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COMPARISON OF SOUND, EXHAUST GAS TEMPERATURE AND SMOKE OPACITY CHARACTERISTICS OF METHYL ESTERS OF VEGETABLE OILS BLENDS

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ABSTRACT

Experiment has been carried out to evaluate the sound, exhaust gas temperature and smoke opacity characteristics of a single cylinder, four stroke engine fuelled with vegetable oil methyl ester and its blends with standard diesel. Among different vegetable oils which can be used as alternate fuels, five vegetable oils, i.e., Nerium (Nerium oleander), Jatropha (*Jatropha curcas*), Pongamia (*Pongamia pinnata*), Mahua (*Madhuca indica*) and Neem (*Azadirachta indica*) oils were selected for analysis. Tests has been conducted using the fuel blends of 20%, 40%, 60% and 80% biodiesel with standard diesel, with an engine speed of 1800 rpm. It has found that the sound, exhaust gas temperature and smoke opacity characteristics of vegetable oil methyl ester and its diesel blends closely followed those of standard diesel.

Keywords: vegetable oil, methyl ester, sound, exhaust gas temperature, smoke opacity.

INTRODUCTION

Fossil fuels like petroleum, diesel fuel is highly demanded, shortage and also its increasing cost for that reason an alternate source of fuel for diesel is very much needed. It has been found that vegetable oils hold special promise in this regard, since they can be produced from the plants grown in rural areas. Vegetable oil from crops such as soybean, peanut, sunflower, jatropha, mahua, neem, rape, coconut, karanja, cotton, mustard, linseed and castor have been tried in many parts of the world, which lack petroleum reserves as fuels for compression ignition engines. The long chain hydrocarbon structure, vegetable oils have good ignition characteristics, however they cause serious problems such as carbon deposits buildup, poor durability, high density, high viscosity, lower calorific value, more molecular weight and poor combustion. These problems lead to poor thermal efficiency, while using vegetable oil in the diesel engine (Agarwal, 2001).

Biodiesel (or biofuel) refers to a vegetable oil - or animal fat-based diesel fuel consisting of long chain alkyl (methyl, propyl or ethyl) esters. Biodiesel is typically made by chemically reacting lipids (e.g., vegetable oil, animal fat (tallow)) with an alcohol. Biodiesel is meant to be used in standard diesel engines and is thus distinct from the vegetable and waste oils used to fuel converted diesel engines. Biodiesel can be used alone, or blended with petrodiesel (Demirabas, 2007)

Biodiesel can also be used as a low carbon alternative to heating oil the choice of feed is country specific and depends on availability. The United States uses soybean, Europe rapeseed and sunflower, Canada canola, Japan animal fat and Malaysia palm oil. In India, non-edible oil is most suitable as biodiesel feedstock since the demand for edible oil exceeds the domestic supply. It is estimated that the potential availability of such oils in India amounts to about 1 million tons per year, the most abundant oil sources are Jatropha oil, mahua oil, neem oil and Pongamia oil, also known as Karanja oil. Also, implementation of biodiesel in India will lead to many advantages like providing green cover to wasteland, support to agricultural and rural economy, and reduction in dependency on imported crude oil and reduction in air pollution (Tewari, 2003).

Biodiesel is an alternative fuel for diesel engines that is produced by chemically combining vegetable oils and animal fats with an alcohol to form alkyl esters. Extensive research and demonstration projects have shown it can be used pure or in blends with conventional diesel fuel in unmodified diesel engines. Interest in biodiesel has been expanding recently due to government incentives and high petroleum prices. While the current availability of vegetable oil limits the extent to which biodiesel can displace petroleum to a few percent, new oil crops could allow biodiesel to make a major contribution in the future (Jon, 2007).

EXPERIMENTAL APPARATUS AND METHODS

Transesterification of vegetable oil

To reduce the viscosity of the vegetable oils, transesterification method is adopted for the preparation of biodiesel. The procedure involved in this method is as follows: 1000 ml of vegetable oil is taken in a three way flask. 12 grams of sodium hydroxide (NaOH) and 200 ml of methanol (CH_3OH) are taken in a beaker. The sodium hydroxide (NaOH) and the alcohol are thoroughly mixed until it is properly dissolved. The solution obtained is mixed with vegetable oil in three way flask and it is stirred properly. The methoxide solution with vegetable oil is heated to 60ºC and it is continuously stirred at constant rate for 1 hour by stirrer. The solution is poured down to the separating beaker and is allowed to settle for 4 hours. The glycerin settles at the bottom and the methyl ester floats at the top (coarse biodiesel). Methyl ester is separated from the glycerin. This coarse biodiesel is heated above 100ºC and maintained for 10-15 minutes to remove the untreated methanol. Certain impurities like sodium hydroxide (NaOH) etc are still dissolved in the

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obtained coarse biodiesel. These impurities are cleaned up by washing with 350 ml of water for 1000 ml of coarse biodiesel. This cleaned biodiesel is the methyl ester of vegetable oil.

Engine specification

Engine manufacturer	Kirloskar oil engines ltd
Bore and stroke	87.5 x 110 (mm)
Number of cylinders	1
Compression ratio	17.5: 1
Speed	1800 rpm
Cubic capacity	0.661 litres
Method of cooling	water cooled
Fuel timing	27º by spill (btdc)
Clearance volume	37.8 cc
Rated power	8 hp
Nozzle opening pressure	200 bars

Experimental setup

The engine used for the investigation is kirloskar SV1, single cylinder, four stroke, constant speed, vertical, water cooled, high speed compression ignition diesel engine. The kirloskar engine is mounted on the ground. The test engine was directly coupled to an eddy current dynamometer with suitable switching and control facility for loading the engine. The experimental setup is shown in the Figure-1.

Figure-1. Experimental setup.

Measurement of smoke

To measure smoke emission, an opacity (AVL make) type smoke meter was used. The AVL smoke meter works on light extinction principle. It consists of a flexible sampling hose with appropriate exhaust gas probe. The sampling probe is inserted in the exhaust pipe approximately 200 mm from the engine. A continuous exhaust sample is passed through the tube of about 46 cm length, which has a light source at one end the other end fitted with a photo cell. The amount of the light passing through the smoke column is sensed as an indication of smoke level. The smoke meter consists of display unit. The photographic view of smoke meter is shown in the Figure-2.

Figure-2. Smoke meter.

Temperature measurement

Temperature of the exhaust gas was measured with Chromel Alumel (K-Type) thermocouples. with Chromel Alumel (K-Type) thermocouple is Composed of a positive leg, which is approximately 90% nickel, 10 chromium and a negative leg, which is approximately 95% nickel, 2% aluminum, 2% manganese and 1% silicon. Due to its reliability and accuracy, Type K is used extensively at temperatures up to 1260°C (2300°F). The photographic view of Chromel Alumel (K-Type) thermocouples is shown in the Figuire-3.

Figure-3. Chromel alumel (k-type) thermocouples.

Sound measurement

Noise from the engine is measure by Rion sound level meter. The photographic view of Rion sound level meter is shown in the Figure-4.

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Figure-4. Rion sound level meter.

RESULTS AND DISCUSSIONS

Sound characteristics

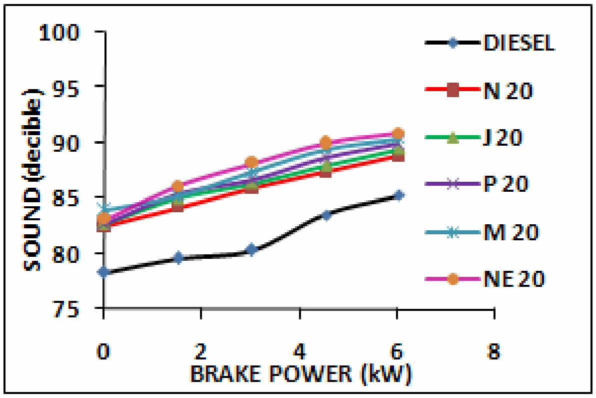

Figure-4. Comparison of noise of diesel with N20, J20, P20, M20 and NE20.

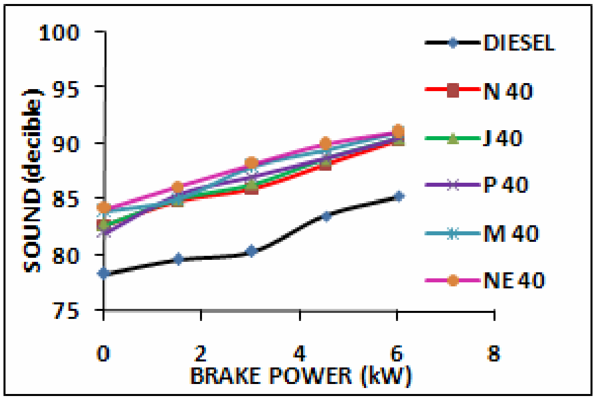

Figure-5. Comparison of noise of diesel with N40, J40, P40, M40 and NE40.

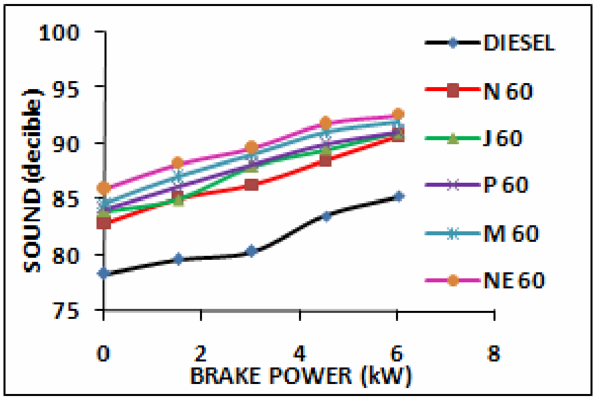

Figure-6. Comparison of noise of diesel with N60, J60, P60, M60 and NE60.

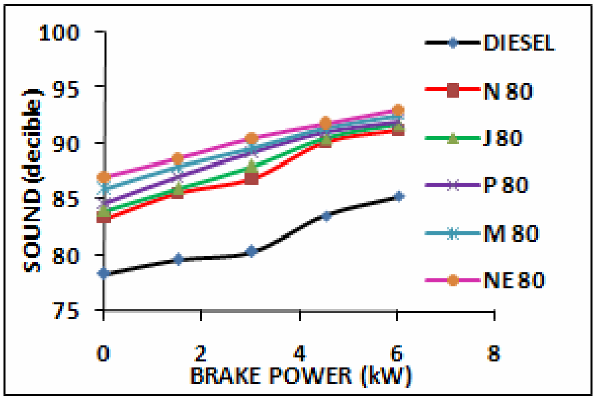

Figure-7. Comparison of noise of diesel with N80, J80, P80, M80 and NE80.

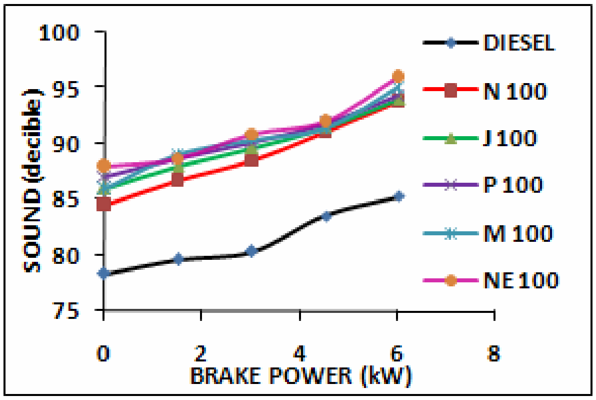

Figure-8. Comparison of noise of diesel with N100, J100, P100, M100 and NE100.

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Exhaust gas temperature

Comparison of the Exhaust gas temperature characteristics for different methyl ester of vegetable oils blends is shown in Figures 9 to 13. It can be seen that the Exhaust gas temperature characteristics for diesel is least and highest in the case of biodiesel blends. This behaviour is due to sharp increase in fuel consumption rates at higher loads. Biodiesels and their blends due to their improved qualities burn more quickly and liberate heat than diesel fuel. As a result the exhaust flue gas temperature of biodiesel and blends are higher. The Exhaust gas temperature trend at 20% blend of biodiesel is as N20 < J20 < P20 < M20 < NE20. For other blends, the trend is approximately similar to that for 20% blend.

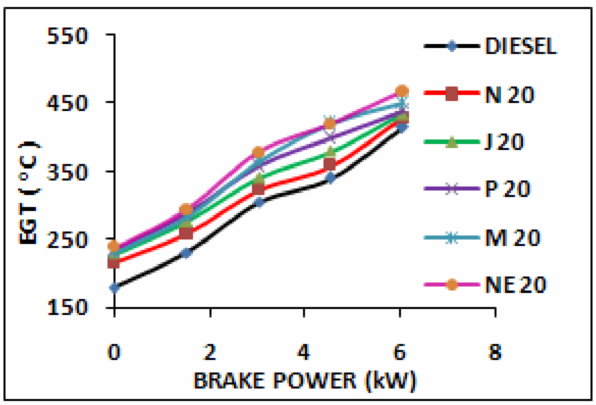

Figure-9. Comparison of EGT of diesel with N20, J20, P20, M20 and NE20.

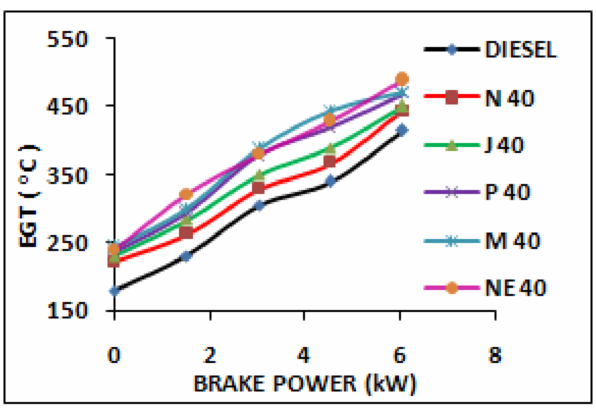

Figure-10. Comparison of EGT of diesel with N40, J40, P40, M40 and NE40.

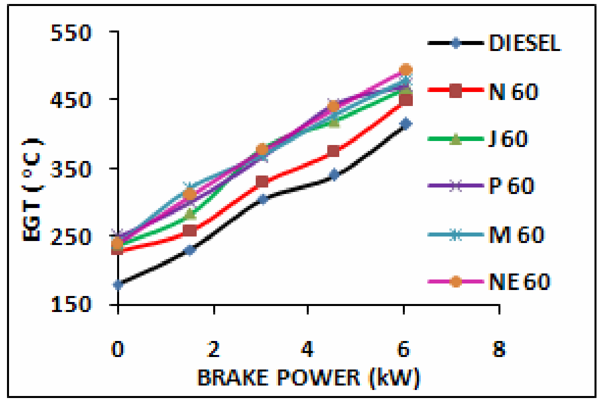

Figure-11. Comparison of EGT of diesel with N60, J60, P60, M60 and NE60.

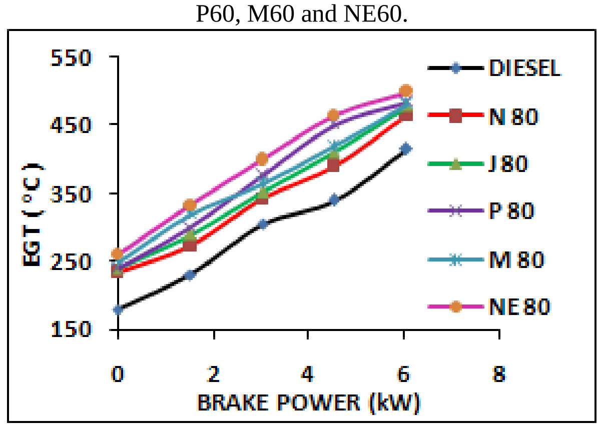

Figure-12. Comparison of EGT of diesel with N80, J80, P80, M80 and NE80.

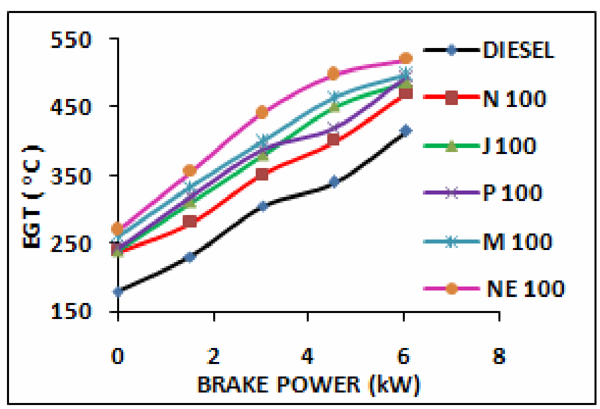

Figure-13. Comparison of EGT of diesel with N100, J100, P100, M100 and NE100.

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Smoke opacity

Comparison of the Smoke opacity characteristics for different methyl ester of vegetable oils blends is shown in Figures 14 to 18. It can be seen that the Smoke opacity characteristics for diesel is least and highest in the case of biodiesel blends. This is because of lower viscosity and higher volatility, which helps in good mixture formation for the complete combustion takes places for diesel and due to higher viscosity and higher volatility, which results in incomplete combustion for biodiesel blends. The Smoke opacity trend at 20% blend of biodiesel is as N20 < J20 < P20 < M20 < NE20. For other blends, the trend is approximately similar to that for 20% blend.

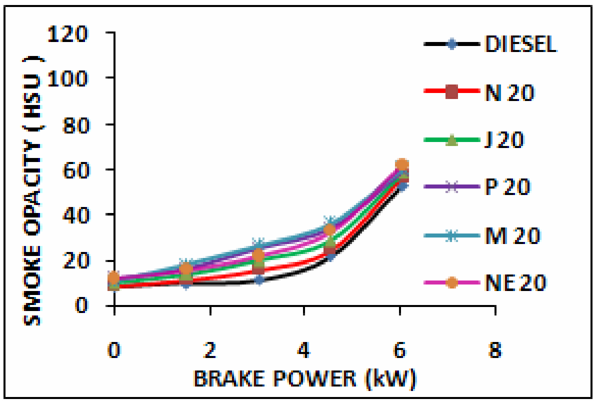

Figure-14. Comparison of smoke opacity of diesel with N20, J20, P20, M20 and NE20.

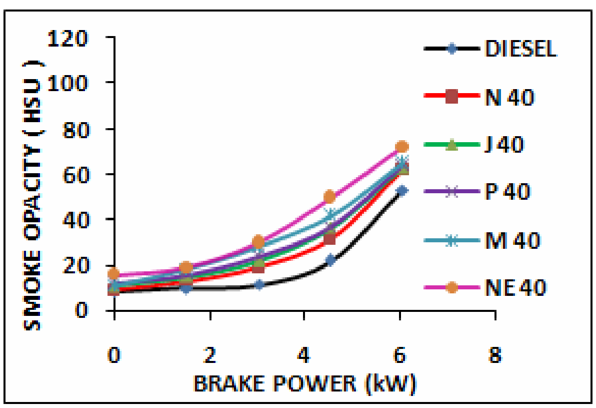

Figure-15. Comparison of smoke opacity of diesel with N40, J40, P40, M40 and NE40.

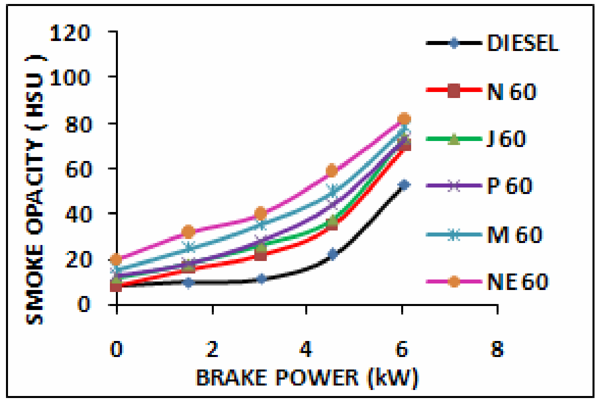

Figure-16. Comparison of smoke opacity of diesel with N60, J60, P60, M60 and NE60.

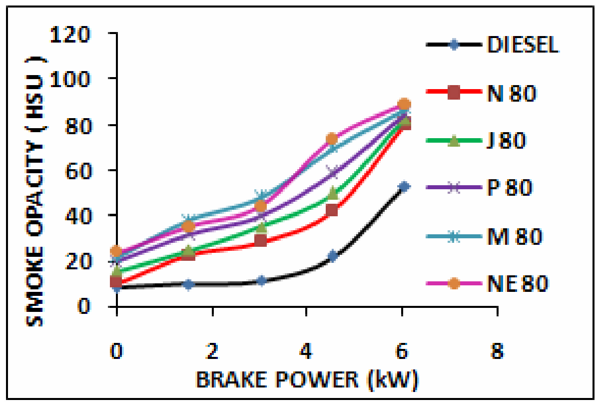

Figure-17. Comparison of smoke opacity of diesel with N80, J80, P80, M80 and NE80.

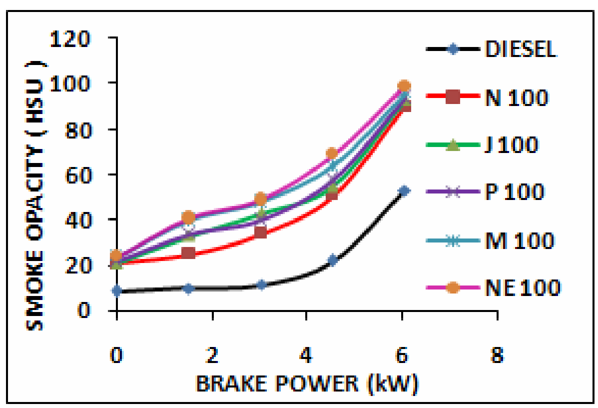

Figure-18. Comparison of smoke opacity of diesel with N100, J100, P100, M100 and NE100.

CONCLUSIONS

From the above results and discussions, the following important points are observed and the effect of injection timing are listed,

- After trans-esterification of vegetable oil, the kinematic viscosity and density is reduced while the calorific value is increased.
- The experimental results such as Sound, Exhaust gas temperature and Smoke opacity characteristics of the methyl ester of vegetable oil blends are almost comparable to that of diesel fuel results.

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