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Evaluation Of Mahua Oil Prepared By Two Step Transesterification For Performance And Emission Characteristics

Allen Jeffrey.J[1], A.Anbazhagan[2], Candace Livingston[3], J.Earnest Shalom[4], A.Franswithin Ajay[5], K.Arun[6]
[1, 2](Assistant professor, Mechanical dept, Loyola Institute Of Technology/Chennai)
[3, 4, 5, 6](Mechanical dept, Loyola Institute Of Technology/Chennai)
Corresponding Author: Allen Jeffrey.J

ABSTRACT : *Since the requirement of fossil fuel increases day by day, the world is in the urge of finding suitable alternative fuels that are environmental friendly. The production of biodiesel is in large scale from the non edible oil using methanol and an alkaline catalyst. In India non edible type oil and fats are widely available. Normally, the biodiesel is blended with mineral diesel and used as fuel for diesel engine. Biodiesel is produced from vegetable oil and animal fat which is suitable for gasoline. In this experiment biodiesel is prepared from mahua oil (MO) using two step transesterification process, by adding methanol and sodium hydroxide pellets. As vegetable oil and animal fats have Free Fatty Acid (FFA) content transesterification process is used for breaking down of larger molecules to smaller molecules there by reducing the FFA content in the oil. This study presents the result of experimental investigation on the effects of mahua oil biodiesel and its blends on performance and emission characteristics of a four stroke diesel engine. It was evident that there was a drop in performance but in terms of emission biodiesel proved to be lesser when compared with diesel fuel.*

KEYWORDS - *Biodiesel, Emission, Free Fatty Acid, Mahua Oil, performance, Two Step Transesterification.*

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I INTRODUCTION

The world faces severe demand for fuel mainly due to the increased usage as well as parallel depletion of fossil fuel resource. Fossil fuels such as petroleum, natural gas and coal have been meeting most industrial and commercial demands for relatively low cost, high energy density, transportable fuels for decades. India's fuel consumption is likely to hit 200 million tons in 2016/17. Demand for petroleum products is increasing as the economy grows and India has the best growth among the large. Due to recent energy crisis and dwindling resource of crude oil the demand for alternate liquid fuels particularly diesel is increasing. Bio fuels are being given serious consideration as potential sources of energy of the future, particularly in developing countries like India. The use of edible oil to produce biodiesel in India is not feasible due to the demand and supply of such oil. As India is deficient in edible oils, some developing works have been carried out by government of India for producing bio diesel from non edible oil. Bio fuels are drawing more attention worldwide as substitutes for petroleum-derived transportation fuels to address energy cost, energy security and global warming concerns associated with liquid fossil fuels. The term bio fuel is used here to mean any liquid fuel made from plant material or animal fat that can be used as a substitute for petroleum-derived fuel. ASTM International defines biodiesel as a fuel composed of mono alkyl esters of long-chain fatty acids derived from renewable vegetable oils or animal fats. (ASTM International is an international standards organization that develops and publishes voluntary consensus technical standards for a wide range of materials, products, systems, and services).

The percentage content of fatty acids in mahua oil is 35-45. The mahua tree starts bearing seeds from seventh year of planting. Mahua seed oil is a common ingredient of hydrogenated fat in India. It is obtained from the seed kernels and is a pale yellow, semi-solid fat at room temperature. It is also used in the manufacture of various products such as soap and glycerin. Crude mahua oil generally contains high percentage of Free Fatty

Acid (FFA). The chemical process by which biodiesel is prepared is known as the transesterification reaction. The properties like density, viscosity, flash and fire point of Mahua oil under test are higher, and calorific value is lower, and are in the range of 86% that of diesel. The production of biodiesel with high fatty acid was carried out by two step pre-treatment process in which sulphuric acid was used as a primary catalyst. In the second step methanol and sodium hydroxide pellets are used to produce Mahua oil biodiesel at 50^{O}c to 60^{O}c.The present researchers considered among several non edible seed oil, Mahua oil is considered because of the following reasons. [5]

- These are non edible type oils.
- These trees are indigenous to India, grow even in draught places and found abundantly in all parts of India
- This oil can easily substitute for petroleum based Hydro Carbon fuel.

Generally mahua oil biodiesel was obtained by employing two stage transesterification with Acid/Base catalyst, biocatalyst and supercritical Mathanolysis process. The two stage transesterification process comprises of primarily acid esterification to reduce the free fatty acid content and the base catalyzed esterification to convert the vegetable oil into fatty Methyl ester. [1] Therefore study deals with the evaluation of mahua oil biodiesel by two step transesterification for combustion performance and emission characteristics.

II MATERIALS AND METHOD

From Tamil Nadu the mahua seeds are collected and maintained with less than 5% of moisture and mahua oil is extracted by using expeller process. Under laboratory conditions the pre-treatment and the transesterification process were carried out consisting of 1000cc inverted neck flask in air tight conditions. It was found that the free fatty acid content in mahua oil was about 18% under titration method [5].The reaction environment was maintained at room temperature and 50^{O}c to 60^{O}c with 5% of concentrated sulphuric acid. The mixture was continuously stirred at 450 rpm for above 90 minutes with an interval of 15 minutes. Followed by the base catalyst reaction is carried out with Methanol and the sodium hydroxide pellets as catalyst added and stirred for one hour. The oil is now transferred to the separating flask and allowed to cool for the glycerol to settle.

Figure (1) Raw mahua oil

Figure (2) Separating flask

III EXPERIMENTAL SETUP

The Mahua oil biodiesel is tested in a four stroke compression ignition engine inside the laboratory. The specification of the four stroke engine is mentioned in the table below. It is a single cylinder vertical air cooled diesel engine.

Table (1) Engine Specification

Rated Power	4.4 KW
Rated Speed	1500 Rpm
Bore Diameter	87.5mm
Stroke	110mm
Compression Ratio	17.5:1
Orifice Diameter	29.6mm
Coefficient of Discharge	0.6
C.V of fuel	42500KJ/Kg
Density of diesel	860Kg/m3

Emission characteristics were analyzed by AVL DI GAS 444. A five gas analyzer was used to analyze the emission percentage of CO, HC, CO_2, O_2, NOx and the exhaust gas temperature. The break thermal efficiency, mechanical efficiency and the indicated thermal efficiency is calculated for the readings taken from the engine and the graph is plotted.

IV. RESULT AND DISCUSSION

I. PERFORMANCE CHARACTERISTICS

1. BRAKE THERMAL EFFICIENCY

Brake Thermal Efficiency is described as break power of a internal combustion engine as a function of the thermal input from the conventional fuel. Brake thermal efficiency and load are directly proportional to each other. Hence forth brake thermal efficiency rises as the load is increased. From no load to full load the brake thermal efficiency of diesel is higher than biodiesel and its blends. Since mahua oil biodiesel has higher density, higher viscosity and low volatility results to the poor mixture formation than pure diesel. The brake power Vs brake thermal efficiency graph is shown in the Fig (3)

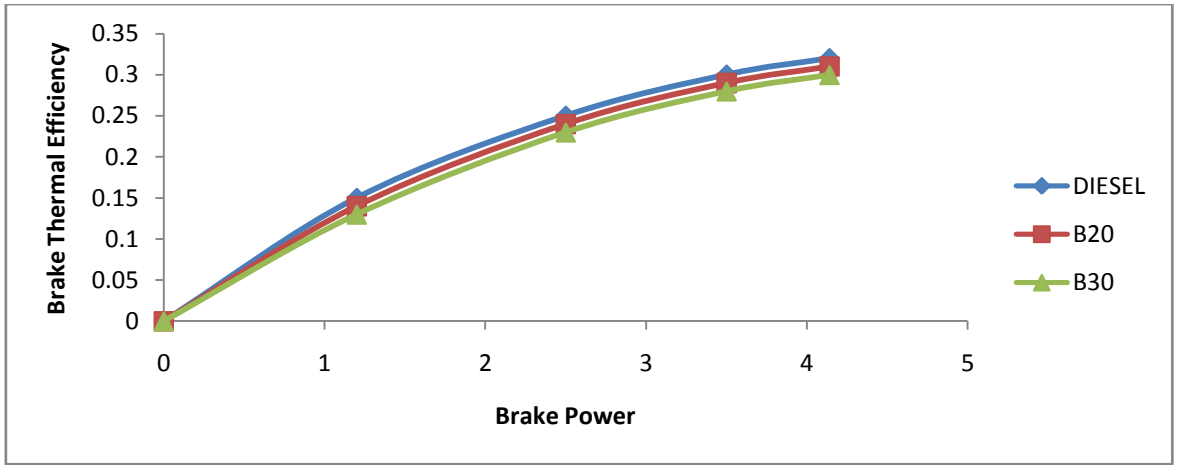

Figure (3) Brake power Vs Brake thermal efficiency

2. SPECIFIC FUEL CONSUMPTION

Specific fuel consumption is the amount of fuel utilized by an internal combustion engine for every single unit of power output. It is inversely proportional to break thermal efficiency. Compared with diesel fuel the specific fuel consumption is higher for bio diesel and its blends because of the low calorific value and higher viscosity of the biodiesel. The brake power Vs specific fuel consumption is shown in the Fig (4)

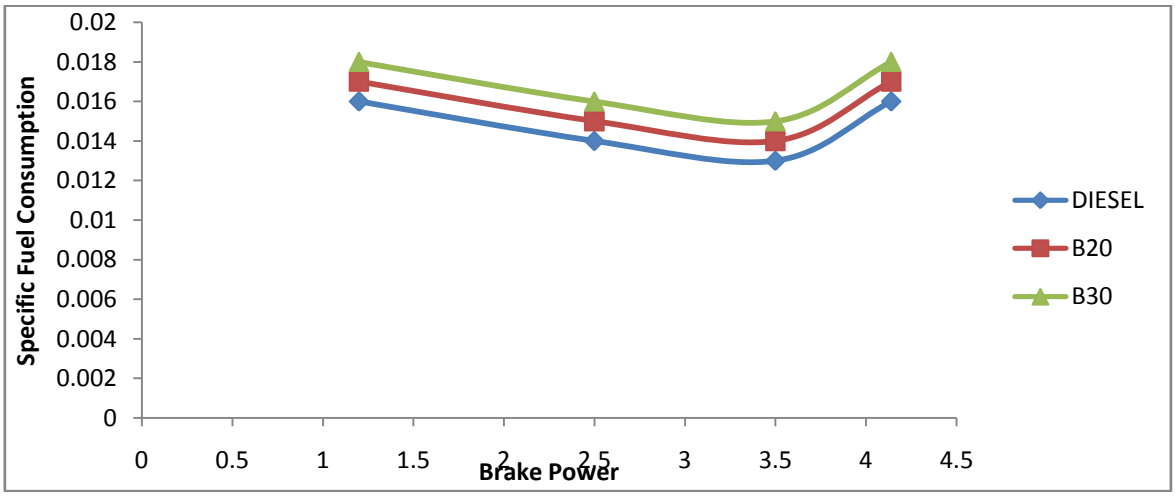

Figure (4) Brake power Vs Specific fuel consumption

II. EMISSION CHARACTERISTICS

1. Carbon monoxide

Carbon monoxide is a result of incomplete combustion due to the insufficient oxygen as it consists of carbon atoms in it. Compared to neat diesel fuel mahua oil and its blends produce lower carbon monoxide emission due to the oxygen content that enables the combustion process. As the load increases the carbon monoxide is also increased there were evident drop in carbon monoxide emission when biodiesel blends was used as fuel. The load Vs carbon monoxide emission graph is shown in Fig (5).

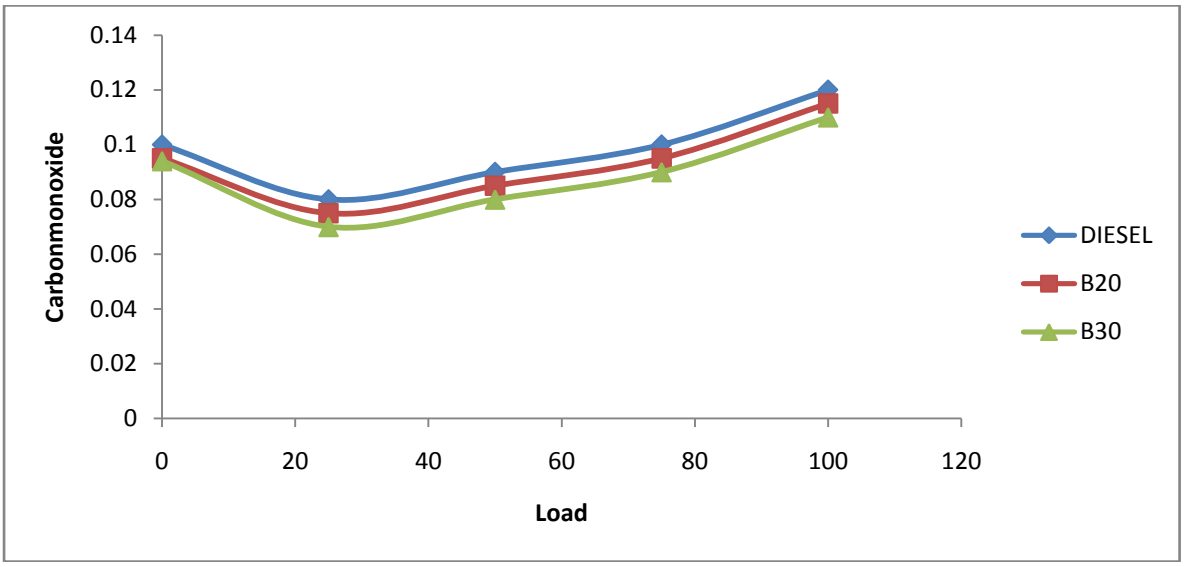

Figure (5) Load Vs Carbon monoxide

2. Nitrogen oxide emission

NOx emission produced is comparatively high in mahua oil biodiesel than diesel due to the presence of oxygen content that enables the combustion by increasing the cylinder temperature and NOx emission. The load Vs NO_x emission graph is shown in Fig (6).

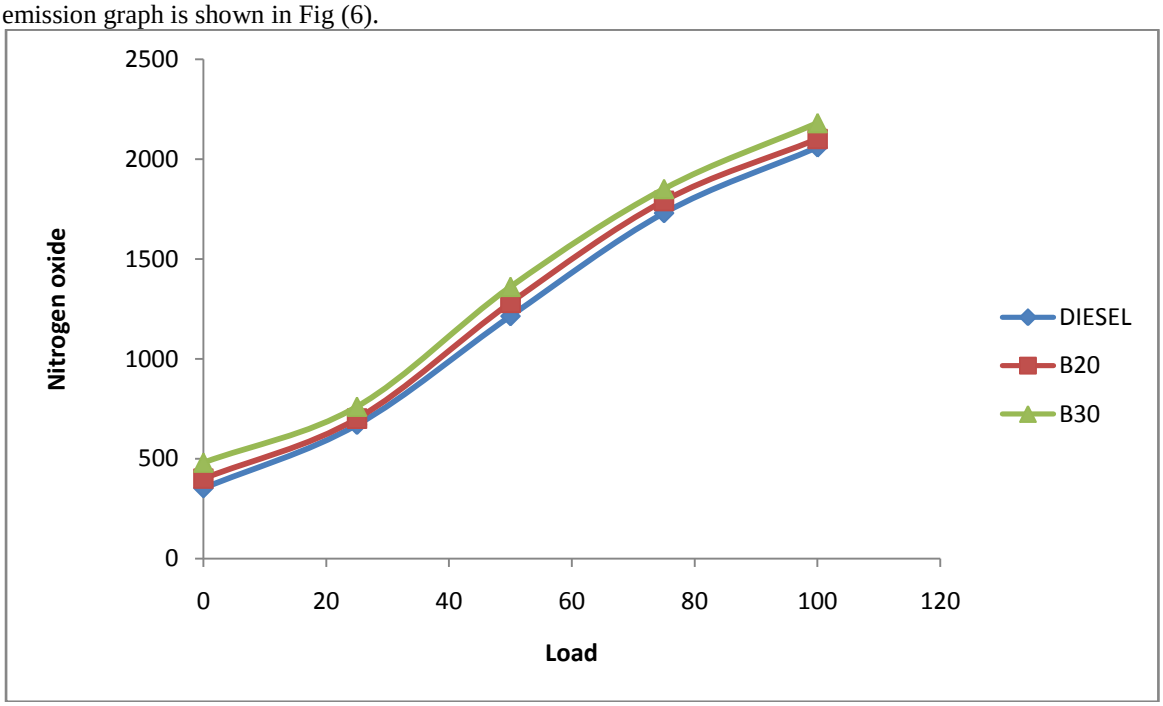

Figure (6) Load Vs Nitrogen oxide

3. Hydrocarbon emission

The major contributor to smog is hydrocarbon emission it is outcome from an engine due unburnt fuel particles

The variation of unburned hydrocarbon emissions for straight diesel and biodiesel blends is shown in Fig (7) Comparing with diesel fuel the use of biodiesel and its blends in the internal combustion engine decreases the hydrocarbon emission to great extent it is evident that around 5 to 8 percent reduction in emission when biodiesel is used as fuel

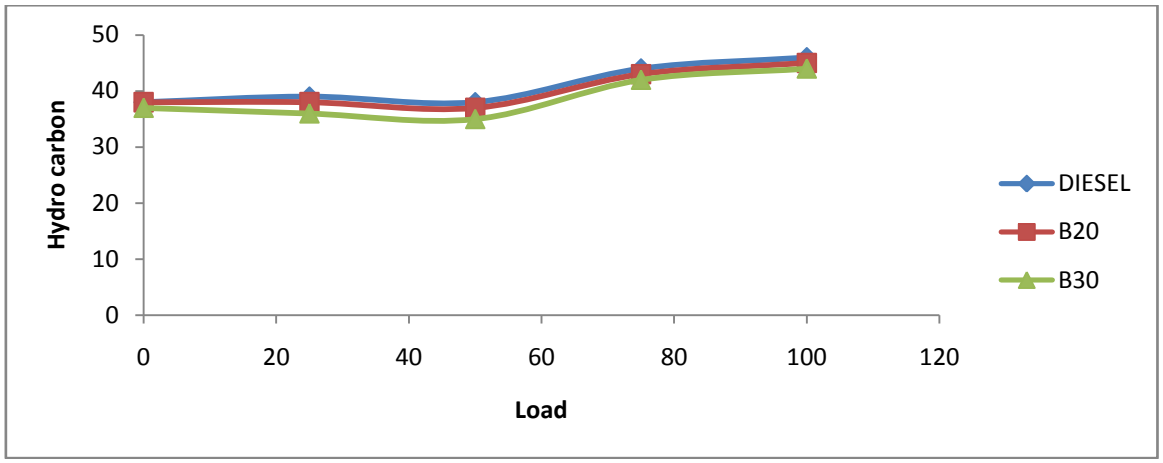

Figure (7) Load Vs Hydrocarbon emission

V. CONCLUSION

Biodiesel was prepared by two step transesterification process by adding 5% of concentrated sulphuric acid followed by the base catalyst reaction using methanol and sodium hydroxide pellets under suitable temperature with respective time intervals. The biodiesel blends are tested in a four stroke diesel engine for emission, combustion and performance characteristics. It is found that Brake thermal efficiency of the biodiesel blends is comparatively low with diesel. As the biodiesel has low calorific value and higher viscosity the specific fuel consumption is high in biodiesel when compared to diesel. Compared to the neat diesel fuels the carbon monoxide emission and hydrocarbon emission is low in the mahua oil biodiesel. It is observed that the NOx emission is more in mahua oil biodiesel.

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