, 3, 4… in this case we should use n-1 initial step with a single-step method such as Euler, Taylor or Runge-Kutta. In this research, for example we describe the Runge-Kutta single-step methodto approximate the n-1 initial step as following:

(4.6) $$y(t_m) = y_m,\ y'(t_m) = p(t_m) = p_m \qquad 0 < m < n$$

Then we describe

(4.7) $$\begin{cases} k_1 = hf_1(t_m, w_m, v_m) \\ . \\ k_2 = hf_1(t_m + h, w_m + k_1, v_m + l_1) \end{cases}$$

(4.8) $$\begin{cases} k_2 = hf_2(t_m, w_m, v_m) \\ . \\ k_2 = hf_2(t_m + h, w_m + k_1, v_m + l_1) \end{cases}$$

Now suppose that we want to obtain the value of$v_{m+1}, w_{m+1}$by v_m, w_m, we have:

(4.9) $$\begin{cases} w_{m+1} = w_m + \frac{1}{2}(k_1 + k_2) \\ . \\ v_{m+1} = v_m + \frac{1}{2}(l_1 + l_2) \end{cases}$$

Now suppose that we are in n step that after this step we want to use Adam Bashforth multi-step method; general form of these methods is as below:

(4.10)

$$\begin{cases} w_{i+1} = a_{n-1}w_i + a_{n-2}w_{i-1} + \cdots + a_0 w_{i-(n-1)} + h(b_{n-1}f_1(t_i, w_i, v_i) \\ \qquad + \cdots + b_0 f_1\left(t_{i-(n-1)}, w_{i-(n-1)}, v_{i-(n-1)}\right) \\ . \\ w_0 = \alpha_0, w_1 = \alpha_1, \dots, w_{n-1} = \alpha_{n-1} \end{cases}$$

That the relation (10-3) is determined per$i = n, n+1, \dots, N$

And also

(4.11) $$\begin{cases} v_{i+1} = c_{n-1}v_i + c_{n-2}v_{i-1} + \cdots + c_0 v_{i-(n-1)} + h(b_{n-1}f_2(t_i, w_i v_i) \\ \qquad + \cdots + b_0 f_2\left(t_{i-(n-1)}, w_{i-(n-1)}, v_{i-(n-1)}\right) \\ . \\ v_0 = \beta_0, v_1 = \beta_1, \dots, v_{n-1} = \beta_{n-1} \end{cases}$$

Now in continue we will discuss about the process of obtaining multi-step methods mentioned above briefly.

5. Numerical examplesand tables

In this section, the approximate solutions obtained from Adam Bashforth multi-step methods are compared with exact solution by using numerical example and we obtain their proximity rate to the exact solution.

Example: find the solution of the following second-order linear equation

$$y'' - 6y' + 9y = 0 \quad y(0) = 0,\ \ y'(0) = 2,\ \ t \in [0,1]$$

The exact solution is$y = 2te^{3t}$.

Note 1:we have shown m-step Adam Bashforth methods and their derivatives with AB'_m و AB_m respectively in below tables.

Note 2:in below tables, which we have used m-step Adam Bashforth methods for approximation, we have obtained previous m-1 step with a single-step method; here Euler and Runge-Kutta methods are applied to obtain previous m-1 step.

Table 1: in this table, the approximate solutions obtained from $AB_4 AB_2$,. are compared with each other to approximate the true answer.

t	*y*	AB_2	AB_4	$\lvert y - AB_2\rvert$	$\lvert y - AB_4\rvert$
0	*0*	-	-	-	-
0.1	*0.2700*	-	-	-	-
0.2	*0.7288*	*0.5800*	-	*0.1488*	-
0.3	*1.4758*	*1.2015*	-	*0.2743*	-
0.4	*2.6561*	*2.1779*	*1.9920*	*0.4782*	*0.7341*
0.5	*4.4817*	*6.677*	*3.4089*	*0.8046*	*1.0728*
0.6	*7.2596*	*5.9408*	*5.6759*	*1.3181*	*1.5836*
0.7	*11.4326*	*9.3145*	*9.0902*	*2.1182*	*2.3424*
0.8	*17.6371*	*14.2897*	*14.2047*	*3.3474*	*3.4324*
0.9	*26.7835*	*21.5636*	*21.7309*	*5.2199*	*4.9934*
1	*40.1711*	*32.1216*	*32.9390*	*8.0495*	*7.2321*

Table 2:in this table, the approximate solutions obtained from AB'_4 و AB'_2 methods are compared witheach other to approximate true answer derivation which means y'.

t	*Y*	AB'_2	AB'_4	$\lvert y - AB'_2\rvert$	$\lvert y - AB'_4\rvert$
0	2	-	-	-	-
0.1	3.5096	-	-	-	-
0.2	5.8308	5.2100	-	0.6208	-
0.3	9.3465	8.2460	-	1.005	-
0.4	14.6085	12.7434	11.6656	1.865	2.9429
0.5	22.4084	19.3392	18.2125	3.0693	4.1959
0.6	33.8870	28.9374	27.8049	4.9406	6.0732
0.7	50.6303	42.8139	41.8019	7.8163	8.8284
0.8	74.9576	62.7640	62.2173	12.1936	12.7403
0.9	110.1100	91.3079	91.8201	18.8022	18.2899
1	160.6843	131.9753	134.5014	28.7090	26.1828

Again we solve the previous example with two-step and three-step methods except that in previous examples we selected Euler driver single-step method and tables 3 and 4 are Runge-Kuttadriver single-step method.

Table 3: in this table, the approximate solutions obtained from AB_4 و AB_2 methods are compared with eachother to approximate the true solution (Runge-Kutta second-order single step method is used).

T	*Y*	AB_2	AB_4	$\lvert y - AB_2\rvert$	$\lvert y - AB_4\rvert$
0	0	-	-	-	-
0.1	0.2700	-	-	-	-
0.2	0.7288	0.6805	-	0.0483	-
0.3	1.4758	1.3533	-	0.1225	-
0.4	2.6561	2.4028	2.4247	0.2533	**0.2314**
0.5	4.4817	4.0069	4.1485	0.4748	**0.3332**
0.6	7.2596	6.4207	6.7695	0.8389	**0.4900**
0.7	11.4326	10.0083	10.7052	1.4244	**0.7275**
0.8	17.6371	15.2872	16.5673	2.3499	**1.0698**
0.9	26.7835	22.9908	25.2212	3.7927	**1.5623**
1	40.1711	34.1549	37.9010	6.0162	**2.2701**

Table 4: in this table, the approximate solutions obtained from AB'_4 و AB'_2 are compared with each other for derived approximation of true solution (Runge-Kutta second-order single step method is used).

T	*y*	AB'_2	AB'_4	$\lvert y - AB'_2\rvert$	$\lvert y - AB'_4\rvert$
0	2	-	-	-	-
0.1	3.5096	-	-	-	-
0.2	5.8308	5.6420	-	0.1888	-
0.3	9.3465	8.8771	-	0.4694	-
0.4	14.6085	13.6532	13.7373	0.9554	**0.8712**
0.5	22.4084	20.6432	21.1749	0.7653	**0.2336**
0.6	33.8780	30.7981	32.0877	3.0800	**1.7904**
0.7	50.6303	45.4586	48.0042	5.1717	**2.6260**
0.8	74.9576	66.5100	71.1368	8.4476	**3.8208**
0.9	110.1100	96.5974	104.5831	13.5126	**5.5269**
1	160.6843	139.4237	152.7439	21.2606	**7.9404**

IV. CONCLUSION

In this research, we used Adams Bashforth multi-step methods to solve high-order differential equations. In the example solved, tables 1 and 2 respectively are showing the comparison of approximate solutions obtained from multi-step methods and their derivatives with true answer and derivatives of true answer. Tables 3 and 4 are as well as tables 1 and 2 except that in tables 1 and 2, Euler driver single-step method is used and in tables 3 and 4, Runge-Kutta deriver single-step method is used. It should be noted that the accuracy of Runge-Kutta driver method is more than the Euler driver method. However, in Adam Bashforth method, as the number of steps increase, the greater accuracy will be obtained.

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Effect of Manganese Addition and the Initial Aspect Ratios on the Densification Mechanism/S and Barrelling In Sintered Hyper Eutectoid P/M Steel Preforms During Hot Upset Forging

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ABSTRACT:- Present investigation pertains to evaluate the materials behaviour during hot upset forging of sintered hyper eutectoid P/M steels containing manganese and these steels are Fe-1.0%C-0.0%Mn, Fe-1.0%C-1.75%Mn,Fe-1.0%C,Fe-1.0%c-2.75%Mn and Fe-1.0%C-3.75%Mn respectively. These compositions from individual elemental powders were homogeneously blended separately in a potmill for a period of 36 hours. Preforms of initial aspect ratio of 0.43 and 0.83 with a diameter of 27.5mm were compacted to a density level of 85±1 per cent of theoretical by applying pressures in the range of 480±10 MPa and by taking pre-weighed powder blends. These compacts were coated with the indigenously developed ceramic coating to protect them against oxidation during sintering at 1150˚±10˚C in an electric muffle furnace for a period of ninety minutes. Once sintering schedule was completed, the sintered preforms of all compositions and both aspect ratios were hot upset forged to different height strains and then oil quenched. Quenched discs were thoroughly cleaned and dried. Initial and final dimensions of sintered and forged discs of all compositions were made including density measurements. Based on the initial parameters, various parameters were calculated such as true diameter and height strains, bulging ratios, relative densities, Poisson's ratios and diameter strains considering circular and parabolic bulging. Various plots were drawn among the calculated parameters and were critically analyzed. Critical analyses of these plots have yielded various empirical relationships fully describing the material behaviour during hot upset forging.

Keywords: - Aspect ratio, Blended, Compact, diameter, elemental, Forged, homogeneously, upset.

I. INTRODUCTION

Technically, the classification of alloy steels has been carried out in such a manner so as to consider the steel as low alloy if and only if, the total content of the alloying elements are lower than 5% and medium if the content ranges in between 5% to 10%, and, the steel is termed as high alloy steel if the steel contained the alloying elements beyond 10% [1]. It is true, that the plain carbon steels are quite satisfactory in various engineering applications subject to conditions that their strengths and other expectations are not, too, rigorous. Further it is reported that these steels can be employed in service where the temperature of applications is moderately low and the environments in which they are used is not, too, hostile. The major draw backs of these plain carbon steels have been successfully encountered by the addition of selective alloying elements. Therefore, the alloy steels can be redefined as the one whose basic characteristic properties are attributed to one or other alloying elements other than carbon. It has been also reported elsewhere [2] that several alloy steels do fulfil the strength requirements of a given application by inducing sufficient harden ability in the desired section size.

However, the exact options are limited by certain specific requirements such as low temperature toughness, creep resistance, corrosion or wear resistance including the freedom from temper embrittlement. It is reported [3] that manganese is one of the least expensive alloying elements and is virtually present in all steels as deoxidizer. Manganese is inherited with the characteristic features to reduce the tendency of hot-shortness resulting from the presence of sulphur, and, thus enabling the steel to be hot worked easily. Further manganese strengthens ferrite and is mild carbide former. Apart from the above, the manganese strengthens the steel in the as rolled condition and further imparts enhancement of strength and ductility to the steel in the heat treated condition. It is reported [4-15] that hot forging of P/M preforms is a highly developing process which can produce dense products from metal powders which are being employed in structural applications. P/M forging imparts improved densification coupled with a large amount of deformation in a single stroke of the punch of the press. It is also reported [16] that engineering parts can be produced to net shape with almost cent per cent dense via sintering the preforms followed by hot forging with high ductility. Apart from these, it has been conclusively established that the pores present in the component act as initiators of cracks under cyclic loading [17], and, therefore, there is a strong need to eliminate them by scientifically designed, fabricated and heat treated dies [18, 19].

Production of parts or components by powder preform forging (PPF) is an attractive process as it blends time, material and costs [20] saving advantages. The P/M preforms come under the category of porous materials experiencing plastic deformation when subjected to compressive loadings, thus, an increase in the achieved density. Technically, the magnitude of deforming blows and the dies associated with the conventional forgings are replaced by one blow and one die on a preform shaped from powder or powder blends by compaction followed by sintering. Thus, PPF is carried out in confined or closed dies which in turn ensures full densification and also eliminates the possibilities of flash formation [21]. In order to achieve mechanical properties equal to or superior to to conventionally produced parts, the P/M preforms must be designed to accommodate the metal flow and also the provision to eliminate any possibility of fracture. Another consideration must be made on the type of stresses and their stress levels required acquiring the final component or the part with full density while forming them for actual applications. Thus, these information would truly provide a real estimate of the stresses required, the press capacity to hot forge the desired component [22], and, hence, the process would provide the feasibility [23] to fabricate quite complex components in one forging operation, Therefore, engineering components can be manufactured to almost cent per cent density levels through powder or powder blend compaction and sintering followed by hot forging inducing fairly high ductility in the components.

Present investigation attempts to investigate the influence of manganese addition 0.0%, 1.75%, 2.75% and 3.75% respectively in Fe-1.0%C steel on the various aspects of densification, bulging, and Poisson's ratio under the conditions of normal, circular and parabolic modes of bulging considered during high temperature forgings of sintered P/M manganese steels.

II. EXPERIMENTAL DETAILS

II.1 Materials Required

Atomized iron powder of -180μm was procured from M/s. The Sundaram Fasteners Limited, Hyderabad, Andhra Pradesh, India. The manganese powder of -37μm was supplied by M/s. The Speciality Powders Pvt. Ltd., Mumbai, Maharashtra, India. However, the graphite powder of -5μm was provided by courtesy The M/s. Asbury Graphite Inc., New Jersey, U. S. A. The chemical analysis of the iron powder yielded a purity of 99.65% with 0.35% insoluble impurities whereas the chemical purity of manganese was found out to be 99.38% with an insoluble impurity content of 0.62%.The ash content of graphite powder was found to be 1.79%, i.e., remaining 98.21% was the effective carbon content. The basic characteristics of the respective powder blends are given in Table 1. However, the sieve size analysis of the base powder, i.e., iron is provided Table 2. High Carbon and High Chromium (HCHC) steel was required to fabricate the

Table 1 Characterization of Iron Powder and Powder Blends

Systems	Apparent Density, g/cc	Flow rate, S/100g.	Compressibility, g/cc at a pressure of 480±10MPa.
Fe-1.0%C	2.89	63	6.37
Fe-1.0%C-1.75%Mn	2.84	67	6.32
Fe-1.0%C-2.75%Mn	2.80	69	6.24
Fe-1.0%C-3.75%Mn	2.77	73	6.13

compaction die set assembly. The compaction assembly included was the mother die, the punch and the bottom insert. These die parts have been machined from suitable blanks, heat treated in the range of 950º±10ºC for one hour to four hours depending upon the part keeping in mind that every 25mm diameter part was heated and soaked for one hour at the above temperature and quenched in oil. The hardness values were in the range of 59-61Rc. These parts were tempered to hardness values of 54-56Rc. Powder compaction was carried out using 1.0MN capacity Universal Testing Machine. Apart from these, an electric muffle furnace was required to be used during sintering the compacts, which was kept near the Friction Screw Press of 1.0 MN capacity. This press was subsequently used for hot upset forging the above steels. The die material selected for the hot dies was Molybdenum die steel which are having the rectangular dimensions of 240 mm X150 mm X 100mm.

Table 2 Sieve Size Analysis of Iron Powder

Powder Sieve Size, µm	-180 + 150	-150 +125	-125 +106	-106 +90	-90 +75	-75 +63	-63 +53	-53 +37	-37
Wt% powder retained	1.52	1.83	23.12	1.11	21.86	2.21	18.60	13.62	**16.11**
Cum. Wt% powder retained	**1.52**	**3.35**	**26.47**	**27.58**	**49.44**	**51.65**	**70.25**	**83.87**	**99.98**

II.2 Blending of Mixes of Elemental Powders

Powder mixes corresponding to yield the steel compositions, namely, Fe-1%C-0.0%Mn, Fe-1.0%C-0.0%Mn, Fe-1.0%C-1.75%Mn, Fe-1.0%C, Fe-1.0%c-2.75%Mn and Fe-1.0%C-3.75%Mn respectively were blended in a separate pots on a pot mill for a period of 36 hours. Initially pre-weighed elemental powders corresponding to yield the above compositions were kept in separate pots with powder mix to porcelain balls of 15-20mm diameters in the weight ratio of 1.1:1 and the pot lids were securely tightened and fixed on the pot mill and mill was switched on. At an interval of every one hour the pot mill was switched off and nearly 110 g of powder mix from each pot was taken out and measurements such as flow rates and apparent densities were measured. Once, this operation was completed, the powder mixes were returned back to the respective pots and their respective lids were tightened properly and the pots were re-fixed on the pot mill and the mill was switched on again. This schedule was continued till the lost three observations of flow rates and apparent densities were consistent. It was found out that the blending time of 36 hours was most suitable to yield homogeneous blends for each mix. Thus, the blending time was fixed as 36 hours for each powder mix. Now, the powder blends were ready for compact preparations.

II.3 Compaction of Powder lends

Compaction of Powder Blends Powder blends corresponding to Fe-1.0%C-0.0%Mn, Fe-1.0%C-1.75%Mn, Fe-1.0%C, Fe-1.0%C-2.75%Mn and Fe-1.0%C, Fe-1.0%C-3.75%Mn compositions were accurately weighed for

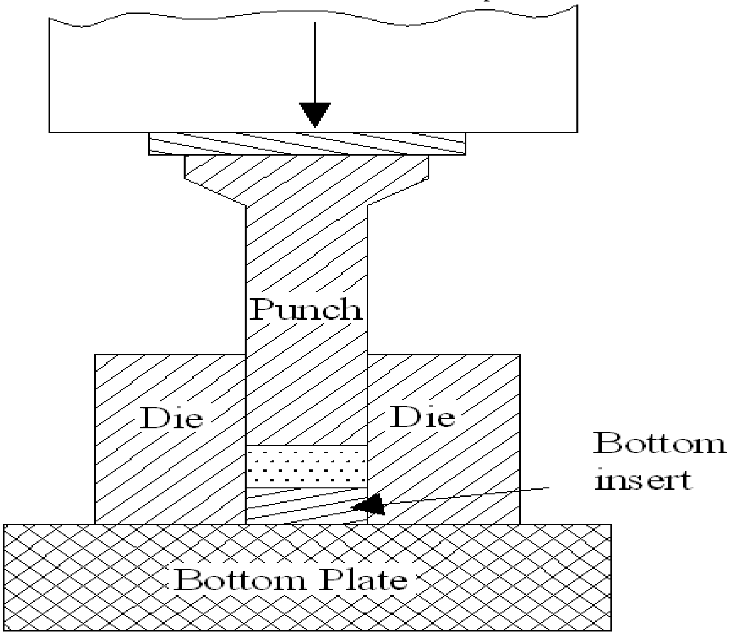


Figure 1 Schematic Diagram of Complete Compaction Assembly.

Compact preparations of initial aspect ratios of 0.43, and 0.83 respectively. Compacts of above initial aspect ratios were prepared by using Universal Testing Machine of 1.0 MN capacity and suitable die set assembly. The preform densities were maintained in the range of 85±1 per cent of theoretical by applying the pressure in the range of480±10 MPa The diameter of the compaction die was $24.84^{\pm 0.01}$ mm. Graphite powder with acetone as a paste was employed as lubricant during compaction. Powder compaction assembly is shown in figure 1. A minimum of 12 compacts of each aspect ratios and for all four compositions were prepared.

II.4 Application of Indigenously Developed Ceramic Coating

Indigenously developed ceramic coating [24] was applied on the entire surfaces of all the compacts to protect them against oxidation during sintering in the temperature range of 1150 ± 10^0C for a period of ninety minutes and subsequently transferring them to the bottom die of the friction screw press for hot upset forging. The ceramic coating was applied on the entire compact surfaces of all the compacts and the same was allowed to dry for a period of i6 hours in an ambient conditions. All coated compacts were recoated perpendicular to the direction of the previous coating and this, coating, too, was allowed to dry for a further period of 16 hours under the aforementioned ambient conditions. Now the coated compacts were ready for further processing.

II.5 Sintering of Ceramic Coated Compacts

Once the drying operation was completed, twenty-four (24) compacts of one composition were kept in a rectangular ceramic tray and the tray was charged inside the electric muffle furnace. The furnace was switched on and the temperature was raised to 750º±10ºC and retained at this temperature for a period of 50 minutes to allow the volatile ingredients to come out. Immediately after this the furnace temperature was raised to 1150 ± 10ºC and this temperature was retained for a period of ninety minutes. This completes the sintering schedule. Now, the sintered compacts were ready to undergo the next step of operation. Same step was followed for each composition so as to maintain the identity of each composition.

II.6 Hot Upset Forging of Sintered Compacts

All sintered compacts except two of each aspect ratio, namely, 0.43, and 0.83 respectively of each composition were hot upset forged to different height strains on a 1.0MN capacity friction screw press using flat molybdenum die steel plates. Immediately after hot upset forging, the sintered preforms, forged discs were quenched in linseed oil bath so as to retain the sintered and forged structures whichever is the case.

II.7 Removal of Residual Ceramic Coating From All the Oil Quenched

Residual ceramic coatings from the sintered oil quenched and forged oil quenched were removed by mild machining/grinding or by mild filing or by using abrasive papers ensuring that no metal is abraded out. This procedure was employed to all the forged preforms of disc shaped of all compositions and all aspect ratios. This adoption of removal of ceramic coating would bring high order of uniformity as well as the accuracy in density measurements along with their actual forged dimensions.

II.8 Dimensional Measurements of Cleaned sintered and Forged Discs and the Different Required Parameters to be calculated.

The measurements of the initial parameters like forged height, contact diameters (D_{ct} and D_{cb}), bulged diameter (Db), density and the other parameters for the calculation of such as True Height Strain $\{\varepsilon_h = (\ln H_o/H_f)\}$, True Diameter Strains, namely, conventional $\varepsilon_d = \{\ln (D_{cf}/D_o)\}$, diameter strain for circular arc of barrelling, $\varepsilon_{dcb} = \{(\ln[(2D_b^2+D_{cf}^2)/(3D_0^2)])/2\}$, diameter strain for parabolic arc of barrelling; $\varepsilon_{dpb} = \{(\ln[(8D_b^2+4D_bD_{cf}+3D_c^2)/(15D_0^2)])/2\}$ respectively, Bulging Ratio (D_b/D_o), and the Poisson's Ratios, conventional $[\{\ln (D_{cf}/D_o)\}/2\{\ln (H_0/H_f)\}]$, Poisson's Ratio differently defined by Narayanasamy and Pandey along with others were calculated [25-28] for circular arc of barrelling $[\{\ln[(2D_b^2+D_{cf}^2)/(3D_0^2)]\}/\{2 \ln(H_0/H_f)\}]$ and Poisson's Ratio for parabolic arc of barrelling $[\{\ln[(8D_b^2+4D_bD_{cf}+3D_{cf}^2)/(15D_0^2)]\}/\{2 \ln(H_0/H_f)\}]$ and also the evaluation of fractional theoretical density to investigate the various aspects of densification behaviour has been carried out.

II.9 Density Measurements of sintered and forged Discs

Density measurements of all the forged and cleaned compacts were found out by employing Archimedean principle [15] whereas, the density of sintered compacts were found out by calculating the volume geometrically and the mass in air using Adair-180 electronic balance with a sensitivity of 10^{-4}. A very fine water repellent oil film [17] was employed on all the forged compacts so as to avoid the penetration of water into the pores, thus, not affecting the calculations of the true volumes of the forged compacts. Typical formula used is given as under:

$$\rho_f, g/cc = \{M_{air}/(M_{air} - M_{water})\} \times \rho_{water} \quad ....(1)$$

Where, M_{air} = Mass of the forged disc in air in g, M_{water} = Mass of the forged disc in water in g, and, ρ_{water} is the density of water. Density correction was introduced depending upon the room temperature by using standard chart for density variation of water with respect to temperature.

II.10 **Various Plots Drawn for Analysis of Experimental Data and Calculated Parameters**

In order to arrive at a fruitful conclusion of the present investigation various plots were drawn, and, the same were critically analysed which yielded various empirical relationships correlating relevant parameters, and, thus, expressing them through various mathematical equations. The plots that were drawn are among the various parameters are (1) Relative density V/s. True height strain; Relative density V/s. True diameter strain; Relative density V/s. True diameter strain with circular barrelling and relative density V/s.True diameter strain for parabolic barrelling, Poisson's Ratio against fractional theoretical densities, fractional theoretical densities V/s.bulging ratio (D_b/D_0), Log (%fractional theoretical density) V/s. Log (D_b/D_0) and the bulge ratio against per cent theoretical densities were plotted in order to evaluate the complete densification mechanism/s.

III. RESULTS AND DISCUSSION

III.1 Deformation and Densification

Fig. 4 shows the plots drawn between relative density (ρ_f/ρ_{th}) and the true height strains(ln (H_0 /H_f)) exhibiting the influence of initial preform geometry and the compositions of the steels. Irrespective of the composition of the steel, the lower aspect ratio preforms densified at a much faster pace compared to the larger aspect ratio preforms. This is attributed to the fact that during hot upset forging the load transfer across the axial direction is quite rapid and uniform in lower aspect ratio preforms due to lower level of resistance

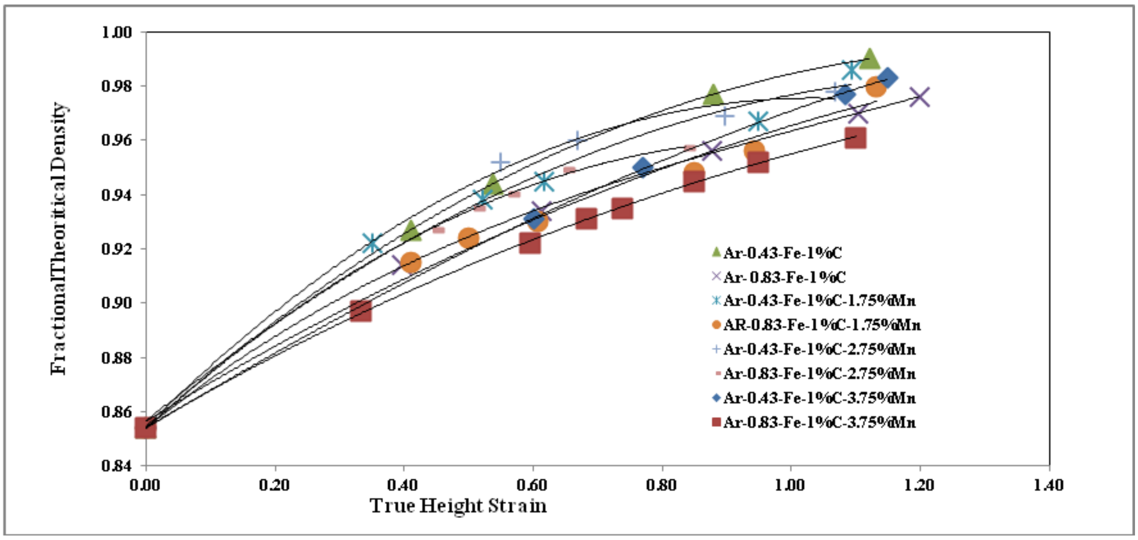


Figure 4 Effect of Initial Aspect Ratio (H_0/D_0) On the Relationship between Fractional Theoretical Densities and True Height Strains.

Offered by them against deformation as compared to the larger aspect ratio preforms which offered higher level of resistance. Further, this can be associated to the fact that lower aspect ratio preforms contained lower level of pore bed as compared to larger aspect ratio preforms which contained higher level of pore bed and hence offered enhanced resistance to deformation and densification. All curves in this figure are found to be quite similar to each other in nature, and, therefore, they all must be represented by a similar mathematical expression. The curve fitting technique employed for these curves have yielded a third order polynomial of the form as given in equation (1) to which they conformed to is given beneath:

$$(\rho_f/\rho_{th}) = a_0 + a_1\epsilon_h + a_2\epsilon_h^2 + a_3\epsilon_h^3 \quad .... \quad (2)$$

Where, 'a_0', 'a_1', 'a_2', and 'a_3' were found to be empirically determined constants but were found to depend upon initial preform geometry and the steel compositions. All these constants are tabulated in Table 3. Examining Table 3 carefully, it is found that the constant 'a_o' is in very much in close proximity to initial relative density (ρ_0/ρ_{th}) of the preforms. Hence, this constant did not contribute to the densification at all. However, the constant

Table 3 Coefficients of third order polynomial of the form: $(\rho_f / \rho_{th}) = a_0 + a_1\epsilon_h + a_2\epsilon_h^2 + a_3\epsilon_h^3$; $\epsilon_h = \ln(H_0/H_f)$

Composition	Coefficients of the third order polynomial					Regression Coefficient
	H_0/D_0	a_o	a_1	a_2	a_3	R^2
Fe - 1.0%C	0.43	0.854	0.213	-0.089	0.006	1.000
	0.83	0.854	0.190	-0.116	0.035	0.999
Fe - 1.0%C - 1.75Mn	0.43	0.846	0.336	-0.409	0.200	1.000
	0.83	0.844	0.274	-0.309	0.152	0.999
Fe - 1.0%C - 2.75%Mn	0.43	0.846	0.357	-0.383	0.154	1.000
	0.83	0.845	0.222	-0.065	-0.047	0.999
Fe - 1.0%C - 3.75%Mn	0.43	0.854	0.141	-0.016	-0.007	0.999
	0.83	0.854	0.141	-0.046	0.005	0.999

'a_1' is linearly multiplied to the true height strain and has always remained positive, and, therefore, this contributed to densification linearly. But, the constant 'a_2' is negative and is multiplied to the square of the true height strain which in general has been less than unity and, therefore, its square will be much less than unity and the product of 'a_2' and the square of the true height strain would become negligibly small. Obviously, this constant would literally moderate the densification curves in the final stages of deformation, i.e., the curves would tend to plateau. Similarly the constant 'a_3' is either positive or negative, but of a low magnitude and, hence, its effect in densification is negligibly small. Thus, the major contribution to densification is associated with the constant 'a_1'. However, the values of constants 'a_2' and 'a_3' only assisted to densification mechanism in such a manner so as to plateau the densification curves in the final stages of densification. Apart from this, the values of regression coefficient 'R^2', is found to be either unity or very much close to unity, and, hence, the densification curves are the best fit curves. Therefore, the proposed empirical relationship stands justified.

III.2 Deformation, Densification and Diameter strains

Figs. 5, 6 and 7 represent the plots between the relative density (ρ_f/ρ_{th}) and the true diameter strains for conventional (fig.5),for circular barrelling, (ε_{dcb}), (fig.6) and for parabolic barrelling, (ε_{dpb}), (fig.7) respectively. Curves shown in the figures 5 and 6 are found to be similar in characteristic nature and are further found to conform to a second order polynomial of the form:

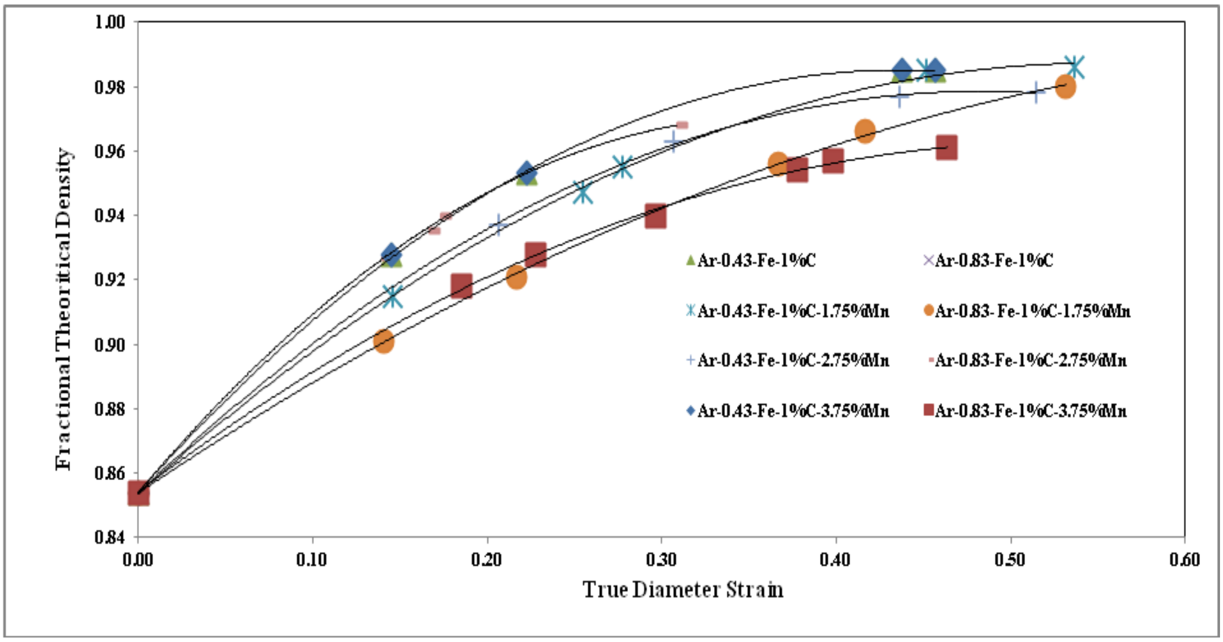


Figure 5 Effect of Initial Aspect Ratio (H_0/D_0) on the Relationship between Fractional Theoretical Densities and the True Diameter Strain.

Table 4 Coefficient of the polynomial of the form: $\rho_f/\rho_{th} = b_0\varepsilon_d + b_1\,\varepsilon_d + b_2\varepsilon_d^2$

Composition	H/D	b_0	b_1	$-b_2$	R^2
Fe-1%C	0.43	0.854	0.6	0.689	0.999
	0.83	0.854	0.411	0.389	0.999
Fe-1%C-1.75%Mn	0.43	0.846	0.531	0.504	0.999
	0.83	0.846	0.413	0.308	0.999
Fe-1%C-2.75%Mn	0.43	0.846	0.563	0.598	0.999
	0.83	0.845	0.727	1.067	0.999
Fe-1%C-3.75%Mn	0.43	0.854	0.600	0.689	0.999
	0.83	0.854	0.411	0.389	0.999

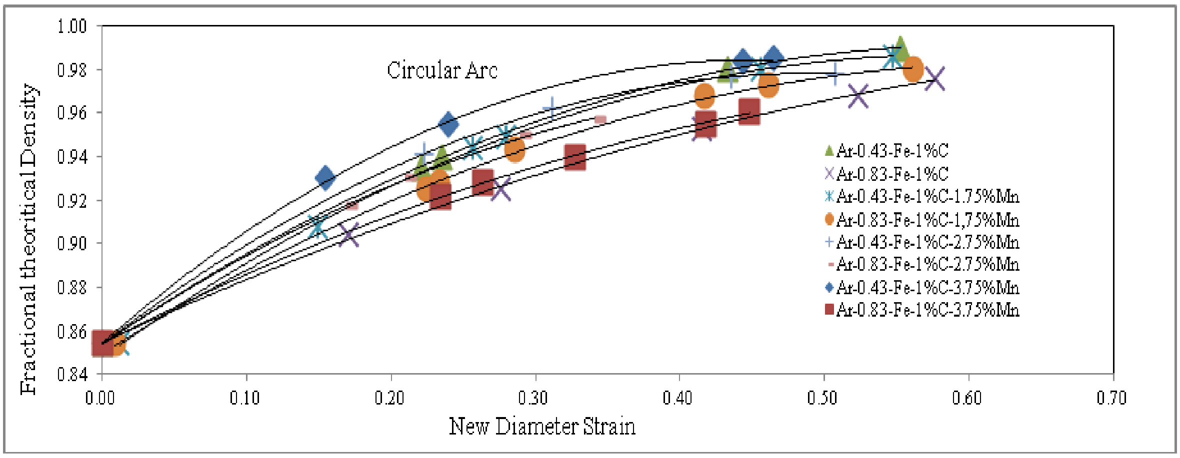


Figure 6 Effect of Initial Aspect Ratio (H_0/D_0) on the Relationship between Fractional Theoretical Densities and New Diameter Strains for Circular Arc.

Table 5 Coefficient of the polynomial of the form: $\rho_f/\rho_{th} = c_0\varepsilon_{dc} + c_1\,\varepsilon_{dc} - c_2\varepsilon_{dc}^2$

Composition	H/D	c_0	c_1	$-c_2$	R^2
Fe-1%C	0.43	0.854	0.451	0.371	1
	0.83	0.854	0.307	0.170	0.99
Fe-1%C-1.75%Mn	0.43	0.839	0.523	0.471	0.99
	0.83	0.839	0.472	0.394	0.99
Fe-1%C-2.75%Mn	0.43	0.846	0.553	0.578	1
	0.83	0.844	0.523	0.566	0.99
Fe-1.0%C-3.75%Mn	0.43	0.854	0.578	0.643	0.99
	0.83	0.854	0.341	0.235	0.99

$$(\rho_f/\rho_{th}) = b_0 + b_1\epsilon_d + b_2\epsilon_d^2 \text{ ------- -------- -------- ----- } (3), \text{ and,}$$

$$(\rho_f/\rho_{th}) = c_0 + c_1\epsilon_{dcb} + c_2\epsilon_{dcb}^2 \ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

Where, $\epsilon_d = \ln(D_c/D_0)$ and $\varepsilon_{dcb} = \{(\ln[(2D_b^2+D_{cf}^2)/(3D_0^2)])/2\}$, respectively. All these constants b_0, b_1, b_2, c_0, c_1, and c_2 are tabulated in Tables 4 and 5 respectively. The constants b_0 and c_0 do not contribute to densification as they are in close proximity of the initial preform relative densities (ρ_0/ρ_{th}), whereas the constants b_1 and c_1 are linearly multiplied to the respective true diameter strains and hence assisted to densification linearly as all of them were positive irrespective of compositions and the initial preform geometries. However, the constants b_2 and c_2 are all negative but of low magnitude and are multiplied to square of true respective diameter strains which itself is much less than unity, and, hence, these constants only assisted in the flattening of the curves in the final stages of deformation and densification. This is true, irrespective of the composition and the initial preform geometries. Similarly, fig.7 is drawn between the relative density (ρ_f/ρ_{th}) and the new diameter strain considering the parabolic form of barrelling. Since, all the curves in this figure are found to be similar in characteristic nature, and, therefore, they must be represented by a similar mathematical expression.

Hence, an attempt has been made to assess the curve fittings appropriately. The employed curve fitting technique has yielded a third order polynomial of the form:

$$(\rho_f /\rho_{th}) = d_o + d_1\epsilon_{dp} + d_2\epsilon_{dpb}^2 + d_3\epsilon_{dpb}^3 \text{------ ------- -----} (5)$$

Where, d_0, d_1, d_2 and d_3 are empirically determined constants and are found to depend upon initial preform geometries and the compositions of the steels investigated in the present study. These constants are tabulated in Table 6. The constant 'd_0' in each case is found to be in close proximity to the initial preform densities and, therefore, did not contribute to densification in any form. However, the constant values of 'd_1' and 'd_3' are positive, and, therefore, they assist in enhancing the forged densities as the deformations are advanced. But, the constant values of 'a_2' are found to be all negative, and, therefore, they tend to flatten the curves in their final stages of journey. Since, the values of the regression coefficient 'R^2' are found to be unity in each case, and, therefore, it is conclusively established that the consideration of parabolic barrelling during hot upset forging is highly pronounced.

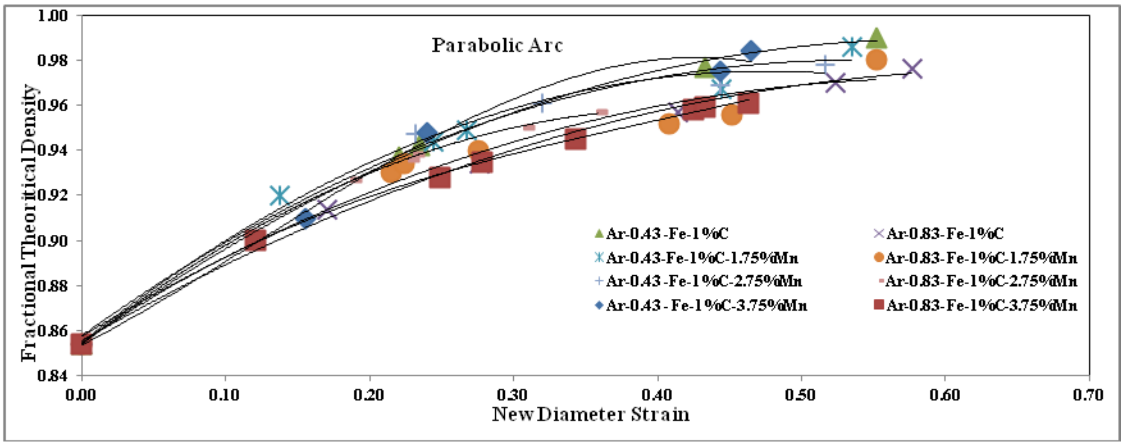


Figure 7 Effect of Initial Aspect Ratio (H_0/D_0) on the Relationship between Fractional Theoretical Density and New Diameter Strain for Parabolic Arc.

Table 6 Coefficient of the polynomial of $(\rho_f/\rho_{th}) = d_0\varepsilon_{dp} + d_1\,\varepsilon_{dp} - d_2\varepsilon_{dp}^2 + d_3\varepsilon_{dp}^3$

Composition	H/D	d_0	d_1	$-d_2$	d_3	R^2
Fe-1%C	0.43	0.85	0.51	0.70	0.39	1.00
	0.83	0.85	0.44	0.67	0.46	1.00
Fe-1%C-1.75%Mn	0.43	0.85	0.77	1.95	1.87	1.00
	0.83	0.84	0.73	1.90	1.85	1.00
Fe-1%C-2.75%Mn	0.43	0.85	0.77	1.75	1.48	1.00
	0.83	0.85	0.66	1.44	1.29	1.00
Fe-1%C-3.75%Mn	0.43	0.85	0.83	2.53	2.88	1.00
	0.83	0.85	0.51	1.28	1.43	1.00

III.3 Deformation, Densification and the Poisson's Ratio

Figs. 8, 9 and 10 are drawn between the Poisson's ratio, υ_{pg}, υ_{pc} and υ_{pp} respectively and the relative density (ρ_f/ρ_{th}). Observing these figures carefully, it is found that all the curves in each of the above figures 8, 9 and 10 are similar in their characteristic natures and, therefore, they all must be expressed by a similar mathematical expression. Curve fittings have yielded a second order polynomial between the Poisson's ratios (υ_{pg}, υ_{pc} and υ_{pp}) and the relative density (ρ_f/ρ_{th}). Thus, these expressions have the following forms:

For General Deformation:

$$\upsilon_{pg} = f_0 + f_1(\rho_f/\rho_{th}) + f_2(\rho_f/\rho_{th})^2, \quad \text{... ... ...} (6)$$

For Circular Barrelling:

$$\upsilon_{pc} = g_0 + g_1(\rho_f/\rho_{th}) + g_2(\rho_f/\rho_{th})^2, \quad \text{... ... ...} (7)$$

For Parabolic Barrelling:

$$\upsilon_{pp} = l_0 + l_1(\rho_f/\rho_{th}) + l_2(\rho_f/\rho_{th})^2 \quad \text{... ... ...} (8)$$

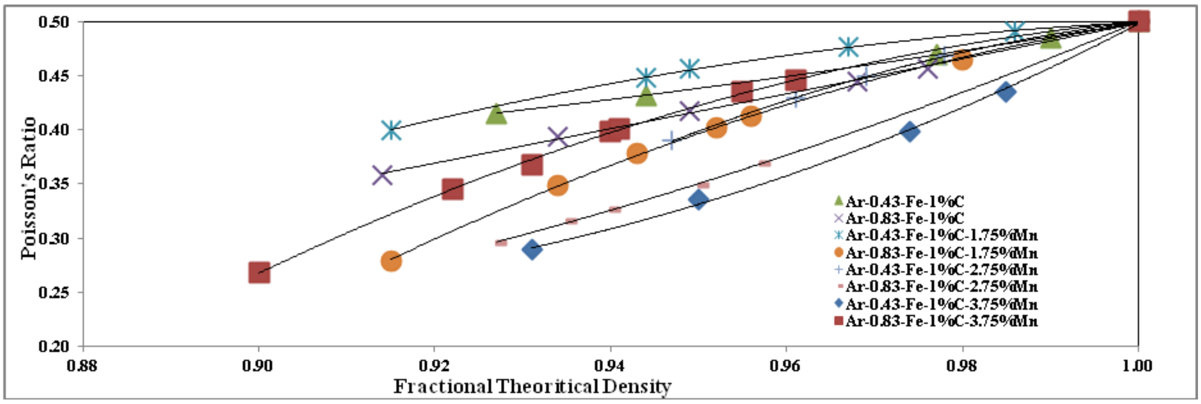


Figure 8 Effect of Initial Aspect Ratio (H_0/D_0) on the Relationship between Conventional Poisson's Ratio and Fractional Theoretical Density.

Table 7 Coefficient of the polynomial of the form: $\gamma = f_0\ (\rho_f/\rho_{th}) + f_1(\rho_f/\rho_{th}) + f_2(\rho_f/\rho_{th})^2$ for Considering no Barrellings.

Composition	H/D	f_0	f_1	f_2	R^2
Fe-1%C	0.43	2.34	-5.06	3.22	1.00
	0.83	-0.76	0.86	0.40	1.00
Fe-1%C-1.75%Mn	0.43	-8.84	18.28	-8.93	1.00
	0.83	-15.93	31.57	-15.14	1.00
Fe-1%C-2.75%Mn	0.43	-20.57	41.13	-20.05	1.00
	0.83	6.01	-14.46	8.95	1.00
Fe-1%C-3.75%Mn	0.43	33.67	-72.79	39.62	1.00
	0.83	-15.62	31.45	-15.32	1.00

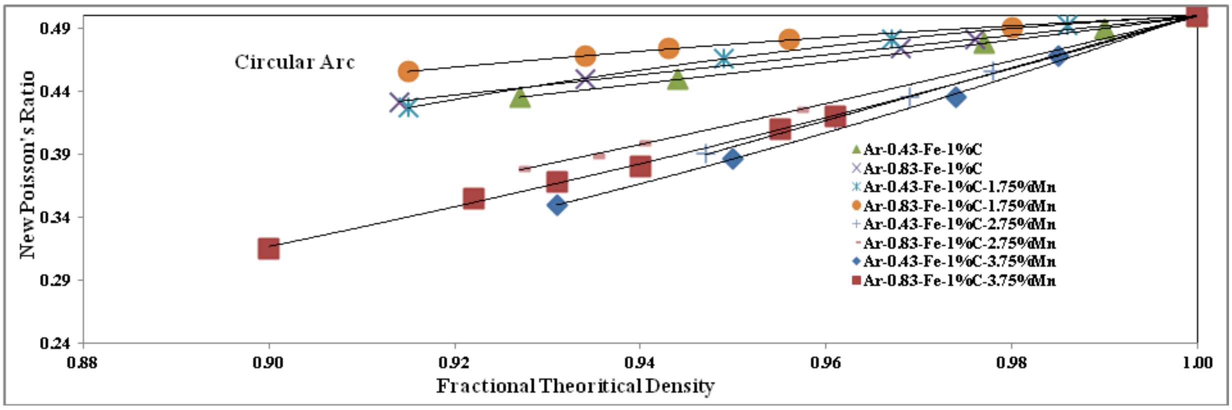


Figure 9 Effect of Initial Aspect Ratio (H_0/D_0) on the Relationship between New Poisson's and Fractional Theoretical Density for Circular Arc.

Table 8 Coefficient of the polynomial of the form: $\gamma_p' = g_0\ (\rho_f/\rho_{th}) + g_1(\rho_f/\rho_{th}) + g_2(\rho_f/\rho_{th})^2$ for Circular Arc of Barrelling.

Composition	H/D	g_0	g_1	g_2	R^2
Fe-1%C	0.43	0.53	-1.02	0.98	1.00
	0.83	0.68	1.61	-0.43	1.00
Fe-1%C-1.75%Mn	0.43	-5.45	11.52	-5.57	1.00
	0.83	-1.91	4.48	-2.07	1.00
Fe-1%C-2.75%Mn	0.43	-1.53	1.97	0.06	1.00
	0.83	-2.28	-2.28	2.05	1.00
Fe-1%C- 3.65%Mn	0.43	13.34	-30.36	17.52	1.00
	0.83	1.46	-4.06	3.10	1.00

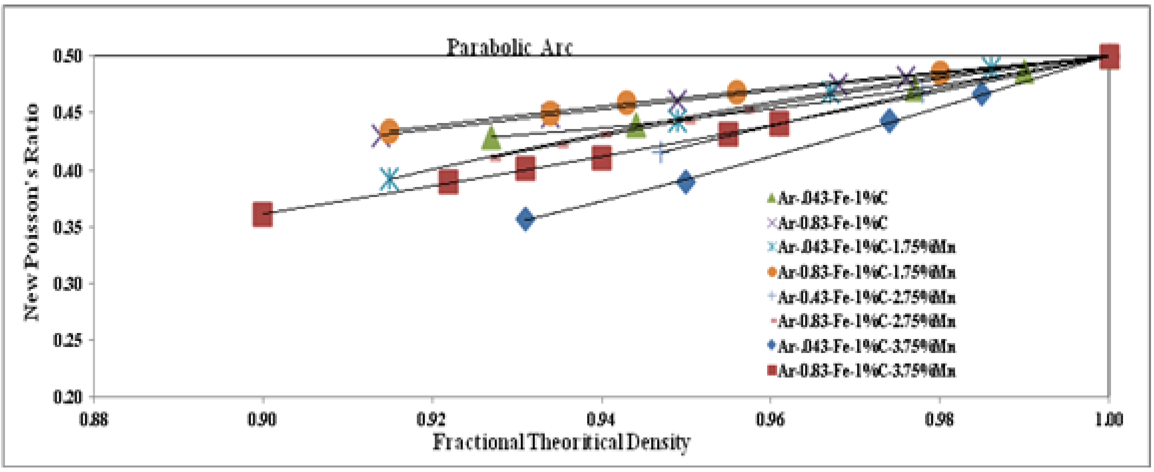
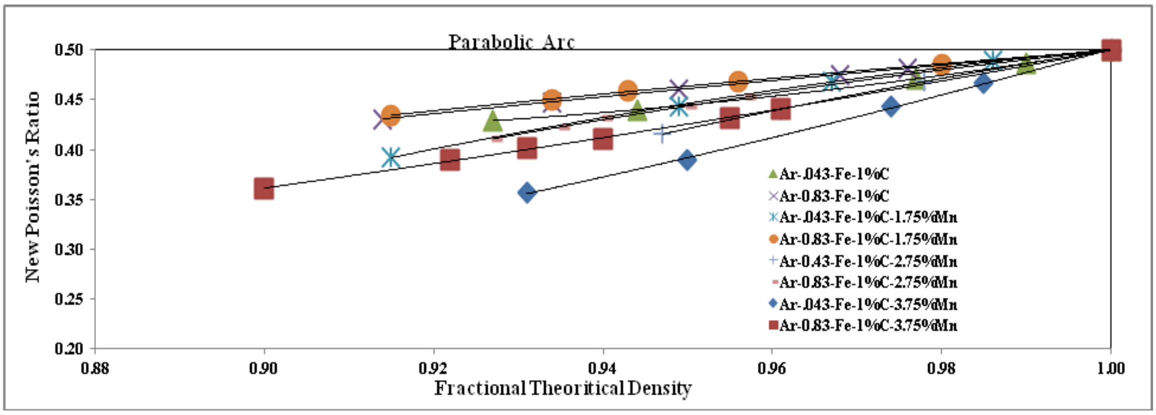


Figure 10 Effect of Initial Aspect Ratio (Ho/Do) and Fractional Theoretical Density for Parabolic Arc.

Table 9 Coefficient of the polynomial of the form: $\gamma_p'' = i_0(\rho_f/\rho_{th}) + i_1(\rho_f/\rho_{th}) + i_2(\rho_f/\rho_{th})^2$ for Parabolic Arc.

Composition	H/D	i_0	i_1	i_2	R^2
Fe-1%C	0.43	4.87	-10.13	5.76	1.00
	0.83	-1.04	2.34	0.80	1.00
Fe-1%C-1.75%Mn	0.43	-5.84	11.88	-5.54	1.00
	0.83	-1.51	3.36	-1.35	1.00
Fe-1%C-2.75%Mn	0.43	-5.91	11.50	-5.08	1.00
	0.83	-4.73	9.56	-4.33	1.00
Fe-1%C-3.75%Mn	0.43	18.93	-41.64	23.22	1.00
	0.83	0.91	-2.41	2.00	1.00



Where, f_0, f_1, f_2, g_0, g_1, g_2, l_0, l_1 and l_2 are empirically determined constants. All these constants are tabulated in Tables 7, 8 and 9 respectively for each aspect ratio and for each composition. These constants have not followed any set pattern instead either one is negative and two are positive or one is positive and the other two are (-) ve.

Since the values of regression coefficients (R^2) in each case is found to be unity, and, therefore, it can be taken for granted that the above proposed empirical relationships for Poisson's ratio against the relative density are the most ideal ones. Further it is found that in the near vicinity of cent per cent densification, the Poisson's ratio value attained had been 0.50 which is the case in the event of an ideal deformation where no barrelling is encountered.

III.4 Deformation, Densifications and Strains

Figs. 11, 12 and 13 are drawn between the true diameter strains (ϵ_{dg}, ϵ_{dc} and ϵ_{dp}) and the true height strains [ln (H_0/H_f)] where, ϵ_{dg} is the general true diameter strain without considering any barrelling; ϵ_{dc} is the true diameter strain considering circular barrelling whereas, ϵ_{dp} is the true diameter strain considering parabolic barrelling. All data points in each figure for all aspect ratios and for all compositions lie below the theoretical line representing ideal deformation. All the curves corresponding to each aspect ratio and for each composition in each of the figures 11, 12 and 13 are similar in characteristic nature and the curve fitting has yielded second order polynomials of the form as beneath:

III.4.1 When No Barrelling considered

$$\epsilon_{dg} = j_0 + j_1\, \epsilon_h + j_2\, \epsilon_h^2 \quad \text{........ ....} \quad (9)$$

III .4.2 When Circular Barrelling considered

$$\epsilon_{dc} = k_0 + k_1\, \epsilon_h + k_2\, \epsilon_h^2 \quad \text{.... ....} \quad (10)$$

III.4.3 When Parabolic Barrelling considered

$$\epsilon_{dp} = m_0 + m_1\epsilon_h + m_2\, \epsilon_h^2 \quad \text{.......... ... ...} \quad (11)$$

where , j_0, j_1, j_2, k_0, k_1, k_2, m_0, m_1 and m_2 are empirically determined constants and are found to depend upon the initial preform geometry and the compositions of the steels investigated. All these constants are tabulated in Tables 10, 11 and 12 respectively. Since the values of j_0, k_0 and m_0 are in close proximity to zero and hence do not contribute to true diameter strain on deformation because at no deformation there is no diameter strain or height strain. Hence, these constants are taken to be zero. j_1, k_1 and m_1 are all positive and are linearly multiplied

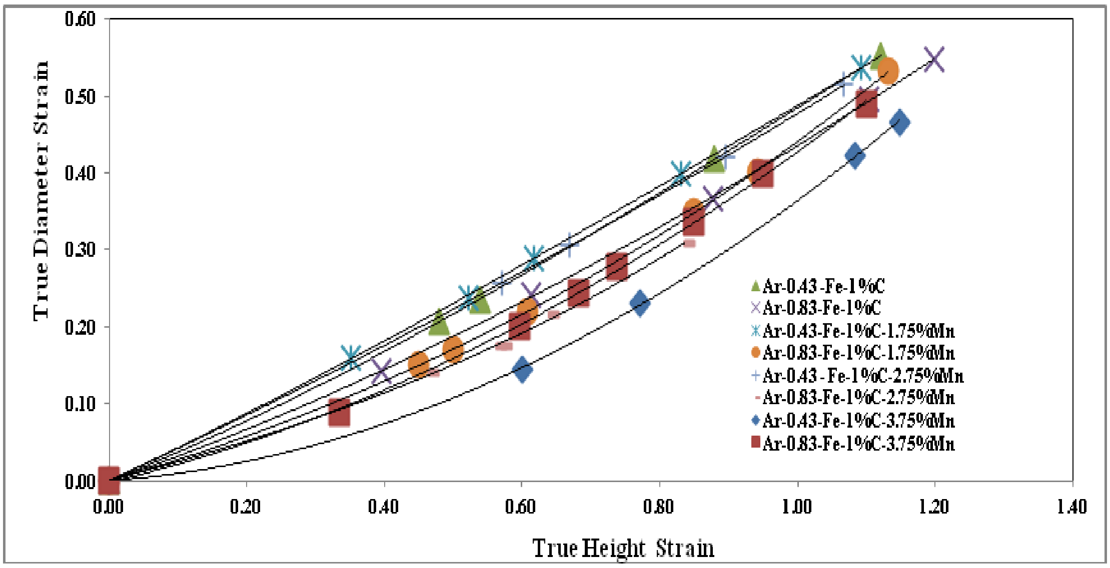


Figure 11 Effect of Initial Aspect Ratio (H_0/D_0) on the Relationship between True Diameter Strain and True Height Strain

Table 10 Coefficient of the polynomial of the form: $\varepsilon_{dnew} = j_0\,(\varepsilon_h) + j_1\,(\varepsilon_h) + j_2\,(\varepsilon_h)^2$

Composition	H/D	j_0	j_1	j_2	R^2
Fe-1%C	0.43	0.001	0.391	0.092	1.0
	0.83	0.001	0.319	0.116	1.0
Fe-1%C-1.75%Mn	0.43	0.000	0.438	0.049	1.0
	0.83	0.000	0.239	0.202	0.99
Fe-1%C-2.75%Mn	0.43	-0.001	0.414	0.064	1.0
	0.83	0.000	0.198	0.205	0.99
Fe-1%C-3.75%Mn	0.43	-0.002	0.215	0.215	1.00
	0.83	0.000	0.068	0.296	0.99

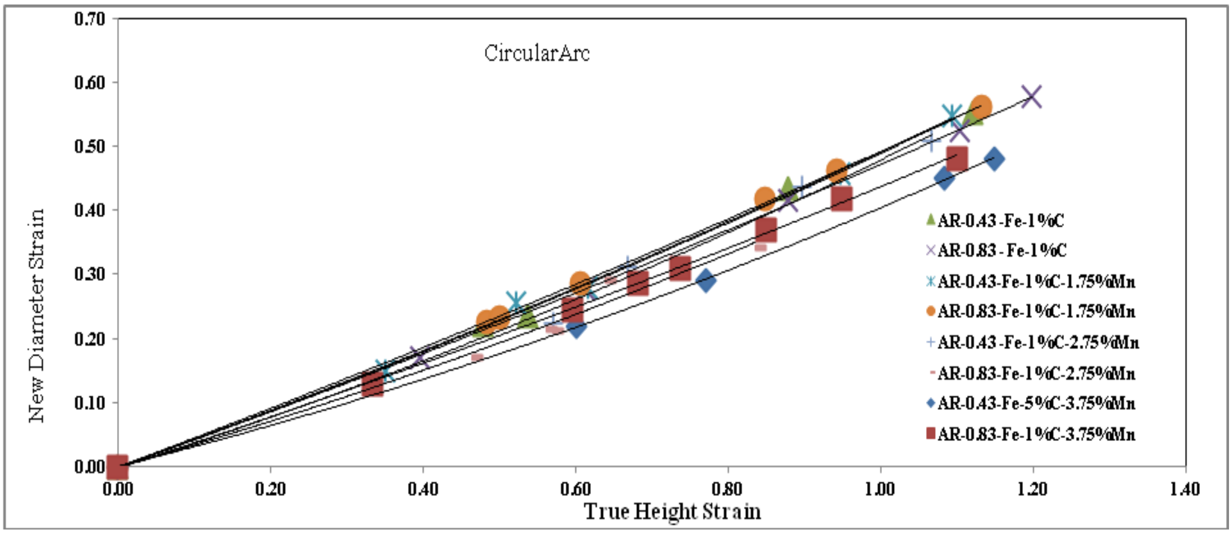


Figure 12 Effect of Initial Aspect Ratio (H_0/D_0) on the Relationship between New Diameter Strain and True Height Strain for Circular Arc

Table 11 Coefficients of the polynomial of the form: $\varepsilon_{dnewc} = k_0\,(\varepsilon_h) + k_1\,(\varepsilon_h) + k_2(\varepsilon_h)^2$

Composition	H/D	k_0	k_1	k_2	R^2
Fe-1%C	0.43	-0.001	0.42	0.07	1.00
	0.83	-0.001	0.42	0.05	1.00
Fe-1%C-1.75%Mn	0.43	-0.0001	0.43	0.06	1.00
	0.83	-0.0001	0.45	0.04	1.00
Fe-1%C-2.75%Mn	0.43	-0.002	0.38	0.11	0.99
	0.83	-0.001	0.34	0.09	0.98
Fe-1%C-3.75%Mn	0.43	0.001	0.11	0.26	1.00
	0.83	-0.002	0.39	0.05	1.00

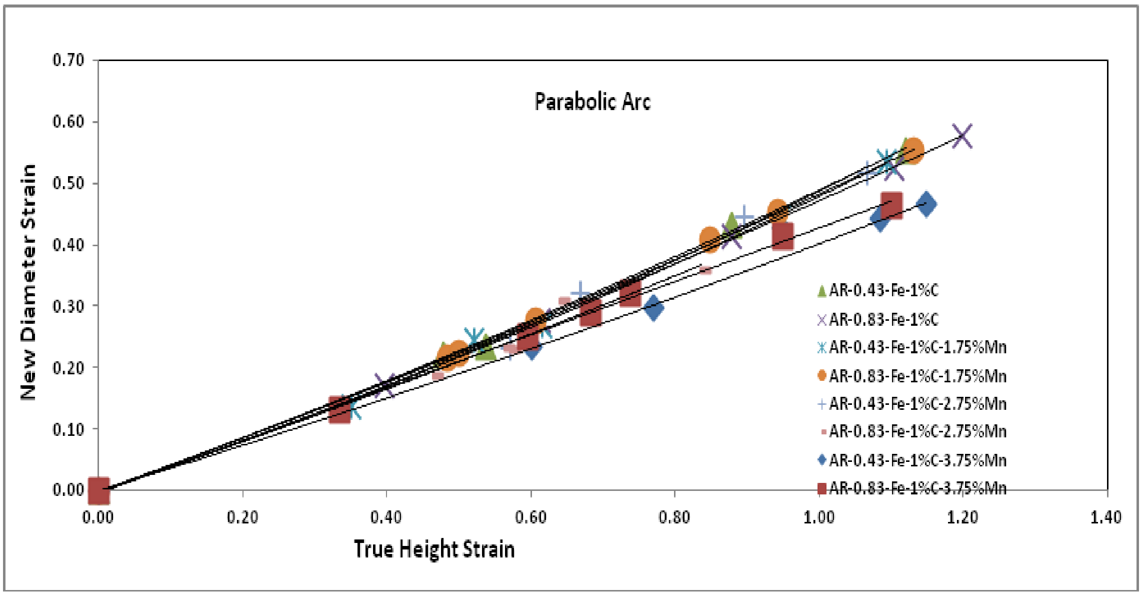


Figure 13 Effect of Initial Aspect Ratio (H_0/D_0) on the Relationship between New Diameter Strain and True Height Strain for Parabolic Arc.

Table 12 Coefficient of the polynomial of the form: $\varepsilon_{dnewp} = -l_0\,(\varepsilon_h) + l_1\,(\varepsilon_h) + l_2\,(\varepsilon_h)^2$

Composition	H/D	$-l_0$	l_1	l_2	R^2
Fe-1%C	0.43	0.001	0.424	0.066	0.999
	0.83	0.001	0.423	0.048	0.999
Fe-1%C-1.75%Mn	0.43	0.001	0.391	0.087	0.997
	0.83	0.001	0.422	0.060	0.999
Fe-1%C-2.75%Mn	0.43	0.002	0.397	0.092	0.993
	0.83	0.002	0.398	0.055	0.980
Fe-1%C-3.75%Mn	0.43	0.004	0.426	0.005	0.998
	0.83	0.001	0.101	0.274	0.998

III.5 Deformation, Densification and Bulging

Fig. 14 has been drawn between the relative density (ρ_f/ρ_{th}) and the bulging ratio for all the steels compositions and both aspect ratios. Curves in this figure are found to be similar in characteristic features and, therefore, they can be represented by the similar mathematical expression. Curve fitting techniques attempted for the curves in this figure yielded a second order polynomial between relative density and the bulging ratio (D_b/D_0) of the form:

$$(\rho_f/\rho_{th}) = m_0 + m_1\,(D_b/D_0) + m_2\,(D_b/D_0)^2 \quad \text{..... .... (12)}$$

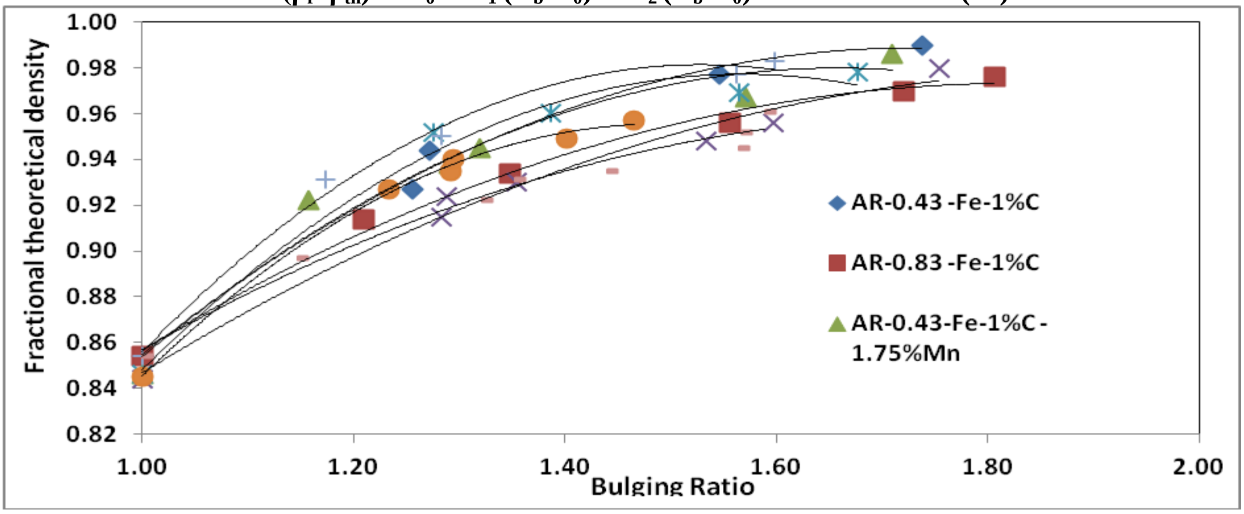


Figure 14 Effect of Initial Preform Geometry and Composition of Steels on the Relationship Between Fractional Theoretical Density and the Bulge Ratio (Db/D0) during Hot upset Forging of Sintered Fe-1% C-X Mn Steels.

Table 13 Coefficients of the Second Order Polynomial of the form: $\rho_f/\rho_{th} = m_0 + m_1\,(D_b/D_0) + m_2\,(D_b/D_0)^2$ Hot Upset Forging Sintered Fe - 1% C - X Mn P/M Steels of Different Initial Aspect Ratios

Composition	H/D	m_1	m_2	m_3	R^2
Fe-1%C	0.43	-0.2531	0.8744	0.2332	0.9911
	0.83	-0.17	0.6215	0.4053	0.993
Fe-1%C-1.75%Mn	0.43	-0.292	0.968	0.1776	0.9607
	0.83	-0.1511	0.5852	0.4127	0.9826
Fe-1%C-2.75%Mn	0.43	-0.4014	1.258	-0.0085	0.983
	0.83	0.4595	1.369	-0.0641	0.9969
Fe-1%C-3.75%Mn	0.43	-0.4493	1.3734	0.0682	0.9918
	0.83	-0.1669	0.596	0.4277	0.9796

III. 5.1 Power Law Relationship between [% (FTD)] and Bulging Ratio (D_b/D_0)

Fig. 15 is drawn between Log (%(ρ_f/ρ_{th})) and the Log (bulging ratio), i.e., Log (D_b/D_0) showing the influence of initial preform geometries during hot upset forging of sintered Fe-1.0%C-0.0%Mn, Fe-1.0%C-1.75%Mn, Fe-1.0%C, Fe-1.0%C-2.75%Mn and Fe-1.0%C, Fe-1.0%C-3.75%Mn sintered PM steel. It is observed that all the data points exhibit straight lines in two distinct segments for a given aspect ratio and for the given steel. The corresponding slopes and the intercepts are reported in Table 13. In the first segment the values of the regression coefficients are exactly unity, therefore, the curve fitting carried out is perfectly ideal in this region. However, the regression coefficients in the second segments are beyond 0.9591 a minimum to 0.9951 a maximum value. Hence, it can be taken up as empirically as a very good curve fitting; the slopes of the lines in the respective segments are represented by p_1 and q_1.Whereas, the intercepts of the lines in the respective segments are denoted by p_2 and q_2 respectively. Thus, on conversion of these logarithmic lines into the power law equation format, a general power law equation that emerges out is given as beneath:

$$\{\%\ (\rho_f/\rho_{th})\} = P\ (D_b/D_0)^{M} \quad \text{.................. (13)}$$

Where, $\{\%\ (\rho_f/\rho_{th})\}$ is per cent theoretical density achieved at a given height strain and (D_b/D_0) is the corresponding bulging ratio. P is the coefficient and M is the exponent of the power law equation. are already explained above. Thus, it is feasible to represent per cent theoretical density with the bulging ratio by a power law equation of the above form.

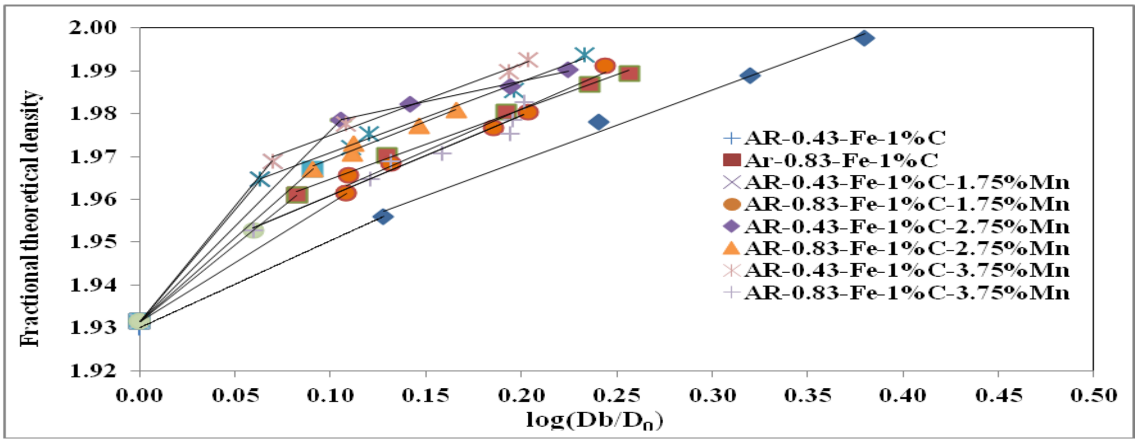


Figure 15 Influence of Initial Aspect Ratio and the Addition of Manganese in Fe - 1.0% C steel on the Relationship Between Log of {% (Relative Density)} and the Log of {Bulge Ratio (Db/D0)] in order to Establish if a Power Law Relationship Exists between Fractional Theoretical Density and the Bulge Radius.

Table 14 Coefficients Of the Lines and the intercepts Drawn Between Log(% Relative Density and the Log (Db/D0) in two Segments Exhibiting the Influence of Manganese Addition in Fe - 1.0%C Steel During Hot Upset Forging For Equation of the Form: Log (Relative Density) = (p_1 or q_1) Log (Db/D0) +Log (p_2 or q_2) i.e., the power Law Equation of the Form: % (ρf/ρth) = (p2 or q2) (Db/D0)$^{(p1\ or\ q1)}$

Composition	H/D	p_1	p_2	R^2	q_1	q_2	R^2
Fe-1%C	0.43	0.2034	1.93	1	0.165	1.9361	0.9927
	0.83	0.3572	1.9315	1	0.1627	1.9484	0.9951
Fe-1%C-1.75%Mn	0.43	0.5264	1.9315	1	0.1659	1.9543	0.9916
	0.83	0.2765	1.9315	1	0.1951	1.9421	0.9757
Fe-1%C-2.75%Mn	0.43	0.446	1.9315	1	0.0949	1.9686	0.99
	0.83	0.3916	1.9315	1	0.1765	1.9517	0.9693
Fe-1%C-3.75%Mn	0.43	0.5385	1.9315	1	0.1669	1.9583	0.9904
	0.83	0.1875	1.9422	1	0.1875	1.9422	0.9591

III.6 Deformation, Densification and Bulge Radius

Fig. 16 is drawn between the radius of curvature of bulging and the relative density (ρ_f/ρ_{th}) for all the four compositions and for all aspect ratios. Curve fitting technique has been attempted and it was established that all the curves conformed to a second order polynomial of the form:

$$R_c = n_0 + n_1 (\rho_f/\rho_{th}) + n_2 (\rho_f/\rho_{th})^2 \quad \text{... ... ... (14)}$$

Where, n_0, n_1 and n_2 are empirically determined constants and these constants are tabulated in Table 13. Above constants are further observed to depend upon the initial preform geometries and also upon the compositions of the systems selected in the present investigation. Further, the values of the regression coefficients (R^2) are found to be in very much close to unity, but, in few cases, the same is less than 0.95. Therefore, in these cases the curve fittings have been reasonably good whereas in other cases where R^2 values were beyond 0.999 and or above it, they had the best fit of the curves.

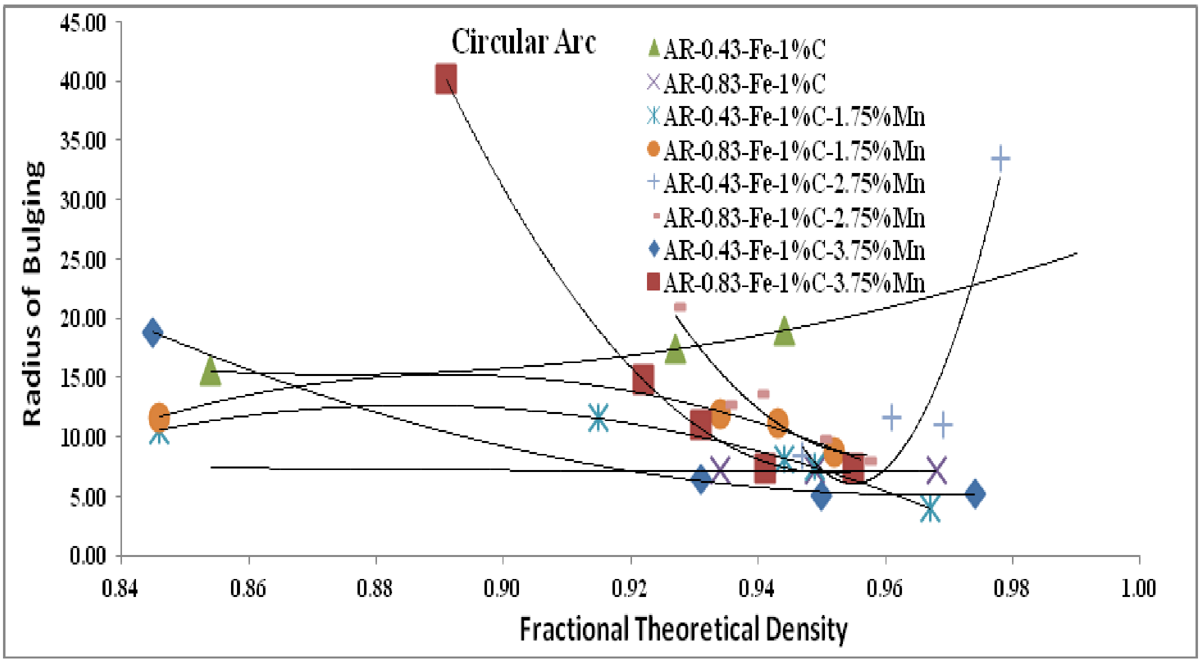


Figure 16 Effect of Initial Aspect Ratio (H_0/D_0) on the Relationship between Radius of Bulging and Fractional Theoretical Density for Circular Arc.

Table 15 Coefficient of the Polynomial of the form: $R_c = m_0\,(\rho_f/\rho_{th}) + m_1\,(\rho_f/\rho_{th}) + m_2\,(\rho_f/\rho_{th})^2$

Composition	H/D	m_0	m_1	m_2	R^2
Fe-1%C	0.42	-1116	2314	-1179	1
	0.83	-560.1	1178	-612	0.999
Fe-1%C-1.75%Mn	0.42	-1018	2327	-1313	0.999
	0.83	-1347	3057	-1714	0.948
Fe-1%C-2.75%Mn	0.42	44349	-92868	48623	0.903
	0.83	11419	-23825	12436	0.922
Fe-1%C-3.75%Mn	0.42	875.3	-1801	931.8	0.999
	0.83	8284	-17403	9147	0.999

IV. CONCLUSIONS

Based upon the experimental data and the calculated parameters and series of plots drawn and their critical analysis have led to the following major findings:

A. Densification curves drawn between relative density and the true height strains were established to conform to a third order polynomial of the form:
$(\rho_f/\rho_{th}) = a_0 + a_1\epsilon_h + a_2\epsilon_h^2 + a_3\epsilon_h^3$; where, '$a_0$', '$a_1$', '$a_2$' and '$a_3$' were found to be empirically determined constants and dependent upon the initial preform geometries and the compositions of the steels. The constant 'a_0' did not contribute to densification as it corresponded to the initial preform relative density. 'a_1' linearly contributed to densification whereas the constants 'a_2' and 'a_3' moderated the densification in the final stages of deformation and densification. Since the values of regression coefficients (R^2) were found to be close to unity, hence, the above is the best empirical relation relating to the relative density and the true height strain.

B. Relative density (ρ_f/ρ_{th}) with respect to the normal diameter strain $\ln(D_{cf}/D_0)$ and the diameter strains considering circular and parabolic barrelling conformed to a second order polynomial of the form : $(\rho_f/\rho_{th}) = b_0 + b_1\epsilon_d + b_2\epsilon_d^2$ for normal deformation and $(\rho_f/\rho_{th}) = c_0 + c_1\epsilon_{dc} + c_2\epsilon_{dc}^2$ for circular barrelling, whereas, for parabolic arc of barrelling , a third order polynomial of the form : $(\rho_f/\rho_{th}) = d_o + d_1\epsilon_{dp} + d_2\epsilon_{dp}^2 + d_3\epsilon_{dp}^3$ existed. 'b_0', 'b_1', 'b_2', 'c_0', 'c_1', 'c_2', 'd_0', 'd_1', 'd_2' and 'd_3' were found to be empirically determined constants and dependent upon the initial preform geometries and the compositions of the steels investigated . 'b_0', 'c_0' and 'd_0' were found to be close to initial relative density (ρ_0/ρ_{th}) of the preform and, therefore, did not contribute to densification. 'b_1' and 'c_1' linearly assisted to densification whereas 'b_2' and 'c_2' being negative retarded the densification more effectively in the final stages of densification. Further, the constants 'd_1' and 'd_3' enhanced the densification on deformation whereas the constant 'd_2' being negative retarded the densification more effectively in the final stages of deformation and densification. Since the regression coefficient (R^2) values were found to be in very much close to unity, hence, the above empirical relations stand well established.

C. It is established that the Poisson's ratio for conventional, circular and parabolic barrelling during hot upset forging were found to be related to relative density (ρ_f/ρ_{th}) by a second order polynomial of general form as: $\upsilon_{pg/cir/para} = m_0 + m_1 (\rho_f/\rho_{th}) + m_2 (\rho_f/\rho_{th})^2$ where 'm_0', 'm_1' and'm_2' are empirically determined constants and are found to be functions of initial preform geometry and the steels compositions. Since the values of the regression coefficients (R^2) have been almost ideally unity, and, therefore, the empirically arrived relationship is highly justified. Further, it has been established that as the densification approached to cent per cent, the values of eth Poisson's ratio approached to an ideal value of 0.5 which means that during final stages of deformation and densification, the flow of pores and material became simultaneous.

D. Variation of true diameter strains whether it was for conventional or for circular or for parabolic barrelling, they all conformed to a second order polynomial with true height strains. The same were expressed by a general mathematical expression of the form: $\epsilon_{dg/cir/para} = s_0 + s_1\epsilon_h + s_2\,\epsilon_h^2$ where 's_0', 's_1'and 's_2' are empirically determined constants found to depend upon initial preform geometries and the steel compositions for respective mode of barrellings. The values of 's_0' was found to be zero or in close proximity to zero, hence, the above equation is simplified as: $\epsilon_{dg/cir/para} = s_1 + s_2\,\epsilon_h^2$. Further, the values of regression coefficient (R^2) where found to be almost unity, and hence, the above expression relating $\epsilon_{dg/cir/para}$ with the true height strain ($\epsilon_h = \ln(H_0/H_f)$ attains the highest degree of validity.

E. It was established that the relationship between relative density **(ρ_f /ρ_{th})** and the bulging ratio conformed to a second order polynomial of the form: $(\rho_f /\rho_{th}) = m_0 + m_1 (D_b/D_0) + m_2 (D_b/D_0)^2$, where '$m_0$', '$m_1$' and '$m_2$' are empirically determined constants and are found to be the functions of the initial preform geometries and the steel compositions taken for the present investigation. Further attempt also established that the % FTD can be expressed as a power law expression of the form: $(\% \ (\rho_f/\rho_{th})) = P\,(D_b/D_0)^M$, where, P and M are empirically determined constants and were found to depend upon the initial preform geometries and the steel compositions.

F. Arc radius of the barrel has been computed and the same was found to be related to the relative density(ρ_f/ρ_{th}) by a second order polynomial of the form: $R_b = n_0 + n_1(\rho_f/\rho_{th}) + n_2(\rho_f/\rho_{th})^2$ where 'n_0','n_1' and 'n_2' are empirically determined constants which depended upon the initial perform geometries and steels investigated. Regression coefficient values (R^2) were found to be in close proximity to unity and, hence, the above relationship stands well justified.

Thus, the present investigation comprehensively deals with the various aspects of hot deformation of hyper-eutectoid P/M steel showing the influence of manganese addition and initial aspect ratios of the preforms on the densification mechanism, different barrelling aspects, showing their typical influence on densification aspects and the variation between diameter strains (conventional, circular and parabolic arc of barrellings) and on the behaviour of Poisson's ratio. The present investigation has led to various new findings which are of paramount importance to the future investigators in the deformation of porous materials.

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The Next Generation Sustainable Fuel : Jatropha Curcas

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***Abstract:* -** Any nation's socioeconomic prosperity is heavily dependent of the availability of energy. But with increasing population and pace of industrialization, especially in developing countries like India, the world is today faced with imminent energy crisis. Skyrocketing oil prices combined with growing concern about global warming caused by greenhouse-gas-emitting fossil fuel burning in forcing scientists to look for viable, clean alternative energy sources for the future. Renewable sources like solar, wind and tidal energy are clean, but they are still too expensive and can not provide the convenience of petrol or diesel for powering vehicles.

Biofuels are the new emerging class of renewable, biodegradable fuel that are non-hazardous and safer for air, water and soil. Also their use reduces the emission of greenhouse gases. Biodeisel is the most common biofuel that can be used directly in any existing, unmodified diesel engine. When used directly in a diesel engine biodiesel is said to produce 75% less pollution than diesel fuel derived from petroleum. Biodiesel can be produced from a variety of oilseed plants. But Jatropha (Jatropha curcas) is currently the first choice because it is resistant to drought and pests; produces seeds containing up to 40% oil, and can yield up to two tones of biodiesel fuel per year per hectare.

***Keywords:* -** *Biofuels, jatropha, transesterification.*

I. INTRODUCTION

The concept dates back to 1885 when Dr. Rudolf Diesel built the first diesel engine with the full intention of running it on vegetative source. He first displayed his engine at the Paris show of 1900 and astounded everyone when he ran the patented engine on any hydrocarbon fuel available - which included gasoline and peanut oil. In 1912 he stated " … the use of vegetable oils for engine fuels may seem insignificant today. But such oils may in the course of time become as important as petroleum and the coal tar products of present time."

Scientists discovered that the viscosity (thickness) of vegetable oils could be reduced in a simple chemical process In 1970 and that it could work well as diesel fuel in modern engine. Since than the technical developments have largely been completed. Plant oil is highly valued as Bio fuel "Diesel" and transformed into Bio Diesel in most industrialized

Bio Diesel is a substitute for, or an additive to, diesel fuel that is derived from the oils and fats of plants, like Sunflower, Canola or Jatropha. It is an alternative fuel that can be used in diesel engines and provides power similar to conventional diesel fuel. Bio Diesel is a renewable domestically produced liquid fuel that can help reduce the countries dependence on foreign oil imports. Recent environmental and economic concerns (Kyoto Protocol) have prompted resurgence in the use of biodiesel throughout the world. In 1991, the European Community, (EC) Proposed a 90% tax reduction for the use of biofuels, including biodiesel. Today, 21 countries worldwide, produce Biodiesel.

Jatropha curcus or Ratanjyot, can prove itself a miracle plant by turning waste land into a moneymaking land. It can help to increase rural incomes, self-sustainbility and alleviate poverty for women, elderly, children and men, triabal communities, small farmers. Jatropha curcus is a drought-resistant perennial, growing well in marginal/poor soil. It is easy to establish, grows relatively quickly and lives, producing seeds for 50 years.

Jatropha the wonder plant produces seeds with an oil content of 37%. The oil can be combusted as fuel without being refined. It burns with clear smoke-free flame, tested successfully as fuel for simple diesel engine. The by-products are press cake a good organic fertilizer, oil contains also insecticide. It is found to be growing in many parts of the country, rugged in nature and can survive with minimum inputs and easy to propagate. Medically it is used for diseases like cancer, piles, snakebite, paralysis, dropsy etc. Jatropha grows wild in many areas of India and even thrives on infertile soil. A good crop can be obtained with little effort. Depending on soil quality and rainfall, oil can be extracted from the jatropha nuts after two to five years. The annual nut yield ranges from 0.5 to 12 tons. The kernels consist of oil to about 60 percent; this can be transformed into biodiesel fuel through esterification [1-4].

II. OIL EXTRACTION FROM JATROPHA SEEDS

Below are some of the methods that are usually followed to extracts the oils from jatropha seeds [5-7].

2.1 Oil Presses

Oil presses method is used to extract the oil using simple mechanical devices. It is also done manually. The most commonly used oil presses method is the Bielenberg ram press method. Bielenberg ram press method is a simple traditional method that uses simple devices to extract the oils. With the help of this method 3 liters of oil can be obtained with 12 kg of seeds.

2.2 Oil Expellers

Oil expellers method is also use for jatropha oil extraction. The most commonly used method is the Sayari oil expeller method. This method is also called as Sundhara oil expeller. Komet oil expellers are also used.These sayari oil expellers was developed in Nepal and is a diesel operated one. Now it is developed in Tanzania and Zimbabwe mainly for the production jatropha oil. Heavy oil expellers are made of heavy cast iron and the light ones are made up of iron sheets. Electricity driven models are also available. Komet oil expeller is a single oil expeller machine that is used not only to extract the jatropha oil as well for the preparation of the oil cakes.

2.3 Traditional Methods

Traditional methods are used in the rural and developing areas for extracting the oils. Traditional methods are simple and the oil is extracted by hand using simple equipment.

2.4 Hot oil extraction

The process of extracting the oil at high pressure is called as hot oil extraction method. Since jatropha oil can regulate the operating temperature it is extracted using the hot oil extraction method.Then the cold oil extraction method it is easy to extract the oil from the hot oil extraction since the oil flows more easily due to higher viscosity. And the press cake that remains after extracting the oil also have less oil content which might be 3 to 7 % approximately. These two reasons make the oil press method very interesting.During the oil extraction method many stuffing of the seeds are converted into gum like substances and some non organic substances. These are unwanted products and so they have to be refined.

2.5 Modern Concepts

Modern methods are followed to extract more oils from the jatropha seeds. In these modern concepts chemical methods like aqueous enzymatic treatment is used. The maximum yield by following this modern method is said to be about 74/5.The main idea in researching the modern concepts is to extract a greater percentage of oil from the jatropha seeds.

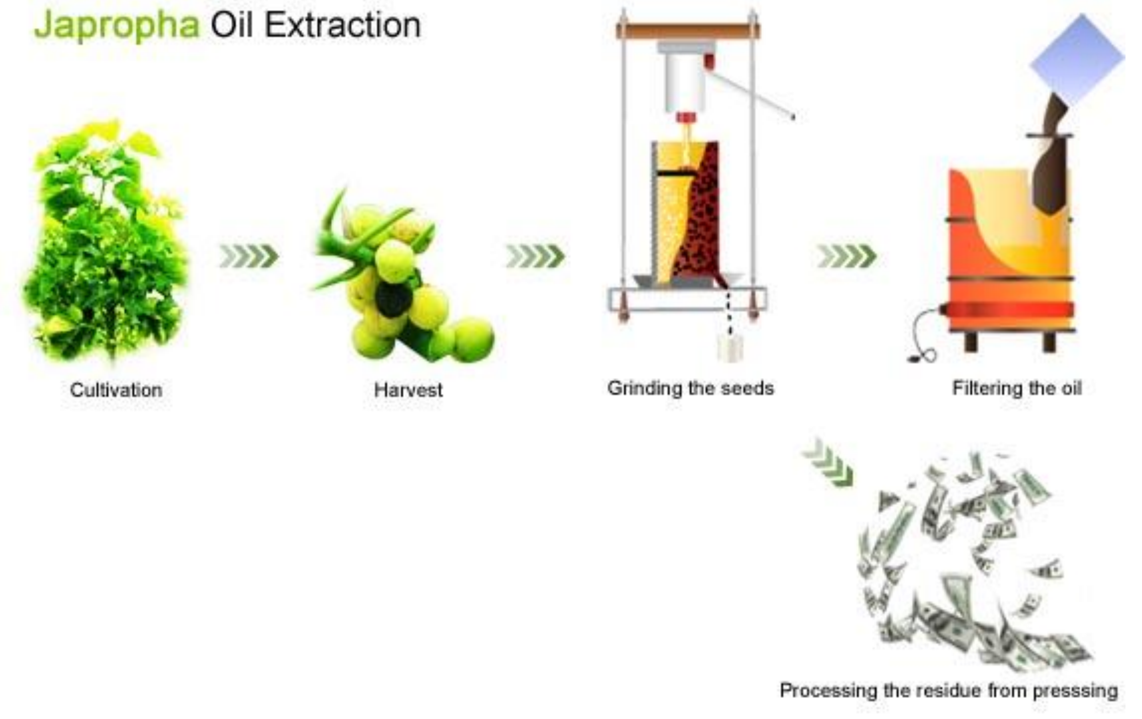
III. TRANSESTERIFICATION BIODIESEL PROCESS

The process of converting vegetable oil into biodiesel fuel is called Transesterification and is luckily less complex then it sounds. Chemically, Transesterification means taking a triglyceride molecule, or a complex fatty acid, neutralizing the free fatty acids, removing the glycerin, and creating an alcohol ester. This is accomplished by mixing methanol with sodium hydroxide to make sodium methoxide. This liquid is then mixed into the vegetable oil. After the mixture has settled, Glycerin is left on the bottom and methyl esters, or biodiesel is left on top and is washed and filtered. The final product Bio Diesel fuel, when used directly in a Diesel Engine will burn up to 75% cleaner then mineral oil Diesel fuel [5-6].

Raw materials required

- Jatropha oil
- Methanol
- Potassium hydroxide
- Isopropyl alcohol
- Distilled water
- Phenolphthalein solution
- Vinegar
- Water

Here is a chart that describes the process of oil extraction from the seeds, Jatropha oil extraction chart



IV. BIODIESEL SCENARIO IN INDIA

The technology is mature and proven. Presently, the indigenously designed bio-fuel plant for 250 lt./day is in operation. We have to design and develop bio-fuel plants of 3 to 10 tones per day capacity for installation in different parts of the country. Effective marketing chain needs to be planned for enabling farmers to reap the benefits directly. Bio-fuel mission will provide technological and employment generation focuses for the rural sector. Use of eleven million hectares of wasteland for Jetropha cultivation can lead to generation of minimum twelve million jobs

As India is deficient in edible oils, non-edible oil is the main choice for producing biodiesel. According to Indian government policy and Indian technology effects. Some development works have been carried out with regards to the production of transesterfied non edible oil and its use in biodiesel by units such as Indian Institute of Science, Bangalore, Tamilnadu Agriculture University Coimbatore and Kumaraguru College of Technology in association with Pan horti consultants. Coimbatore. Generally a Blend of 5% to 20% is used in India (B5 to B20). Indian Oil Corporation has taken up Research and development work to establish the parameters of the production of tranesterified Jatropha Vegetable oil and use of bio diesel in its R&D center at Faridabad. Research is carried out in Kumaraguru College of Technology for marginally altering the engine parameters to suit the Indian Jatropha seeds and to minimize the cost of transesterification[8-9].

V. THE COST

The cost of Bio Diesel is largely dependent on the choice of feedstock and the size of the production facility.If Jatropha feedstock is used, the fuel will cost depending on the country approximately US $ 0,40 per liter plus tax when applicable.

FEED STOCK PRODUCTION PER HECTARE & COST THEREOF

FEEDSTOCK	Country	Yield/hectare (kg)	Rate per barrel(US$)
SOYA OIL	USA	375	73
RAPESEED OIL	Europe	1000	78
JATROPHA OIL	INDIA	3000	43
PALM OIL	Malaysia	5000	46

VI. ADVANTAGES OF JATROPHA CURCUS

- It starts producing seeds within 12 months
- Maximum productivity level is 4-5 years
- Plant remains useful for around 35-50 years
- Seeds can produce around 37% oil content
- Kernels can produce up to 60% oil content
- Its seeds yield an annual equivalent of 0.75 to 2 tons of biodiesel per hectare
- It is a NON-FOOD CROP.

VII. THE ADVANTAGES OF BIO DIESEL

Bio Diesel is the most valuable form of renewable energy that can be used directly in any existing, unmodified diesel engine [6,10-12]

- **Energy Independence:** Considering that oil priced at $60 per barrel has had a disproportionate impact on the poorest countries, 38 of which are net importers and 25 of Which import all of their oil; the question of trying to achieve greater energy independence one day through the development of biofuels has become one of ‘when’ rather than ‘if,’ and, now on a near daily basis, a biofuels programme is being launched somewhere in the developing world.
- **Smaller Trade Deficit:** Rather than importing other countries’ ancient natural resources, we could be using our own living resources to power our development and enhance our economies. Instead of looking to the Mideast for oil, the world could look to the tropics for biofuels. producing more biofuels will save foreign exchange and reduce energy expenditures and allow developing countries to put more of their resources into health, education and other services for their neediest citizens.
- **Economic Growth:** Biofuels create new markets for agricultural products and stimulate rural development because biofuels are generated from crops; they hold enormous potential for farmers. At the community level, farmers that produce dedicated energy crops can grow their incomes and grow their own supply of affordable and reliable energy.At the national level, producing more biofuels will generate new industries, new technologies, new jobs and new markets.
- **Cleaner Air:** Biofuels burn more cleanly than gasoline and diesel. Using biofuels means producing fewer emissions of carbon monoxide, particulates, and toxic chemicals that cause smog, aggravate respiratory and heart disease, and contribute to thousands of premature deaths each year.
- **Less Global Warming:** Biofuels contain carbon that was taken out of the atmosphere by plants and

trees as they grew. The Fossil fuels are adding huge amounts of stored carbon dioxide (CO_2) to the atmosphere, where it traps the Earth's heat like a heavy blanket and causes the world to warm. Studies show that biodiesel reduces CO_2 emissions to a considerable extent and in some cases all most nearly to zero.

- **Soap production:** The glycerin that is a by-product of biodiesel can be used to make soap, and soap can be produced from Jatropha oil itself. It will produce a soft, durable soap, and the rather simple soap making process is well adapted to household or small-scale industrial activity.
- **Other Uses:** Jatropha oil is also used to soften leather and lubricate machinery
- It is excellent at preventing soil erosion, and the leaves that it drops act as soil-enriching mulch

VII. CONCLUSION

As a substitute for fast depleting fossil fuel. Bio diesel had come to stay. In future, it should also serve to reduce and maintain the price of automobile fuel. The under exploited and un exploited vegetable oils are good sources of biofuel. Our country is endowed with many such plants. Research is being carried out now to convert vegetable oils into biodiesel through biotechnological processes using biodiesel. With a concentrated and coordinated effort. Wide use of bio diesel in our country is going to be a reality in the days to come. A national mission on Bio-Diesel has already been proposed by the committee comprising six micro missions covering all aspects of plantation, procurement of seed, extraction of oil, trans-esterification, blending & trade, and research and development. Diesel forms nearly 40% of the energy consumed in the form of hydrocarbon fuels, and its demand is estimated at 40 million tons.

Therefore blending becomes the important National Issue which apart from giving the dividends , it saves the country's exchequer. India has vast stretches of degraded land, mostly in areas with adverse agro-climatic conditions, where species of Jatropha , Mahua etc can be grown easily. Even 30 million hectares planted for bio- diesel can completely replace the current use of biofuels. The production of Bio fuels will also boost the rural economy which will bring more enthusiasm in more than one billion lives in the area.

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