American Journal of Engineering Research (AJER)
e-ISSN : 2320-0847 p-ISSN : 2320-0936
Volume-02, Issue-11, pp-272-275
www.ajer.org

Research Paper Open Access

Automotive (Car Paint): From Local Raw Material Castor Seed Oil (Ricinius Communis), As Plasticizer

Oragwu Ifeoma P.
Department Of Pure &Industrial Chemistry, Anambra State Unversity, Uli.

Abstract: - Drying oils have found applications in almost all decorative, communication and surface coatings. Castor seed oil had been assessed as a plasticizer and film former in automotive paint making. The moisture content of the seed meal was low, therefore, good quality for glossy auto-paint. Soxhlet extraction method was used to extract the oil at 315 ^{0}C, while simple distillation method was used to separate the solvent from the pure oil. The viscosity, refractive index, specific gravity were 0.425 at 26 ^{0}C, 1.471, 2.00 g/cm^{3}, respectively, and are within range for automotive paint application. The mill charge, stabilization and let-down, processes, were carried out within the laboratory conditions. Different colours of paint were prepared from the original formulation by substituting the base pigment with another as desired. The opacity, viscosity, wash-ability, flexibility, compatibility and other quality control tests carried out on the castor oil plasticized auto-paint, compared very well to the Berger auto-fine car paint standard.

Keywords: - *Castor seed oil, pigments, plasticizers, alkyd-resin, auto-paints.*

I. INTROUDUCTION

Castor seed oil (ricinius communis), as one of the drying vegetable oil is derived from the castor oil plant seed, of the family euphorbiaceae. It is one of the most widely used film-forming oil with applications in decorative, communication and surface coatings. The seed plant is wide spreading throughout tropical regions of Africa, India and Mediterranean areas, where they are cultivated as ornamental flowering plants[1].The spring fruit which is greenish to reddish-purple capsule when matured, contains the large oval shiny bean-like poisonous seed[2]. The seed oil is colorless to pale yellow with mild odour, tastes, and commonly referred to as “Palma Christi” or “palm of Christ” due to their medicinal treatments for constipation, wounds,skin diseases etc,[3]. The presence of ricinoleic acid (a mono-saturated compound) with 18 carbon fatty acid having hydroxyl group on the 12th carbon which makes derivatization of other compounds like alkyd resins, possible [4,5, 6]. It is one of the drying oil that could cross-link on exposure to air to form a solid dry film, a property that makes it unique component in automotive paint making.

Paints, generally are pigmented solutions, liquefiable or mastic, which after application to a substrate, dry, to form solid films. The early paints of the Egyptians, were made from egg-shell, insects, plants, animals, minerals, powdered rocks as pigments, resins and water as the commonest solvent, had been improved upon to give better quality and durable coats[6]. Reports had shown that modern paints had been prepared to add shape, beauty, quality and durability to both exterior and interior finishes in automotive vehicles by incorporation of plasticizers[7]. Automotive paint technology are more sophisticated and are composed of blends of resins, fillers, additives, curing agents or extenders, to inhibit rust, cracks, resist fire or light effect on substrates, and designed to withstand other environmental conditions. Environmental Regulation Agencies had advised automotive paint industries to reduce solvent emission in their paint products to check-mate air pollutions [8]. This is because conventional solvents in paints could evaporate into the air during the drying process to release the green house gases that could cause global warming and are detrimental to health [9]. Plasticizers are inert polymeric materials with high boiling point and functions by embedding themselves between the paint components to enhance their cross-linkages[10]. They are dispersants or additives that could increase the plasticity, flexibility, compatibility, washability and durability of auto-paint or gloss paints in general [11]. Studies had shown that plasticizers had been used to improve the strength of glass-fiber reinforced plastic motor cases, concrete clays and related products[12]. An unplasticized surface coats result into loss of flexibility, emblittlement and cracking within a short period of time[13]. Serious negligible damages had been observed as it concerns maximum average loss in burst strength in motor cases without plasticizers than those with plasticizers [14]. Medical reports had also shown that plasticizers are also used to improve hormone-like and estrogenic activities in the body[15]. Researchers had compared other drying oils and proved castor oil good for most chemical or medical products like in the production of cosmetics, coatings, etc [16]. As part of my contributions to improve the economy, health standard, minimize solvent emission of dangerous gases from paints and increase the quality of automotive paints, I embarked on the extraction and application of castor oil as a plasticizer in auto-paints, as an alternative to the expensive and imported linseed oil for applications in automotive or gloss paint making generally.

II. MATERIALS AND METHODS

The apparatus include; soxhlet extraction sets, stopwatch, leveling cup, viscometer cup, refractometer, Hegman finess grinding-guage, water bath, thermometer, heating mantle, steel-metal panels etc. The materials include: titanium dioxide, xylene, white spirit, nitrocellulose, alkyd resin, etc.

2.1: METHODS:

The castor oil seeds were obtained from afor market, Akwaeze in Anaocha local government Area of Anambra State. The hard back, with white spotted shells were carefully separated and the seeds weighed, ground to seed meals of 2.15 mesh and the moisture content taken. The extraction of the oil was carried out at 315 ^{0}C using soxhlet extractor and petroleum ether as the solvent.

The physico-chemical analysis were carried out on the oil sample to ensure its suitability in automotive paint making, according to the ASTM (2010), standard. The viscosity testing was carried out on the oil using Ford #4 viscometer cup at 25 ^{0}C and a stop watch to monitor the flow resistance of the oil. The refractive index was recorded using the Abbe refractometer of AR200 model, while specific gravity test was carried out at the pressure of 1 atm and the value calculated using the formular; specific gravity(SG) = volume of oil sample divided by volume of water. The boiling point was carried out using - 4 to 360 ^{0}C capacity thermometer.

2.2: Preparation of Auto-paint; This process was carried out in three stages:-

The milling stage;

This involves dispersion of 23.65 wt % of titanium dioxide in 70ml of white spirit , using 1000ml ceramic mortar and pestle. The process lasted for 45 minutes while testing the fines of the pigments using Hegman's fines-gauge, until 5.67cm^3/10.5µm fines was achieved, according to the American Society of Testing Material (ASTM) standard(D817-96(2010)[102]) for automotive paints.

The stabilization stage; The temperature of the dispersed pigments was lowered to 25^{0}C by addition of 70ml of xylene while stirring to increase the intermolecular distance and prevent aggregation of the particles. 90 ml of Alkyd resin was added to the paint mixture to ensure good quality .

The let down stage; Involves incorporation of other additives like cyclohexanes and nitrocellulose , plasticizers (castor seeds oil), etc, to increase the flexibility, brushability, plasticity to prevent curing of the paint solution. The temperature of the finished paints were allowed to drop from 78^{0}C to 26^{0}C before storing in an air tight container.

2.3: Quality control tests:

The quality control tests were carried on the paint samples and compared to the commercial Berger auto-paint sample in relation to opacity, drying time, washability, specific gravity, etc. The specific gravity test was carried out on the research sample according to ASTM standard (2007). Opacity testing was performed by spreading the paint on an opacity white paper with black lines across them, and the hiding ability of the research paint was observed visually. The viscosity testing was done using a Ford #4 viscometer cup at 26 ^{0}C and a stop-watch to record the time for the last drop of the paint samples. The paint sample was thinned down for easy brushing before spraying on the metallic panels using a spray gun, while the storage temperature was also determined by the drying time monitoring[20] .

III. RESULTS AND DISCUSSION

The physico-chemical analysis carried out on the castor seed oil to assess its suitability in automotive paint making is shown on table 1. The values of the refractive index of castor seed oil (1.471) and viscosity (0.425 at 25 ^{0}C), are high as compared to the commercial linseed oil or cedar wood oil which are the industrial standard for auto-paint making according Daniel, (2007). The high viscosity is an advantage to control the melt flow of auto-paints. The higher specific gravity of (2.00 g/cm^3), of the oil sample is attributed to the solvent contamination during the extraction process. The high percentage of castor seed oil, titanium dioxide, alkyd resin, with 20.15, 23.15, 11.42 wt. % respectively, as shown on table 2, was chosen in order to formulate a characteristic white glossy and plasticized auto-paint. The drying time of the oil was monitored under the atmospheric condition and the period of film formation was recorded at 30minutes, which was quite good for surface coatings, according to Berger paint standard (1998). The opacity result of the castor seed oil plasticized auto-paint as shown on table 3, indicated that the hiding ability is quite better than the unplasticized sample paint compared to the commercial paint. This could be attributed to the cross-linking effect of the castor oil as plasticizer, when exposed to the atmospheric oxygen, Wollensak, et al, [2003].

The viscosity values for plasticized paint sample is lower as shown on table 3, because addition of the castor oil reduces the cohesion of the intermolecular forces along the chains and increases free flow, flexibility, elongation and workability of the paint components. Ibemesi and Attah (1990), had suggested that drying time of plasticized paints are generally reduced, due to the presence of the ricinoleic acid. The stages of dryness, from dust free time to touch dry, through tack dry and hard dry time, as shown on table 3, exhibited satisfactory quality for the research plasticized automotive paint as compared to the unplasticized commercial paint. The castor seed oil plasticized automotive paint exhibited higher gloss, flexibility, increased adhesion, durability, smooth, ruby and provided additional protections to the substrate against corrosion and other weather conditions, as was observed on the coated steel panel, in accordance to the contributions of Needs, et al [1995].

IV. CONCLUSION

Castor seed oil has been proved to be an alternative to the widely used, expensive, imported linseed oil, in paint making. Farmers are also encouraged to embark on the production of castor seed plant, considering its inexhaustible roles in oil paint making, medicine, cosmetics and other industrial applications. The review on the use of castor oil as plasticizers, in automotive paints are now strongly recommended, in order to minimize solvent emission, to check-mate release of green house gases during paint drying which are hazardous to life. Automobile Engineers are also advised to incorporate castor seed oil as plasticizers in the surface coatings to protect their devices/ automobiles against corrosion, cracks, and to improve their attractive appearances.

Table 1: The physico-chemical analysis of the castor seed oil compared to other drying oils:

Tests	Castor Seed Oil	Linseed Oil	Cedar Wood Oil
Appearance	**Colourless to Pale Yellow**	**Golden Brown to Yellow**	**Pale Yellow to Dark Yellow**
Refractive Index	**1.471**	**1.4835**	**1.516**
Specific gravity (g/cm 3)	**2.00**	**0.945**	**0.9250**
Viscosity at 26 0 C	**0.425**	**0.8**	**2000 mPa**
pH	**4.92**	**-**	**-**
Boiling point (0 C)	**330**	**253**	**-**

The comparative values of the castor seed oil sample to the commonly used commercial drying oils .

Table 2: The formulation for the castor seed oil plasticized top coats (finishes)

Raw Materials	Percentage Weight(wt. %)	Volume (ml)
Castor oil	**20.15**	**168.00**
Titanium dioxide	**23.65**	**200.00**
Xylene	**16.52**	**70.00**
White spirit	**7.42**	**70.00**
Cyclo hexane	**6.79**	**45.00**
Trimethyl benzene	**6.40**	**45.00**
Alkyd resin	**11.42**	**90.00**
Methylethylketone	**5.65**	**192.00**
Nitrocellulose	**2.00**	**110.00**
Total	**100.00**	**1000.00**

Table 3: Results of some quality control testes carried out on the paint samples

Research Paint Sample			Commercial Paint
Tests	**Plasiticized**	**Unplasiticized**	**Unplasticized**
Opacity	**Excellent**	**Fair**	**Good**
Viscosity at 26 ^{0}C	**92.50**	**96.10**	**97.25**
Specific gravity (g/ cm^3)	**1.14**	**1.75**	**1.16**
Dryingtime(minutes);			
dust free time	**2**	**5**	**4**
touch dry time	**3**	**6**	**5**
tack dry time	**4**	**10**	**6**
Hard dry time	**6**	**20**	**10**

Value of some quality testes on the research paint samples

REFERENCES

[1] R.M.R. Philips, (1999), Animal and Biennial Plants, Macmilliam pub., London, 106.

[2] E.P.Sabina, M.K. Rasod, L. Matthew, (2009), Studies on the protective effect of Ricinus Communis Leaves Extract on Carbontetrachloride heptatotoxicity in Albino Rats, *Pharmacology* 2, 905-916.

[3] P. Kalaiselvi, B. Amuradha, C.S. Parameswari, (2003), Protective Effect of Ricinus Communis Leaf Extract against Paracetamol-induced Oxidation of Unsaturated Lipids, Hepato-toxicity, *journal of, (1-2), 97-105.*

[4] M. Ghisari, *Biomedicine*, E.C. Bonafield-Jorgensen,(2009), Effect of Plasticizers and their mixtures on estrogens receptor and thyroid hormonal functions , *Journal of Toxicology, 189(1), 67-77.*

[5] N.J. Frank, (2005), Alkyd Resins, *Ullmann's Encyclopedia of Industrial Chemistry, Willey-VcH, Weinheim, 409.*

[6] P. Slephannie,P.(2011),Oldest Human Paint-making Studio Discovered in Caves, Live Science, 14.

[7] F.C. David and J.H. Christopher (2000), Plasticizers*, Ullmann's E ncyclopedia of Industrial Chemistry, Willey-VcH, Weinheim, 439.*

[8] A.P. Needs, S.E. Caldwell, K.A. Mill, (1995), Mechanism of Free Radical *Lipids*, 30, 277-296.

[9] Sunyer, (2001), "Urban Air Pollution and Chronic Obstructive Pulmonary disease: a review" *European Respiratory journal*, 17(5), 1024-1033.

[10] M. Daniel, (2007), Standard Specification of Linseed Oil for Paints, *Industrial Research and Standard Revision Acts, section 20(25), S.I.159/1949.*

[11] G. Wollensak, E. Spoerl, T.Seiler, (2003), Riboflavin/ultraviolet induced collagen cross linking for the treatment of kertoconus, *American journal of Ophtalmol*, 135 (5), 620- 627.

[12] D.A. Morgan, (1971), Effect of Plasticizers on the Strength of a Plastic Motor Case, *Army Missile Research and Development*, 1, 23.

[13] D.S.Oguniyi,(2006),Castor Oil; A Vital Industrial Raw Material, *Bioresource Technology*, 97(9), 1086-1091.

[14] R.Victor, R.S. Jayalakshamma,(2005),Cost Effective, Qualitative Immersion Oil for Microscopy, *Anatomical Society of India*, 54(2),7-12.

[15] J.A. Ibemesi and J.C. Attah (1990); Solvent Extraction of Oils of Rubber, Melon, Pumpkin and Oil Bean Seeds, *American Oil Chemist's Society, 67(1), 25-27.*

[16] American Society for Testing Materials (ASTM) International, (2010), Chemical Analysis of Paints and Paint Materials, D817-96, [102]. 16.