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INVESTIGATION OF COMPRESSION IGNITION ENGINE FUELLED WITH DIESEL AND BIODIESEL (MAHUA) BLEND

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Abstract
The recent energy trend makes an opportunity to look for substitutes of fossil fuels. Vegetable-oil-based fuels have been considered to be good alternatives to fossil fuels for diesel engines. Bio-fuel commands crucial advantages such as technical feasibility of blending, superiority from the environment and emission reduction angle, its capacity to provide energy security to remote and rural areas and employment generation. This paper presents the results of emission and performance characteristics founded in a single cylinder direct injection diesel engine fuelled with blend (50 MOME) of mahua oil methyl ester.

Keywords : Diesel engine, mahua oil, biodiesel, performance and emissions.

Introduction

Vegetable oils have become more attractive recently because of its environmental benefits and the fact that it is made from renewable resources. Vegetable oils are a renewable and potentially inexhaustible source of energy with an energetic content close to diesel. One of the problems faced in utilizing vegetable oils as CI engine fuels is their higher viscosity, ranging from 9 to 17 times greater than petroleum diesel fuel which results in poor fuel atomization, incomplete combustion and carbon deposition on the injector and the valve seats causing serious engine fouling. Other constraints of the direct application of vegetable oil were its low volatility and polyunsaturated character (Fukuda et al., 2001 and Boehman, 2005). To overcome these constraints, the processes like cracking or pyrolysis, transesterification, micro-emulsification, and blending with diesel, etc were especially developed (Ramadhas et al., 2005; Ayhan Demirbas, 2008 and Sharma et al., 2008).

Saravanan et al (2011) investigated the effect of rice ban oil biodiesel in a 4.4kW direct injection diesel engine and found that the biodiesel blend results in an average reduction of 28% and 355 reduction of hydrocarbon and smoke emissions respectively. Kalam et al (2011) tested the emission and performance characteristics of indirect injection diesel engine fuelled with biodiesel produced from waste cooking oil. They reported that the biodiesel blends produce lesser exhaust emissions than diesel fuel. Deepanraj et al (2011 and 2012) investigated the palm oil biodiesel blends and mahua oil biodiesel blends with diesel in a single cylinder direct injection diesel engine and found that the acceptable thermal efficiencies were obtained and the specific fuel consumption and exhaust gas temperatures were higher than the diesel. Godiganur et al (2009) ran a diesel engine fueled with methyl ester of mahua oil/diesel blends. They found that vegetable oils have to undergo the process of transesterification to be usable in diesel engines. Dilip Kumar Bora et al (2010) performed wear and tear analysis on a single cylinder diesel engine using karanja biodiesel (B20) after 512 hours and reported that the engine can safely operated with biodiesel blend without significant changes in engine power, fuel economy and lubricating oil properties.The objective of the present work is to investigate the compression ignition diesel engine with 50% blend of mahua oil methyl ester.

Materials And Methods

The high viscosity crude mahua oil was reduced to low viscosity by transesterification (Ayhan Demirbas. 2005 and Phan and Phan. 2008). The product obtained from transesterification is called biodiesel. The properties of mahua oil methyl ester (biodiesel) produced is compared with diesel in table 1. The advantages of bio-diesels as diesel fuel are minimal sulfur and aromatic content, and higher flash point, lubricity, cetane number, biodegradability and non-toxicity. On the other hand, their disadvantages include the higher viscosity and pour point, and the lower calorific value and volatility (Table 1). A single cylinder, four stroke, water cooled direct injection diesel engine (Kirloskar) was used for thois experiment and their specifications are shown in Table 2. An eddy-current dynamometer was connected with the engine for loading purpose. An exhaust gas analyzer (Wahun cubic) was used to measure HC, CO and NOx emissions. Bosch smoke meter was used to measure the smoke density.

Table 1. Properties of diesel and biodiesel

Properties	Diesel	Biodiesel
Kinematic viscosity at 40°C (cSt)	3.72	5.8
Density (kg/m3)	840	915
Flash point (°C)	62	129
Fire point (°C)	75	141
Acid value (mg KOH/ gm)	0.20	0.57
Calorific value (kJ/kg)	42800	39400

Figure 1. UBHC Emission Vs. Load

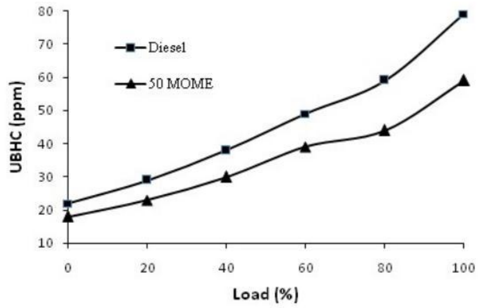


Figure 2. CO Emission Vs. Load

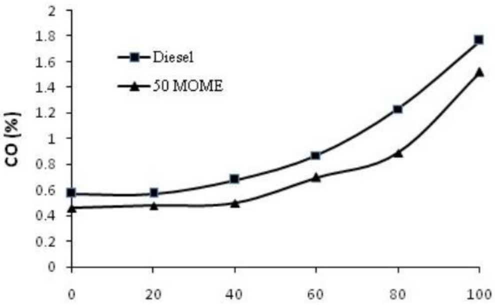


Figure 3. Smoke Emission Vs. Load

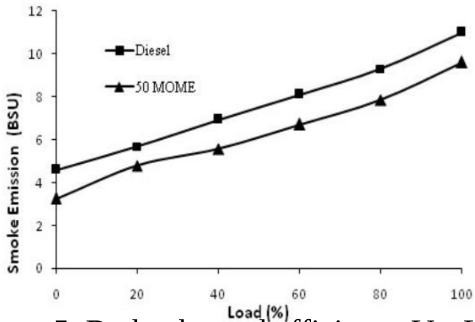


Figure 4. NOx Emission Vs. Load

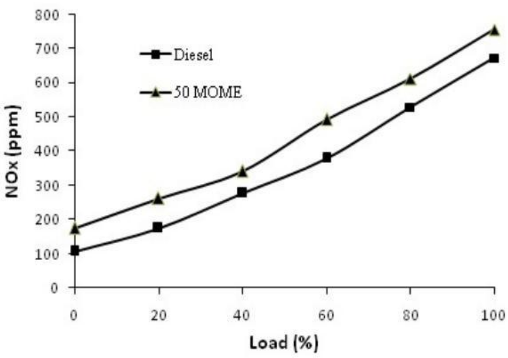
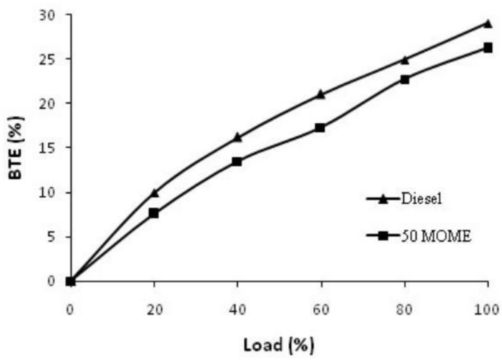


Figure 5. Brake thermal efficiency Vs. Load



Results And Discussions

Fig. 1 and 2 Shows the variation of unburned hydrocarbon emissions (UBHC) and Carbon monoxide (CO) emissions with respect to various loads for both diesel and the MOME blend. From the figure, it is observed that the MOME blend produce lower UBHC emission and CO emission than diesel at all the load conditions. This is due to the better combustion takes inside the combustion chamber due to the availability of higher oxygen atoms in the MOME blend than diesel fuel. At maximum load, the diesel fuel produce 25.31% lower UBHC emission and 13.63% lower CO emission. At 60% of load, the MOME blend produces 20.4% and 19.54% lesser UBHC and CO emission respectively than diesel.Fig 3 shows the variation of smoke emission with respect to various loads for diesel and as well as MOME blend. The smoke emission increases with increase in load. From the figure, it is observed that the smoke emission of MOME blend is lesser than diesel fuel. At maximum load, the smoke emission of MOME blend is 12.72% lower than diesel which is due to better combustion of biodiesel blend than diesel.

Fig 4 shows the variation of oxides of nitrogen (NOx) emission with respect to various loads for diesel and mahua oil methyl ester blend. The NOx emission increases with increase in load and also blend produce higher than diesel fuel. This is because the higher oxygen content in the biodiesel blend enhances the better combustion which increases the incylinder temperature of the combustion chamber which leads to higher NOx emission. At maximum load condition, the MOME blend produce11.3 % higher NOx emission than diesel fuel. Fig 5 shows the variation of brake thermal efficiency with respect to various loads. The brake thermal efficiency is defined as the actual brake work per cycle divided by the amount of fuel chemical energy. From the figure it is observed that brake thermal efficiency increases with increase of load. The brake thermal efficiency of mahua oil methyl ester is lower than diesel fuel because of the lower heating value of biodiesel blend compared to diesel.

Conclusion

From the experimental investigation, it is concluded that there is a significant reduction in unburned hydrocarbon, carbon monoxide and smoke emissions in diesel engine using mahua oil better ester blends. At the same time, the oxides of nitrogen emission increases with mahua oil methyl ester blends. The brake thermal efficiency of the engine also reduces with biodiesel blend due to lower heating value of the fuel.

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