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Research Paper

EXPERIMENTAL INVESTIGATION OF PERFORMANCE PARAMETERS OF SINGLE CYLINDER FOUR STROKE DI DIESEL ENGINE OPERATING ON NEEM OIL BIODIESEL AND ITS BLENDS

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Increasing oil prices, and global warming activates the research and development of substitute energy resources to maintain economic development. The methyl esters of vegetable oil, known as biodiesel are becoming popular because of their low ecological effect and potential as a green substitute for compression ignition engine. The main objective of this study is to investigate the performance of neem oil methyl ester on a single cylinder, four stroke, direct injection, and 8 HP capacity diesel engine. The Experimental research has been performed to analyze the performance of different blends 20% (BD20), 50% (BD50), and 100% (BD100) of neem oil biodiesel. Biodiesel, when compared to conventional diesel fuel, results showed that the brake specific fuel consumption and brake specific energy consumption are higher and brake thermal efficiency less during testing of engine. The brake specific energy consumption is increased by 0.60% to 8.25% and brake thermal efficiency decreased by 0.57% to 7.62% at 12 kg engine brake load as compared to diesel fuel. When the fuel consumption of biodiesel is compared to diesel fuel it observed that the fuel consumption was increased by 2.5% to 19.5% than that of diesel fuel for B20, B50 and B100 bends at 12 kg engine brake load. It is observed that the performance of biodiesel blends is less as compared to plain diesel and during testing of diesel engine run normally for all engine loads. It is investigated that the neem oil biodiesel 20% blend showed very close performance when compared to plain diesel and hence can be used as an alternative fuel for conventional diesel in the future.

Keywords: Diesel engine, Alternate fuel, Neem oil biodiesel, Engine performance

INTRODUCTION

The petroleum fuel depletion moving fast day by day and consequently the price of petroleum fuel hikes have made a severe impact on the power and transport sectors, also on the national and international economy. The

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importance of biodiesel increases gradually due to the depletion of petroleum reserves and improve in environmental concerns (Chen *et al.*, 2008). Neem oil (Azadirachta indica) is non-edible oil and it is available in huge surplus quantities in South Asia. The neem oil production in India is estimated to be 30,000 tons per annum (Karmakar *et al.*, 2012). Vegetable oils are environmentally friendly and it might provide a feasible substitute for diesel since these are renewable in nature. Various non-edible oils, such as Neem oil, jatropha, rubber seed, mahua, waste cooking and cotton seed oils, are investigated for their suitability to diesel engine fuels (Altin *et al.*, 2001; Agarwal and Rajamanoharan, 2009; Belagur and Chitimini, 2010; and Chao *et al.*, 2010). The main disadvantage of the biodiesel is its high production cost due to the high cost of vegetable oil, which accounts for almost 78% of the biodiesel production(Bautista *et al.*, 2009). The esters of vegetable oil are a non-toxic, biodegradable and renewable alternative diesel fuel is receiving attention.

These esters are named biodiesel. The use of raw vegetable oils in engines without any modification consequences in poor performance and directs to wear of engine components (Bari *et al.*, 2004). The brake thermal efficiency is observed maximum of 23.1% with biodiesel, which is 6% lower than that of diesel at full engine load condition. The higher viscosity and lower calorific value of esters direct to the lower brake thermal efficiency and engine performances.

Many researchers have used jatropha oil (neat and modified both forms) as a fuel in CI engine and the following conclusions have been made:

Jatropha oil, diesel and their blends exhibited similar performance and emission characteristics under comparable operating conditions (Forson *et al.*, 2004). With methanol as a secondary fuel in dual fuel mode operation, JTME shows good performance and lesser emission than that of diesel (Kumar *et al.*, 2003). The brake specific fuel consumption decreases with an increase in load for all the fuels. The increase in percentage of JTME in the blend increases the brake specific fuel consumption because of the lower heating value of JTME as compared to the diesel. The Brake Thermal Efficiency (BTE) of JTME-diesel blends decreases with an increase in percentage of JTME in the blends. The decrease in thermal efficiency with an increase in proportion of JTME is due to earlier start of combustion than for diesel, which increases the compression work. The thermal efficiency of CI engine depends on the compression ratio and the fuel-air ratio. With a fixed compression ratio, the thermal efficiency mainly depends only on the fuel-air ratio (Mathur and Sharma, 1997).

The Brake Thermal Efficiency (BTE) of biodiesel was slightly lower than that of diesel at 100% load condition (Kannan *et al.*, 2011). Since the engine operates under constant injection advance, the smaller ignition delay of JTME leads to initiation of combustion much before TDC. This increases the compression work as well as heat loss and thus reduces the efficiency of the engine (Lakshmi Narayana *et al.*, 2007). Lower blends of Tobacco Seed Oil Methyl Ester (TSOME) delivered slightly higher torque and power than mineral diesel at full load due to its slightly higher density and viscosity but at partial engine loads, slightly lower power output, torque and thermal efficiency was observed (Usta, 2005). BSFC was observed to increase with increasing proportion of biodiesel in the fuel. Brake thermal efficiency of B100 was highest among all the test fuels. All blends demonstrated higher thermal efficiency than that of diesel (Atul *et al.*, 2012).

EXPERIMENTAL SETUP AND METHODOLOGY

Experimental setup is shown in Figure 1.

Figure 1: Experimental Set Up of Test Engine

The detail of technical specification of diesel engine is given in Table 1.

Table 1: Technical Specification of Test Engine

Engine Parameters	Details
Make	Kirloskar Oil Engine, Pune
Model	SV1
Type	Vertical, Totally Enclosed, CI, Four Stroke Engine, Water Cooled
No. of Cylinder:	1
Bore Size	87.5 mm
Stroke Length	110 mm
Cubic Capacity	662 CC
Compression Ratio	16.5:1
Engine RPM	1500
Rate of Output	5.88 kW/8 HP

RESULT AND DISCUSSION

Properties of Fuels

The properties of Diesel and Neem Oil Biodiesel are carried out by the help of IOCL, Bhopal, and Department of Chemistry in University Institute of Technology (UIT), Bhopal. The properties of diesel and Neem oil Biodiesel fuel are shown in Table 2.

Table 2: Comparison of the Physical Properties of Diesel, Neem Oil Biodiesel

Property	Diesel	Neem Oil Biodiesel
Density at 50 °C (kg/m^3)	836	873
Specific Gravity	0.836	0.886
Kinematic Viscosity at 40 °C (cst)	2.649	4.84
Cloud Point (°C)	6.4	2.1
Pour Point (°C)	3.2	–1
Flash Point at 40 °C	51	165
Calorific Value (kJ/kg)	42830	38800

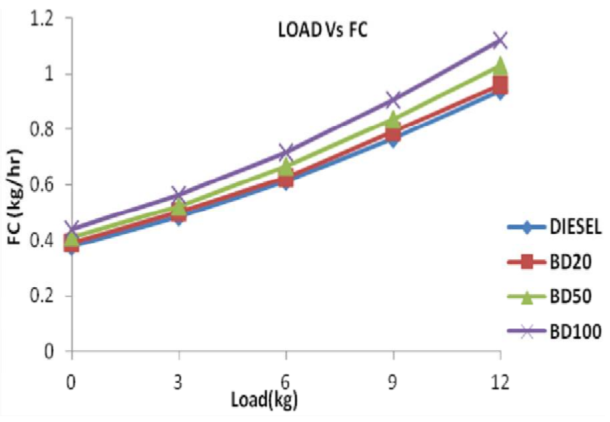
Performance of Diesel Engine

All the experiments are carried out at a constant speed of 1500 RPM by varying the brake load and the data obtained from the experiments are used to evaluate the performance of the diesel engine. The performance parameters studied are fuel consumption, Brake specific fuel consumption, Brake specific energy consumption, and Brake thermal efficiency.

Fuel Consumption (FC)

Figure 2 shows the variation in fuel consumption for diesel and neem oil biodiesel

Figure 2: The Variation of Fuel Consumption (FC) with Different Engine Load for Biodiesel Blends and Pure Diesel Fuel

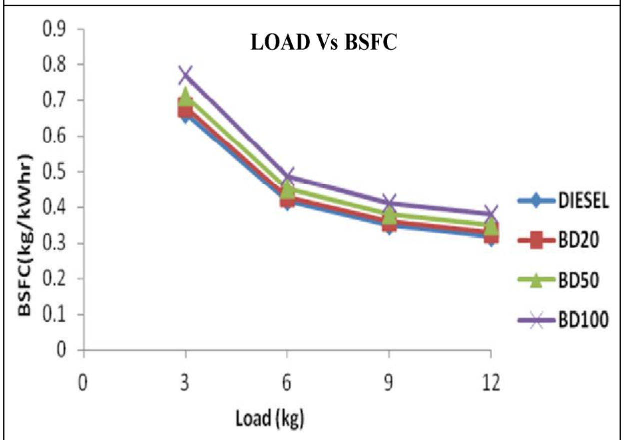


when blends are used 20%, 50% and 100% in diesel engine. As the loads are increased the fuel consumption of diesel engine increased as compared to diesel fuel. at the constant speed of 1500 rpm and 12 kg engine load the fuel consumption of Neem oil biodiesel is increased by approximately 2.5%, 9.86% and 19.5% than that of diesel fuel when the blends are used in diesel engine as BD20, BD50 and BD100 respectively. It is observed that for the same load conditions the diesel engine consume more fuel in comparison to plane diesel fuel. During testing of diesel engine neat biodeisel consumed more fuel than that of the BD20 and BD50 blends.

Brake Specific Fuel Consumption (BSFC)

Figure 3 shows the variation in brake specific fuel consumption for diesel and neem oil biodiesel when blends are used 20%, 50% and 100% biodiesel in diesel engine. The BSFC is an important parameter to evaluate engines performance and determine the fuel efficiency of an engine. The BSFC of diesel engine decreases as the engine brake loads are increased. The brake specific fuel consumption of Neem oil biodiesel are increased by 2.5%, 9.86% and 19.5% correspondingly for BD20, BD50 and neat biodiesel than that of diesel when the 12 kg brake load on the engine and run at constant speed. It is observed that the BSFC of 50% blends is less around 8.25% in comparison to neat biodiesel of Neem oil. It is investigated that the BSFC of Neem oil biodiesel is higher than that of diesel fuel when the blends are BD20, BD50 and BD100 used in diesel engine.

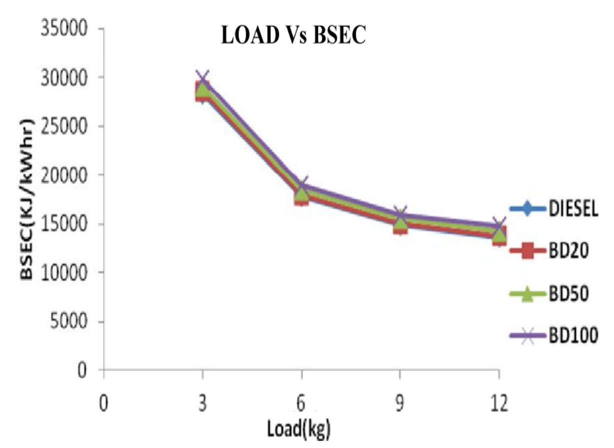
Figure 3: The Variation of Brake Specific Fuel Consumption (BSFC) with Different Engine Load for Biodiesel Blends and Pure Diesel Fuel



Brake Specific Energy Consumption (BSEC)

Figure 4 shows the variation in brake specific energy consumption for diesel and neem oil biodiesel when blends are used 20%, 50% and 100% in diesel engine. The brake specific energy consumption of Neem oil biodiesel is higher in a diesel engine in comparison to diesel due to its lower heating value and higher viscosity. The result showed that the biodiesel consumed higher Brake Specific Energy Consumption (BSEC) than that of diesel for all loads. As the loads are increased the engine consumed more energy for all fuel. The brake specific energy consumption of B20, B50 and B100 blends are increased by approximately 0.60%, 4.87% and 8.25% correspondingly higher in comparison to diesel fuel for constant speed and 12 kg engine load. It is observed that the brake specific energy consumption of neat biodiesel is higher approximately 3.4% as compared to B50 blends at 12 kg brake load.

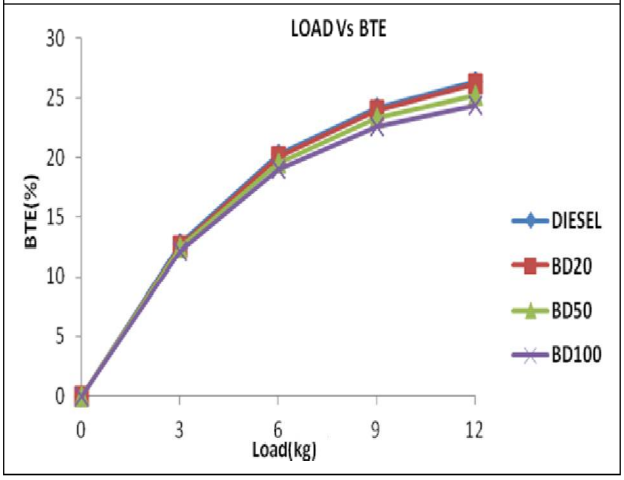
Figure 4: The Variation of Brake Specific Energy Consumption (BSEC) with Different Engine Load for Biodiesel Blends and Pure Diesel Fuel



Brake Thermal Efficiency (BTE)

Figure 5 shows the variation in brake thermal efficiency for diesel & neem oil biodiesel when blends are used 20%, 50% and 100 in diesel engine. The brake thermal efficiency of Neem oil biodiesel is decreased with increase in load for all the test fuels. The Brake Thermal Efficiency (BTE) of biodiesel blends decreased with an increase in amount of biodiesel in the blends. The BTE of Neem oil biodiesel is lower than that of diesel is around 0.57%, 4.48% and 7.62% respectively for B20, B50 and B100 blends. The result showed

Figure 5: The Variation of Brake Thermal Efficiency (BTE) with Different Engine Load for Biodiesel Blends and Pure Diesel Fuel



that the BTE of B50 blend is higher about 3.4% as compared to B100 for 12 kg engine brake loads.

CONCLUSION

The performance of single cylinder four stroke DI diesel engine fuelled with Neem oil biodiesel blends is investigated and the key results are summarized in below:

- The fuel properties of Neem oil biodiesel have a relatively grater flash point (165 °C) that makes it less volatile and far better transportation than diesel fuel.
- The Brake Specific Energy Consumption (BSEC) of Neem oil biodiesel and its blends are higher in comparison to conventional diesel fuel due to its lower heating value and higher viscosity.
- The brake thermal efficiency of Neem oil biodiesel and its blends are lower than that of diesel for all engine brake loads.

It is concluded that the Neem oil biodiesel, i.e., BD20, BD50 and BD100 are running normal during testing of diesel engine.BD20 showed very close performance to diesel fuel. Therefore, from the above analysis it can be resulted that the Neem oil biodiesel showed poor engine performance in comparison to diesel fuel. Biodiesel obtained from Neem oil can be used as a substitute fuel for conventional petro-diesel in future.

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