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Engine Performance Characteristics Evaluation of a Single Cylinder 4-Stroke Diesel Engine with Neem and Pongamia

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Abstract: ***In this work, the biodiesel produced from non-edible oils like Neem and Pongamia oils are prepared by a method of alkaline catalyzed transesterification. Investigation on the engine performance characteristics of selected fuel in a stationary single cylinder, four stroke, naturally aspirated direct injection diesel engine is carried out and the results are tabulated. The engine performances (Brake Thermal efficiency, Brake Specific Fuel Consumption, Brake Power, and Exhaust Gas Temperature) are evaluated.Blends of 25%, 50%, 75% and 100% Biodiesel are used for comparison in the present work with loads varying from 0 to 100% (i.e., stalling load). The results obtained reveal that Neem oil methyl Ester has a performance plot closer to the diesel plot. The experimental study indicates that Neemoil biodiesel can be used as a fuel in compression ignition engine without any engine modification when compared to the other biodiesel blends.***

Keywords: Biodiesel, Performance characteristics, Neem, Pongamia, Comparative analysis

1. Introduction

Vegetable oil is one of the alternatives which can be used as fuel in automotive engines either in the form of straight vegetable oil, or in the form of ethyl or methyl ester. The energy needs of the world are increasing rapidly. The decrease in fossil fuels, emission pollution caused by them and increasing fuel prices make biomass energy sources more attractive. The increase in energy demand and decrease in oil reserves have been focused on biofuels. Biodiesel is a fuel that is manufactured from vegetable oils with the help of catalysts, and may be directly used in diesel vehicles with little or no modification. The biodiesel is reported to be sulfur-free, nontoxic, biodegradable oxygenated and renewable. And the characteristics of biodiesel are very close to diesel fuel [1,2]. And some are better than diesel such as higher cetane number, no aromatics, almost no sulfur, and more than 10% oxygen by weight, which reduce the emission of carbon monoxide, unburned hydrocarbon, and volatile organic compounds [3,4]. An experimental study is carried out to evaluate and compare the use of cottonseed oil, soybean oil, sunflower oil and their corresponding methyl esters. It shows that all tested biodiesel or vegetable oil blends, can be used safely[5,6]. An experimental study is also carried out to examine fuel properties, performance and emissions of different blends of methyl ester of pongamia, jatropha and neem in comparison to diesel fuel. The results indicated that diesel blends showed reasonable efficiencies, lower smoke, CO and HC7. The vegetable oil esters from edible oils may not be the right option for their substitution in diesel engine due to the lack of self-sufficiency of edible oil production in India. Hence, attention has been diverted to test the suitability of non-edible vegetable oils for diesel engine. With the abundance of forest and tree-borne non-edible oils available in India, limited attempts have been made to use the ester of selected non-edible as the alternative fuels for diesel engine8. In this experimental study, the biodiesel from different non-edible oils was produced by a method of alkaline-catalyzed transesterification.

2. Materials and Method

Fuel properties

The fuel properties of Diesel, Neem and Pongamia methyl ester are summarized in Table 1. The blends of methyl esters were compared with different percentages of blends and optimized as a better alternative option for diesel fuel. Many researchers investigated fuel properties of different non-edible oils and its biodiesels and compared with diesel fuel to improve engine performance [9-14].

Engine set-up

Schematic diagram of computerized CI engine test rig is shown in Fig. 1. The engine tests were conducted on single cylinder, direct injection water cooled compression ignition engine. It studies characteristic fuel properties and experimental procedure adopted to evaluate performance of a 5.2kW, diesel engine on the blends. The engine was always operated at a rated speed of 1500RPM. The engine was having a conventional fuel injection system. The engine had been provided with a hemispherical combustion chamber with overhead valves operated through push rods. Cooling of the engine was accomplished by circulating water through the jackets of the engine block and cylinder head.

Table 1: Fuel Properties Of Cottonseed, Jatropa And Mahua Methyl Ester

Properties	Diesel	Neem	Pongamia	ASTM D6751	EN14214
Density (15°C), kg/m^3	842	868	874	-	860-900
Viscosity (40°C), cSt	2.57	2.7	4.34	1.9-6.0	3.5-5.0
Calorific value, kJ/kg	44800	39810	35940	-	-

3. Results and Discussion

3.1 Fuel properties

The experimental results reveal that the density of all the biodiesels are within the standards given in table 1 (ASTM D6751 and EN14214). The density of Neemoil methyl Ester is lesser than pongamia by about 1%. The kinematic viscosities of Neem oil biodiesel is lower by about 37%. The calorific value is seen in Neemand pongamia methyl ester at 39810 and 35940 kJ/kg respectively.

Performance characteristics
Brake Power

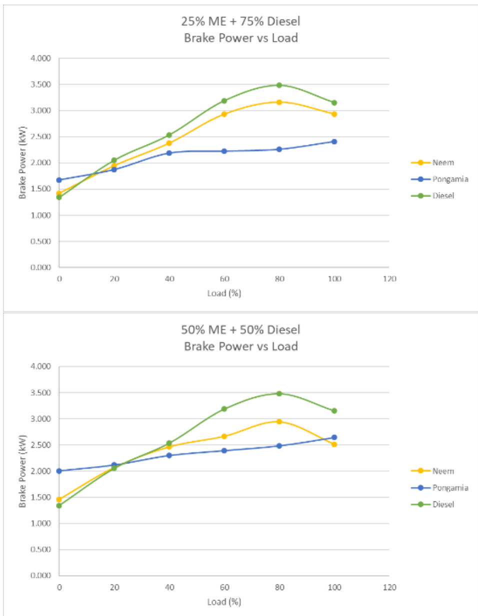
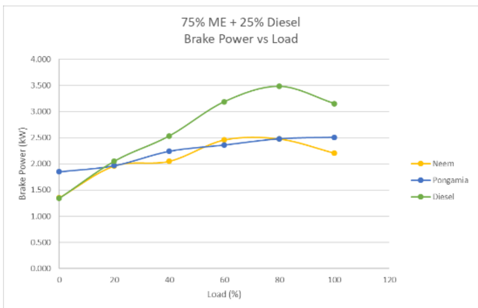


Figure 2: Graphical representation of brake power vs load for 25% and 50% blends of cottonseed, Jatropa and Mahua biodiesel



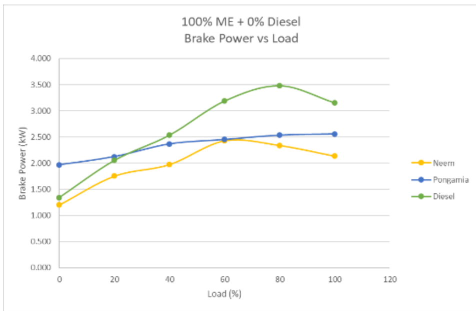


Figure 3: Graphical representation of Brake Power vs load for 75% and 100% blends of cottonseed, Jatropa and Mahua biodiesel

Figure 2and3 shows the graphical representation of the brake power vs load for methyl ester blends with 25%, 50%, 75% and 100% biodiesel mixtures of neem and pongamia oil. The graph indicates that the neem methylester biodiesel blends give higher brake power when the load is varied from 0% to 100% followed by pongamia biodiesel. The brake power of neem oil biodiesel is around 18% lower than pongamia oil methyl ester.

Brake Specific Fuel Consumption

Figure 4 and 5 shows the graphical representation of the brake specific fuel consumption vs load for methyl ester blends with 25%, 50%, 75% and 100% biodiesel mixtures of neem and pongamia oil. The graph indicates that neemoil methylester biodiesel blends give lowest brake specific fuel consumption when the load is varied from 0% to 100% followed by pongamia oil biodiesel. The brake specific fuel consumption of neem oil biodiesel is around 41% higher than pongamia oil methyl ester.

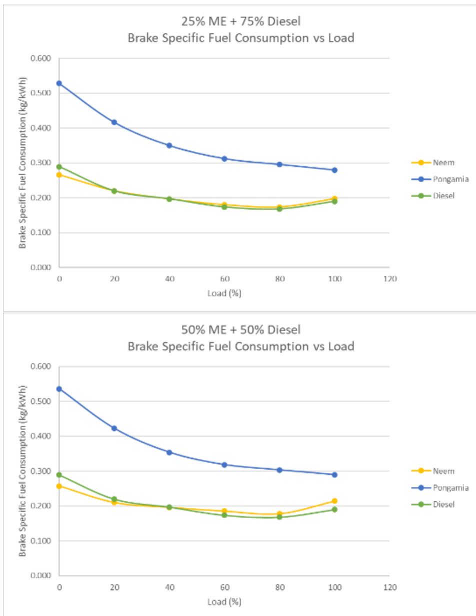


Figure 4: Graphical representation of BSFC vs Load for 25% and 50% blends of cottonseed, Jatropa and Mahua biodiesel

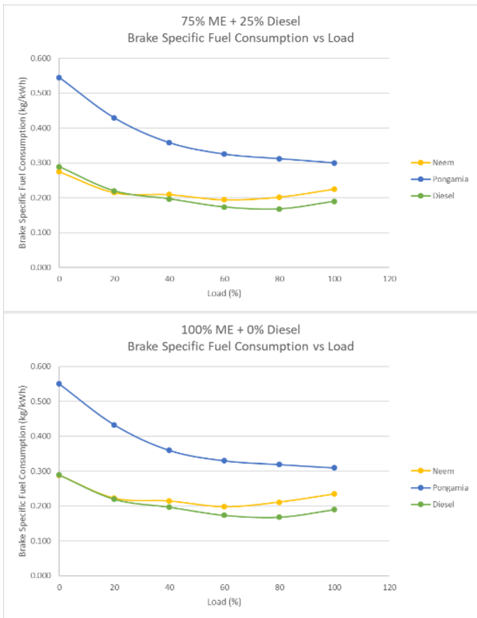


Figure 5: Graphical representation of BSFC vs Load for 75% and 100% blends of cottonseed, Jatropa and Mahua biodiesel

Brake Thermal Efficiency

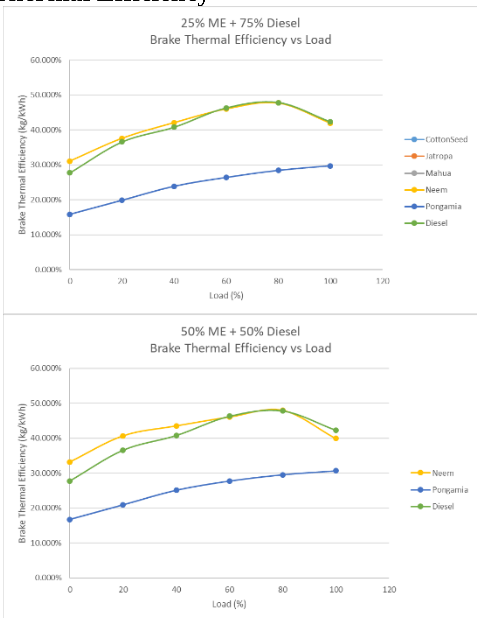
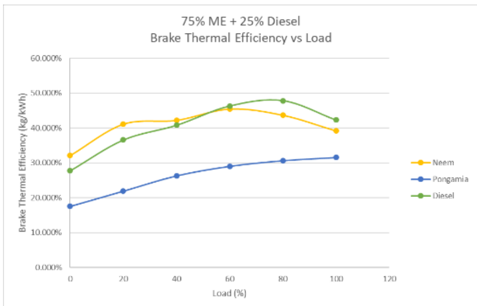


Figure 6: Graphical representation of Brake Thermal Efficiency vs load for 25% and 50% blends of cottonseed, Jatropa and Mahua biodiesel



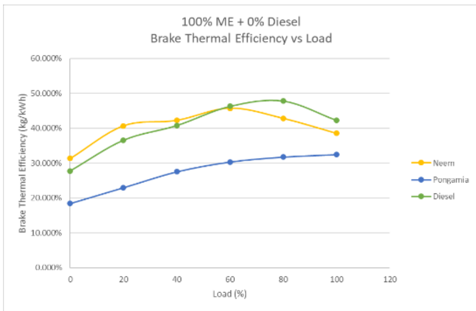


Figure 7: Graphical representation of Brake Thermal Efficiency vs load for 75% and 100% blends of cottonseed, Jatropa and Mahua biodiesel

Figure 6 and 7 shows the graphical representation of the brake thermal efficiency vs load for methyl ester blends with 25%, 50%, 75% and 100% biodiesel mixtures of neem and pongamia oil. The graph indicates that neem oilmethylester biodiesel blends give highest brake thermal efficiency when the load is at60% followed by pongamia oil biodiesel. The brake thermal efficiency of neem oil biodiesel is around 31% higher than pongamia oil methyl ester.

Exhaust Gas Temperature

Figure 8 and 9 shows the graphical representation of the exhaust gas temperature vs load for methyl ester blends with 25%, 50%, 75% and 100% biodiesel mixtures of neem and pongamia oil. The graph indicates that neem oil methylester biodiesel blends give the highest exhaust gas temperature when the load is varied from 0% to 100% followed by pongamia oil biodiesel. The exhaust gas temperature of neem oil biodiesel is around 21% higher than pongamia oil methyl ester.

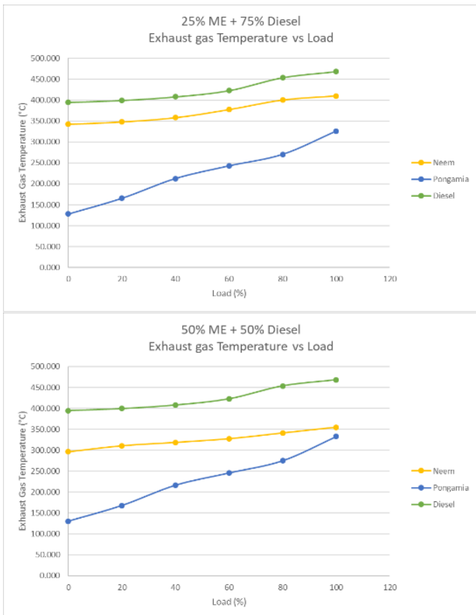


Figure 8: Graphical representation of Exhaust Gas Temperature vs load for 25% and 50% blends of cottonseed, Jatropa and Mahua biodiesel

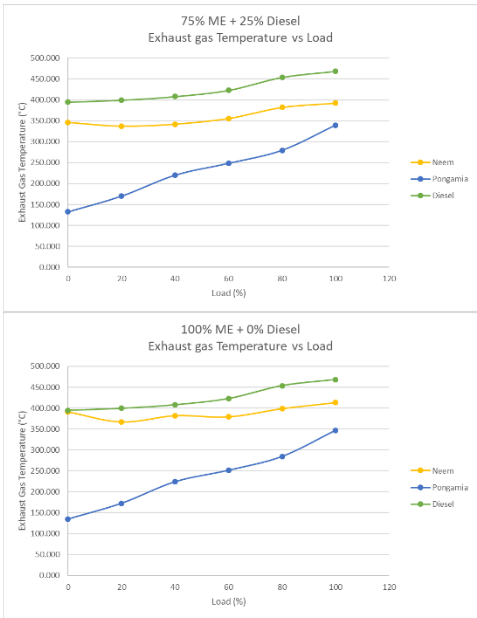


Figure 9: Graphical representation of Exhaust Gas Temperature vs load for 75% and 100% blends of cottonseed, Jatropa and Mahua biodiesel

4. Conclusions

In the present work, the engine performance characteristics of neem oil and pongamia oil biodiesel were compared with that of diesel. The results reveal that neem oil methyl ester is closer to diesel than pongamia oil in terms of brake power, brake specific fuel consumption and exhaust gas temperature. Also, the neem oil biodiesel is close to the performance of diesel which make it a viable replacement for diesel in the future.

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