Experimental investigation of performance, emissions and noise characteristics of methyl esters of Jatropha in single cylinder diesel engine and multicylinder diesel engine light vehicle

S. JAYARAJ*, K. ANNAMALAI, BANUGOPAN, PRABAKARAN and P. ARJUNRAJ

Madras Institute of Technology, Anna University, Chennai (India).

(Received: August 08, 2009; Accepted: October 15, 2009)

ABSTRACT

Ever increasing consumption of fossil fuel and petroleum products has been a matter of great concern for India. The huge out-go of foreign exchange on one hand and the increase in the price of crude oil on the other hand have affected the development of India. Apart from increase in inflation up to 11.91%, pollution and related health hazards, global warming, climatic change, energy security, depletion of fossil fuel and problems related to transport and distribution of non-renewable conventional fuels have propelled alternative energy. Engine Experiment have been carried out to examine performance, emissions of different blends (B20, B40, B60, B80 and B100) of JME in comparison to diesel. The experimental results show that the brake thermal efficiency of all the blends is slightly lower when compared to diesel fuel. However, up to the B60 blend, brake thermal efficiency of JME were almost equal when compared to diesel and injection timing of 27 deg. BTDC. But, slightly increased NOX emission and reduced smoke & noise were observed. When timing was further advanced to 28 & 29 deg. BTDC, the brake thermal efficiency got improved, but NOX produced in the engine was increased when compared to diesel fuel. Vehicle experiment have been carried out to examine the sound of different blends (B50 & B100) of JME in comparison to diesel. The experimental results show that the sound level of all the blends is slightly lower when compared to diesel fuel.

Key words: Vehicle, Bio-diesel, Sound, Emission, Methyl Esters.

INTRODUCTION

Biodiesel is oxygenated fuel and which containing 10% to 15% oxygen by weight. Also it can be said a sulphur-free fuel. These facts lead biodiesel to more complete combustion and less most of the exhaust emissions from diesel engine. But, comparing the fuel properties of biodiesel an diesel fuel, it has higher viscosity, density, pour point, flash point and cetane number than diesel fuel. Also the energy content or net calorific value of biodiesel is about 12% less than that of diesel fuel on a mass basis.

EXPERIMENTAL

The engine used in the experiments is a single cylinder direct injection diesel engine. It is a naturally aspirated water-cooled four stroke diesel engine. The vehicle used in the experiments is a multicylinder diesel engine vehicle. The test engine was directly coupled to an eddy current dynamometer with suitable switching and control facility for loading the engine. The test vehicle was directly coupled to a chassis dynamometer with suitable control facility for loading the vehicle. The engine was set to run at a constant speed of 1800
rpm and the vehicle speed of 2500 rpm. The major pollutants in the exhaust of a diesel engine are smoke. AVL smoke meter was used to measure the smoke density of the exhaust from diesel engine. Crypton 290 Series was used to measure the CO & HC emissions from the engine. The NOX emission from the test engine was measured by chemical luminescent detector type NOX analyser. The sound from the vehicle was measured by Rion Sound Levelmeter.

The engine and vehicle were operated on diesel first and then on methyl esters of jatropha and their blends. The measured data were then analysed from the graphs regarding thermal efficiency, brake specific energy consumption, sound and smoke density of all fuels.

**RESULTS AND DISCUSSION**

The variation of brake thermal efficiency with respect to brake power is discussed for diesel, bio diesel-diesel blends.

Figures 2 to 4 show variation of brake thermal efficiency with brake power for JME and its blends with diesel. For all the blends, the brake thermal efficiency increases with increase in power. Among B20, B40, B60, B80 and B100, bio diesel blends up to B40 has a maximum brake thermal efficiency and it is almost closer to that of diesel. This may be due to better spray characteristics and dissolved oxygen in esters of B40 blends of JME in the combustion chamber, which leads to effective
utilization of air resulting in complete combustion of the fuel. The brake thermal efficiency gradually decreases with increasing percentage of blends of esters (B60 to B100). The high viscosity of the blended fuels inhibits the proper atomization, fuel vaporization and combustion. This is also due to the combined effect of low calorific value, high density and viscosity of the blended fuel.

Figures 5 to 7 show variation of specific energy consumption. Brake specific energy consumption descent from lower to higher load level. It is related with brake thermal efficiency. At higher load level the brake thermal efficiency is increased and brake specific energy consumption decreased. It can be seen that the brake specific energy consumption of JME and their blends are higher.
than that of the diesel fuel. Therefore, the higher brake specific energy consumption of methyl ester fuels are due to the lower net calorific value of these fuels.

The NOX emissions from the test fuel are shown in figures 8 to 10. The NOX formation in combustion process is mainly controlled by the combustion temperature. The combustion temperature is depended on the injection timing of the fuel, ignition delay time and combustion pattern.
Biodiesels with higher speed of sound and buck modulus cause the faster propagation of pressure waves and more rapid pressure rise, and which may shift the injection timing from optimum timing and driving to earlier combustion. The earlier combustion can result higher combustion temperature and higher NOX emission.

The CO emissions from test fuels are shown in figures 11 to 13. The cause of CO emission is similar as HC emission. Generally, CO is generated when there is not enough oxygen to convert all carbon to CO₂. Some fuel does not get burned and some carbon ends up as CO. The other factors of CO emission are poor fuel air mixing, local fuel rich region and incomplete combustion will create some CO. From the experimental results, the CO emission from JME are lower than that of the diesel fuel at all load levels. Therefore, more oxygen in JME show more reductions in CO emission.

The HC emissions of the test fuel are shown in figures 15-17. The cause of HC emission is mostly depending on the combustion. Incomplete combustion produces more HC emission or unburned fuel emission. The HC emission from methyl ester fuel is probably due to the oxygen in methyl ester fuel. Therefore, more oxygen in JME show more reduction in HC emission. The sound emission of the test vehicle are shown in figure 16. From the experimental results, the sound emission from methyl fuels are lower than that of the diesel fuel. The present of fuel oxygen allows the fuel to burn smoothly, so less sound is produced.

**CONCLUSIONS**

A detailed experimental analysis for finding out the combustion characteristics of biodiesel blend vis-a-vis mineral diesel was carried out. The experimental investigation revealed that the overall combustion characteristics were quite similar for biodiesel blend (B40) and mineral diesel. However combustion starts earlier in case of B40. Ignition
delay is lower and combustion duration is slightly longer for B40 compared to mineral diesel. A jeep running on biodiesel shows no particular deviation from a jeep running on fossil diesel as far as vehicle performance is considered.

The storage stability of the biodiesel is a parameter which needs to be studies further as increased emissions were observed with aged biodiesel. In order to come to a more conclusive understanding of the performance of JME biodiesel in JEEP diesel engines additional test are planned.

REFERENCES

1. Shailendra Sinha, Avinash Kumar, Agarwal “Combustion Characteristics of Rice Bran Oil Derived Biodiesel in a Transportation Diesel Engine” SAE 2005-26-354.
2. Thet Myo " The Effect of Fatty Acid Composition on the Combustion Characteristics of Biodiesel” Ph.D., Thesis, Kagoshima University, Japan
3. Sanjeev Mandpe , Suhas Kadlaskar “ On Road Testing of Advanced Common Rail Diesel Vehicles with Biodiesel from The Jatropha Curcas Plant” SAE 2005-26-356.
4. Murugesan, “Experimental and theoretical Investigation of Using Biodiesel in Diesel Engines” Ph.D., Thesis,Anna University, India.