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Mahua Oil Biodiesel Blends as Alternate Fuel in Diesel Engine

Engineering

KEYWORDS : Mahua oil, biodiesel, diesel engine, performance and emission

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ABSTRACT

The results of performance characteristics of a four stroke, direct injection compression ignition by using mahua (Madhuca indica) oil biodiesel and its 50% blend with diesel fuel have been presented in this paper. Short-term engine performance tests were conducted using diesel, mahua oil biodiesel and its 50% blend. The engine performance parameters studied brake thermal efficiency, specific fuel consumption and exhaust gas temperature by using diesel and other fuels.

Introduction

Depletion of fossil fuel resources and increased environmental awareness are driving the researchers and the fuel industry to develop alternative fuels that are environmentally more acceptable and renewable in nature [1]. Transesterified vegetable oil derivatives called 'biodiesel' appear to be the most convenient way of utilizing bio-origin vegetable oils as substitute fuels in diesel engines. The idea of using vegetable oils as fuel for diesel engine is not new. When Rudolf Diesel first invented the diesel engine, he demonstrated it with peanut oil as fuel [2]. Vegetable oils can be used in diesel engines either in raw form, or can be converted into biodiesel. The raw vegetable oils require engine modifications, whereas the biodiesel (methyl esters of vegetable oils) do not require significant modification of existing engine hardware.

Previous research has shown that use of biodiesel from vegetable oils in diesel engines performs well compared to the raw vegetable oils. Lapuerta et al [3] tested the a naturally aspirated diesel engine with waste cooking oil biodiesel and reported that the performance of the engine is slightly lesser than diesel and found drastic reduction in emissions. Suryawanshi [4] investigated the compression ignition engine with coconut oil biodiesel and found similar results of diesel. Lawrence et al [5] studied the performance and emissions of a compression ignition engine using prickly poppy biodiesel blends and found that the engine runs well in biodiesel blends and releases lesser carbon monoxide and unburned hydrocarbon emissions. Banapurmath et al [6] conducted experiments in a single-cylinder, direct injection diesel engine at a constant speed with neat jatropha, karanja, and sesame-oil-derived biodiesel and found decrease in brake thermal efficiency, ignition delay, smoke, CO and HC emissions.

2. Materials and Methods

Mahua oil used in this experiment for preparing biodiesel was purchased from local market in Vellore and the diesel was purchased from local petrol bunk. Biodiesel was prepared by transesterification of mahua oil with methanol in presence of sodium hydroxide catalyst [7-10]. The properties of diesel, mahua oil and mahua oil biodiesel prepared are given in table 1.

Table 1. Properties of diesel & biodiesel

Property	Diesel	Mahua oil	Mahua oil biodiesel
Calorific value (MJ/kg)	42.8	36.3	39.2
Density (kg/m^3)	840	932	910
Viscosity (cSt)	3.6	18	5.9
Flash point (°C)	63	207	130
Fire Point (°C)	75	228	146

Experiments were carried out on a single cylinder, vertical, naturally aspirated, four stroke, constant speed, water cooled, direct injection diesel engine. The layout of experimental setup is shown in the figure 1. Specification of the test engine is given in table 2. The engine was coupled with eddy current dynamometer for loading. The mass flow rate of intake air was measured using an orifice meter connected to a manometer. A surge tank was used to damp out the pulsations produced by the engine, for ensuring a steady flow of air through the intake manifold. The fuel consumption rate was determined using the glass burette and stop watch. The engine speed was measured using a digital tachometer. The exhaust gas temperature was measured with k-type thermocouple.

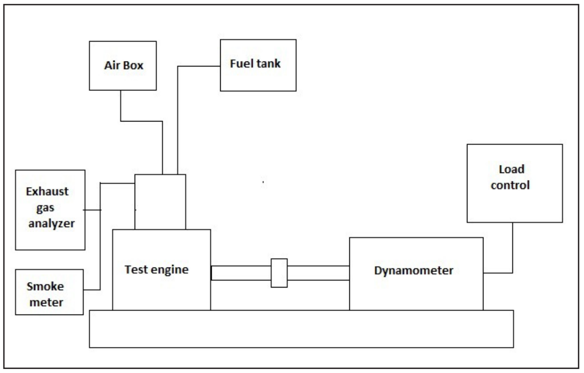

Fig. 1. Experimental setup

Table 2. Specification of the test engine

Make & Model	Kirloskar TV-1
Type	Single cylinder, four stroke, direct injection, water cooled
Bore & stroke (mm)	87.5 x 110
Displacement volume (cc)	661
Speed (rpm)	1500
Dynamometer	Eddy current dynamometer

Results and Discussions

Brake Thermal Efficiency (BTE) is defined as the ratio of brake power to the heat supplied. Figure 2 shows the variation of brake thermal efficiency (BTE) with respect to load. BTE has the tendency to increase with increase in applied load. This is due to the reduction in heat loss and increase in power developed with increase in load. In all the loads, starting from no load to full load of the engine, the BTE of mahua oil biodiesel and its blend are lower than the diesel. This is due to slightly higher viscosity and lower volatility of the fuels than diesel. At maximum load, the brake thermal efficiency of the mahua oil biodiesel and its blend 16.44% and 11.52% lower than diesel respectively.

Figure 3 shows the variation of specific fuel consumption (SFC) with respect to load. The SFC of mahua oil biodiesel and its blend are higher than that of diesel in all loads. The specific fuel consumption depends upon the mass flow rate of hydrogen. The mass flow rate of hydrogen is low for biodiesel whereas for diesel, it is slightly high. So it leads to increase in specific fuel consumption. At maximum load, the specific fuel consumption of mahua oil biodiesel and its blend are 23.21% and 8.96% higher than diesel respectively.

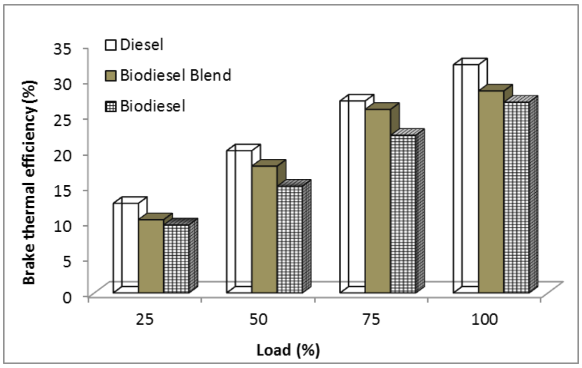

Figure 2. Brake thermal efficiency vs Load

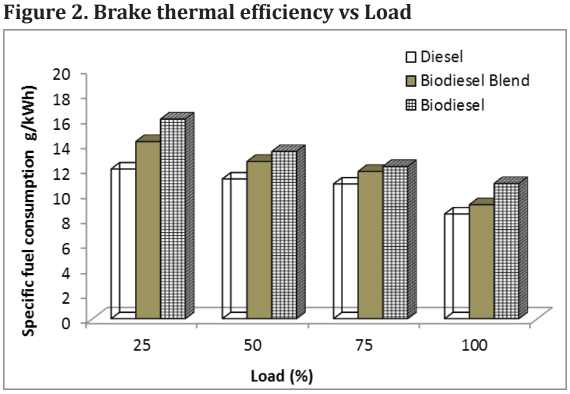

Figure 3. Specific fuel consumption vs Load

Figure 4 shows the variation of exhaust gas temperature (EGT) with respect to load. The mahua oil biodiesel and its blend produce higher exhaust gas temperature than diesel because of oxygen which enables the combustion process and hence the exhaust gas temperature is higher. At maximum load, the exhaust gas temperature of biodiesel and its blend is 12% and 6.52% higher than diesel respectively.

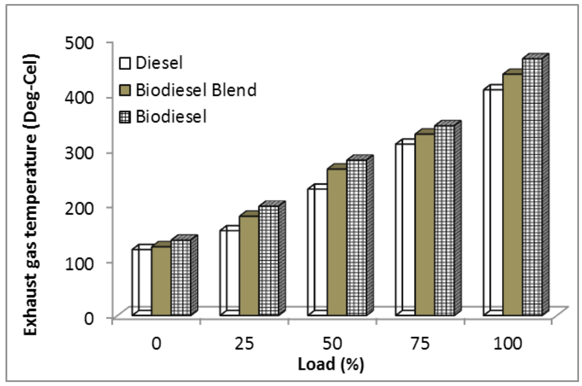

Figure 4. Exhaust gas temperature vs Load

Conclusion

The experiments were carried out on a single cylinder, four stroke, Kirloskar make, direct injection diesel engine using mahua biodiesel and its 50% blend with diesel. The performance characteristics of blends are evaluated and compared with diesel. From the above results, the following conclusions are drawn. Fuel consumption and exhaust gas temperature are high for mahua oil biodiesel and its blend at all loads. The brake thermal efficiency is lesser than the diesel. But in overall view, the engine runs well without any modifications.

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