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Study on Performance and Emission Characteristics of Lard Oil Blended Biodiesel

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***Abstract*: Present work focuses on performance and emission characterises of lard oil blended biodiesel. Biodiesels were prepared through Lard Oil Methyl Ester (LOME) by trans-esterification process. Two blends of biodiesel B10 and B20 were prepared and parameters such as brake thermal efficiency, brake specific fuel consumption, hydrocarbon emission, carbon mono oxide emission, oxides of nitrogen against the load were studied according to standard test procedure. This article provides an overview on selection of optimum blending of lard oil to the diesel.**

***Keywords*: Lard oil, Biodiesel, Trans-esterification, Free Fatty Acid, Brake thermal efficiency, Smoke opacity.**

I. INTRODUCTION

Biodiesels are the mono alkyl esters obtained from vegetable oils or animal fats through trans-esterification process. Biodiesel is considered as the alternative for the depleting petroleum fuels. The properties of the diesel and biodiesel are almost similar so the use of biodiesel in the locomotive engines gained much importance in recent years. The biodiesel has several advantages when compared with diesel fuel such as less sulphur content in the fuel, and lower emission of hydrocarbons, carbon dioxide (CO_2), carbon monoxide (CO) and sulphur dioxide (SO_2), however biodiesel also has some disadvantage such as low calorific value, low oxidation temperature, low volatility and high viscosity which cause severe problem to engine during operation [1]. The scarcity and cost of vegetable oils have made the researchers to show interest in extraction of biodiesel from waste animal fats. The animal fats are inexpensive and more abundant in nature. The animal fat from beef, pork, chicken and mutton are commonly used in biodiesel production [3,4]. The use of animal fats for producing biodiesel has several advantages such as higher cetane number, high oxidation tendency and good lubricating property.

Ejikeme et al. [5] derived biodiesel by trans-esterification of pork lard oil with methanol and sodium hydroxide as catalyst at different temperature. The fuel properties of lard oil methyl esters were determined using ASTM standards for biodiesel. The results obtained from the test indicate the related fuel properties of the biodiesel obtained are within the standard for biodiesel. The authors infer that the biodiesel obtained from pork lard can be used as the fuel in compression ignition engine. Sunil J. D'Souza et al. [6] studied the production of biodiesel from lard oil and analysed the emission and performance characteristics of CI engine fuelled with lard oil methyl ester (LOME) and diesel by varying the compression ratio. The experiment is conducted in variable compression ratio diesel engine at a constant speed of 1500 rpm for different blends like B10, B20and B30 with compression ratio of 16:1, 17:1 and 17.5:1. The experimental results reveal that blends of LOME reduces the brake thermal efficiency and increases brake specific fuel consumption as the compression ratio is increased. There is a decrease in the HC, CO, CO_2, and smoke opacity, increase in emission of NOx as the percentage of LOME blend and compression ratio increases. The enhanced performance and emission characteristics are found with 17.5 compression ratio for different blends of LOME.

This work focused on the preparation, testing and comparison of neat diesel and blends of lard oil methyl ester and suggests the optimum blend that would cause least emission without any considerable reduction in the performance of the compression ignition engine

II. SYNTHESIS OF BIODIESEL

2.1 Extraction of lard oil from Pork lard:

1. Fat was isolated from pig meat and the fat was chopped into approximate size of $10mm^2$.
2. The chopped pieces are put into a beaker of 5 litre capacity with water around a quarter the volume of the fat. Heat is supplied and stirred continuously till the water gets dissipated completely.
3. Solid fat was melted as it was further cooked and was sieved using a cloth, permitted to cool around 50°C and water proportionate to double the volume included.
4. The fat floating on the water is gathered, dried, weighed and put away in refrigerator for biodiesel production.

2.2 Free Fatty Acid (FFA) Test:

1. Isopropyl alcohol of about 50 ml is taken in a clean and dry conical flask.
2. Add few drops of 0.1N NaOH solution into a conical flask and shake it well.
3. 10 grams of lard oil is measured and added to the conical flask.
4. The mixture is heated to about 60°C.
5. Few drops of Phenolphthalein indicator is added to the heated mixture.
6. The mixture is titrated against 0.1N NaOH solution.
7. Titration is done until the pink colour remains for at least 1 minute and burette reading is taken

$$\text{FFA Content} = \frac{28.2 \times (\text{Normality of NaOH}) \times (\text{Titration value})}{\text{Weight of the oil}} \quad [1]$$

$$= \frac{28.2 \times 0.1 \times 6.0}{10.3}$$

$$= 1.640$$

If the FFA content is more than 4 two stage trans-esterification process is to be performed. In the present work titration value is 6, and the FFA content is 1.640 which is under 4, so single stage trans-esterification is adequate to produce biodiesel.

2.3 Trans-esterification of lard oil:

The trans-esterification was done by using three neck round bottom flask which is shown in figure [1]. One litre of lard oil is measured and transferred to three necks round bottom flask and heated up to 65˚C. The solution of methanol with 3.664 grams of NaOH is prepared and transferred to the lard oil at 65˚C in the round bottom flask which is shown in figure [1]. The mixture is maintained at 65˚C for two hours for the chemical reactions to take place. The mixture is stirred at a speed of 600-800 rpm by a magnetic stirrer inserted inside the flask during the transfer of lard oil. After two hours of chemical reaction the mixture is transferred to a separating funnel and kept for two hours for the settling of glycerine which is shown in figure 3.3. The glycerine settled down at the bottom was drained. The biodiesel (Lard oil methyl ester) obtained from trans-esterification is heated to about 75˚C in order to recover the methanol. The biodiesel is washed in hot water so that soap and glycerine content in biodiesel is removed. The LOME obtained is further heated up to 110˚c so that the moisture and water content in biodiesel is eliminated.

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Figure [1]. Transestrification of oil.

The Bio-diesel is transferred to the three neck flask reaction vessel and necessary arrangements for distillation setup like heating, stirring and fixing the double wall condenser along with the recovery flask is done. The mixture is maintained at 75°C and stirred at 100 rpm. The methanol starts evaporating and the condensed methanol is collected and measured.

III. RESULT AND DISCUSSION

3.1 Brake Thermal Efficiency:

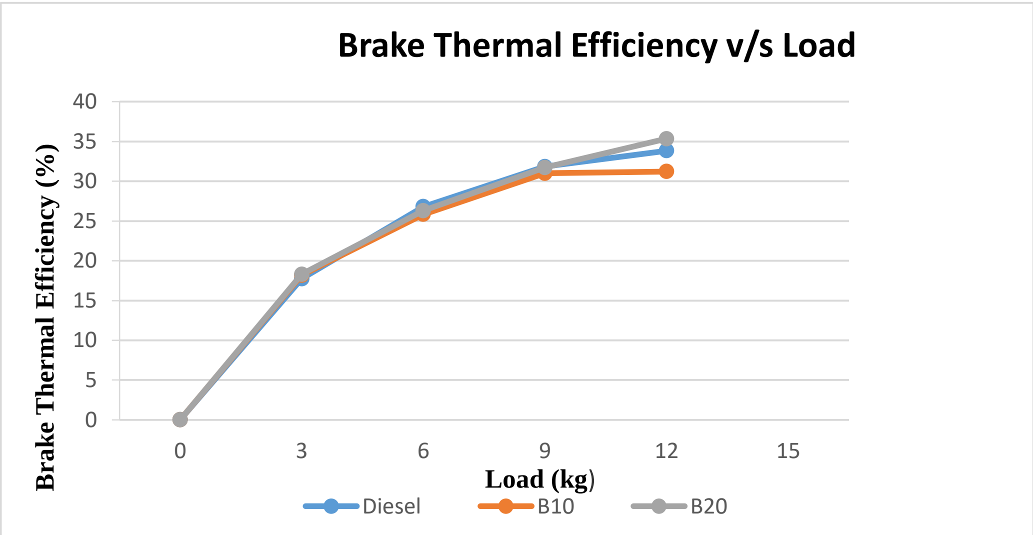

Figure [2]. Brake thermal efficiency VS Load

The variation of brake thermal efficiency against load is shown in the figure 2. From the figure 2 it is observed that the brake thermal efficiency of the VCR diesel engine has shown an improvement with the blend B20. At the maximum load condition, the brake thermal efficiency is found maximum. From the experimental result it is observed that the brake thermal efficiency of the engine is increased by 4.46% when it is fuelled with 20% blended diesel (B20) at maximum load.

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3.2 Brake Specific Fuel Consumption:

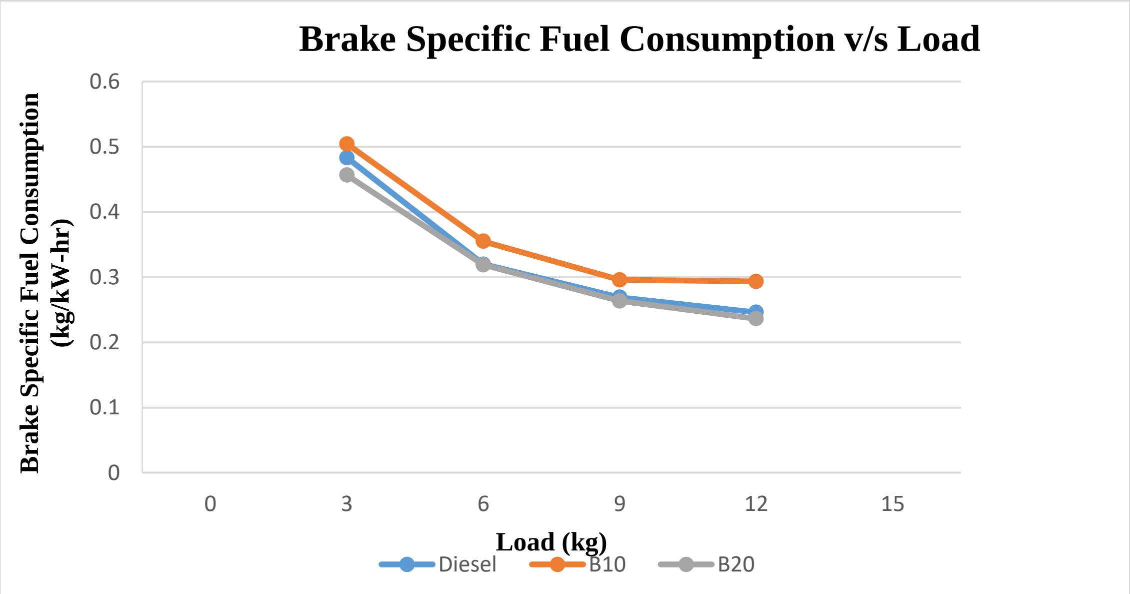

Figure [3]. BSFC VS Load

The variation of brake specific fuel consumption is shown in the figure3. As the load on the engine increased the brake specific fuel consumption gets decreased. From the experimental results it is observed that the brake specific fuel consumption of the engine decreased when it is fuelled with 20% blended diesel (B20) at maximum load condition. The fuel with low calorific value is consumed more to produce the same power output when compared to fuel with relatively high calorific value.

3.3 Carbon monoxide emission:

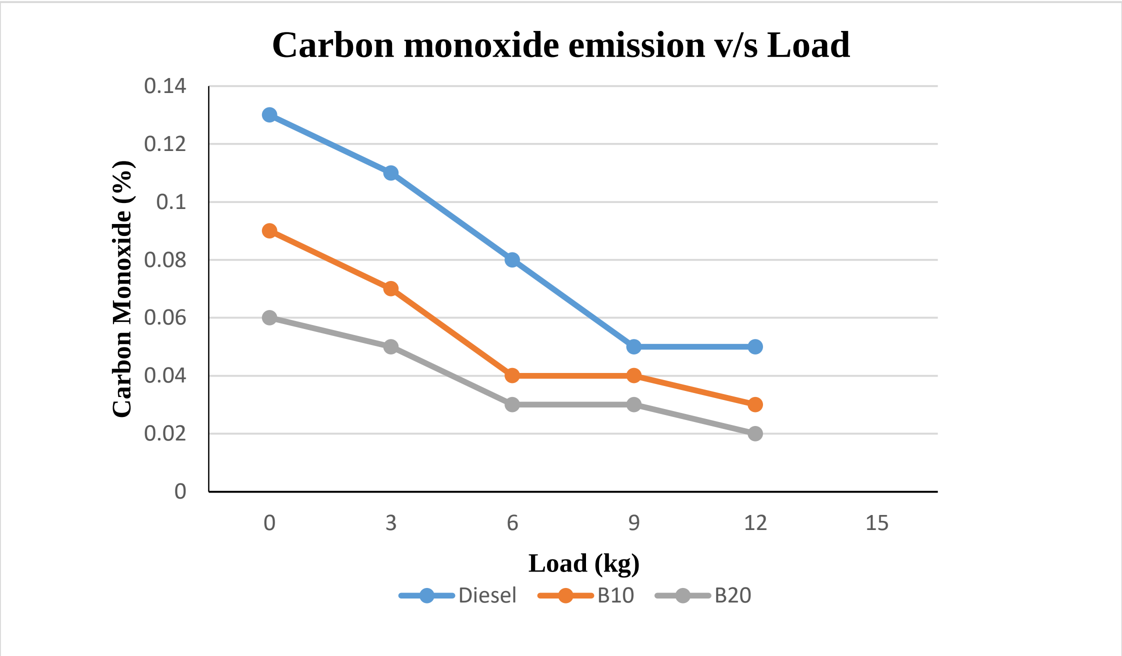

Figure [4]. Carbon Monoxide %VS Load

The variation in emission of Carbon monoxide against load is shown in the figure 4. It has been observed that the emission of carbon monoxide decreased with increase in load. At full load condition the emission of Carbon monoxide gets reduced by 27% for diesel LOME20 when compared to diesel fuel, this may be due to better combustion of fuel.

3.4 Oxides of nitrogen:

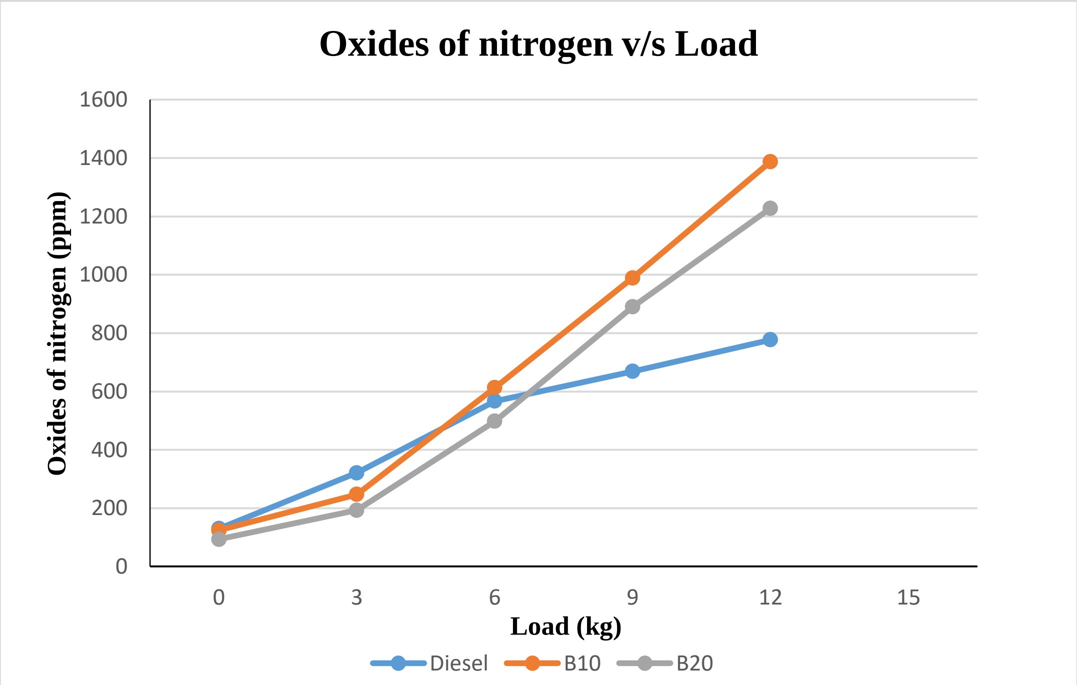

Figure [5]. Oxides of Nitrogen VS Load

The figure 5, shows the variation of oxides of nitrogen against load. The discharge of NO_x is a phenomenon depends mainly on the combustion temperature. It is observed that the emission of NO_x of both the fuel blends B10 and B20 are higher when compared to diesel fuel. However, B20 fuel gives comparatively 7.2% lesser NO_x emission then that of B10 diesel. Higher temperature and accessibility of oxygen are two primary explanations behind development of NO_x as nitrogen and oxygen responds at higher temperatures.

3.5 Smoke opacity:

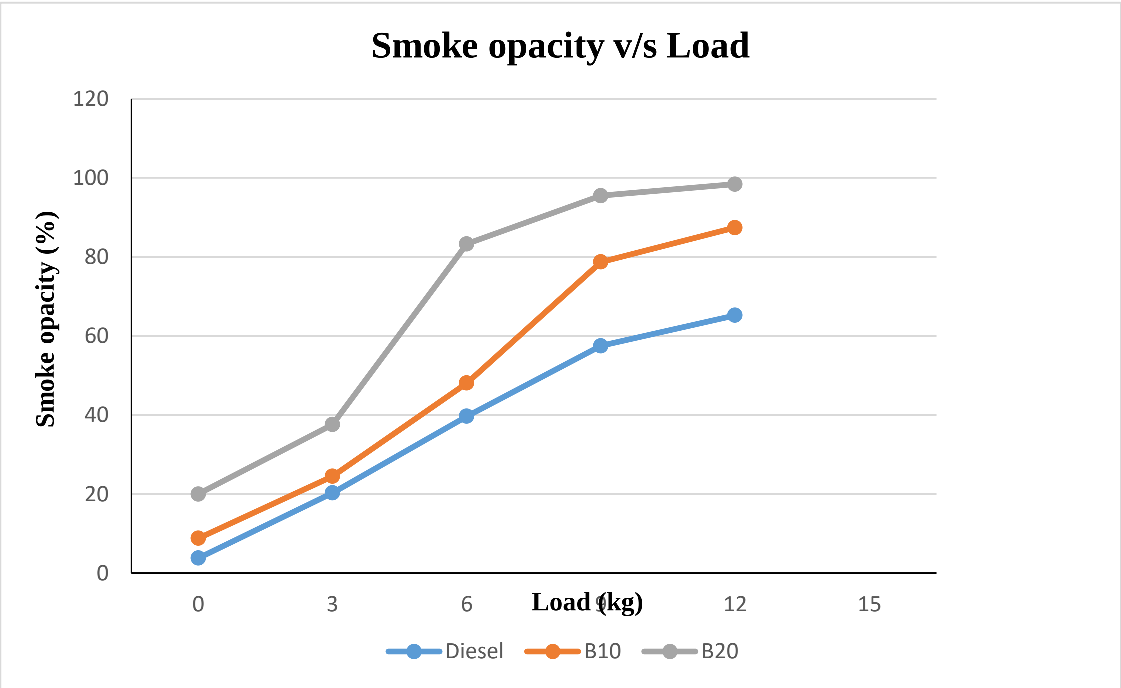

Figure [6]. Smoke opacity VS Load

The variation in smoke opacity against load is shown in figure 6. It has been observed that the smoke opacity gets increased with increase in load. At full load condition the smoke opacity gets increased for B10 and B20 fuel blends when compared with diesel fuel. The incomplete combustion of the fuel is the key reason for the smoke.

IV. CONCLUSIONS

The following conclusions may be drawn from the experimental investigation conducted on VCR diesel engine fuelled with diesel and blends of Lard oil methyl ester (B10 and B20);

- An improvement of 4.46% in brake thermal efficiency was observed in B20 blend when compared with pure diesel at full load condition.
- The brake specific fuel consumption for B20 was comparatively lower then B10 and pure diesel at full load condition.
- B20 blend showed 28.57% and 27% reduction in emission of harmful pollutants such as Hydrocarbon and CO in the exhaust gases when compared with pure diesel at full load.
- B20 blend showed 7.2% lesser NO_x emission compared to B10
- The smoke opacity as observed was higher for blended diesel when compared with pure diesel.

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