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Performance Analysis of CI engine by using Blends Diesel and Biodiesel (Mahua Oil)

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Abstract— Inflation in fuel prices and unprecedented shortage of its supply have promoted the interest in development of the alternative sources for petroleum fuels. In this present work, investigations were carried out to study the performance, of blends of mahua oil. The results were compared with diesel fuel, and the selected mahua fuel blends (05%, 10%,15%,20%,25%,50%). For this experiment a single cylinder, four stroke, water cooled diesel engine was used. Initially the engine was run with diesel fuel and the readings were recorded. Then the engine was run with the blends of mahua oil (B05, B10, B15, B20, B25, B50) added by volume basis and the readings were taken. Tests were carried out over entire range of engine operation at varying conditions of load. The engine performance parameters such as specific fuel consumption, brake thermal efficiency, exhaust gas temperature, indicated thermal efficiency, and mechanical efficiency were recorded. The lower blends of biodiesel increases the brake thermal efficiency and reduces the specific fuel consumption. The experimental results proved that the use of biodiesel (mahua oil) in compression ignition engine is a viable alternative to diesel.

Index Terms— CI engine, Diesel, Mahua Oil, Blends, Calorific Value, Density, Brake Specific Fule Consumption, Performance, Indicated Power, Emission

1 INTRODUCTION

India is home to 1.2 billion people, who are about, 17% of world population, and its thirst for energy is unquenchable. One harsh result of its meteoric growth is the widening gap between the energy produced and energy required by the country. On an average india produces about 826,000 barrels of oil per day and requires about 3,319,000 barrels of oil per day (2010) (statistical review of world energy, 2011). Further, with the growth of human population and industrialization there will steadily increase in energy demand. Major sources of energy are petroleum, coal, and natural gas which are non-renewable source of energy. Due to the increasing demand of energy all over the world had lead to depletion of non-renewable source of energy. Biodiesel does not contain petroleum, but petroleum can be mixed to produce a biodiesel blend (e.g. B20, b50) that can be used in many different vehicles. Pure biodiesel fuel (i.e. B100) though, can only be used in diesel engines. Biodiesel is biodegradable and non-toxic, making it so safe that it is even safer than the commonly used table salt. The waste and degraded land after reclamation can be used to grow the resource, produce oil and its conversion to biodiesel. Biodiesel's are mono alkyl ester of long chain fatty acids of vege-table oil or animal fats either from plant or animal.

2 WHAT IS BIODIESEL?

2.1 Biodiese l

Biodiesel is defined as a fuel comprised of mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats. It can be directly used in the compression ignition engine. Biodiesel fuel is a clean burning alternative fuel that comes from 100% renewable resources. Many people believe that the biodiesel is the fuel of the future. Sometimes it is also known as biofuels. Biodiesel does not contain petroleum, but petroleum can be mixed to produce a biodiesel blend i.e. B20 (20% biodiesel and 80% petroleum), B50 (50% biodiesel and 50% petroleum) that can be used in many different automobiles. Pure biodiesel fuel B100 though, can only be used in diesel engines. Biodiesel is biodegradable and non-toxic, making it so safe that it is even safer than the commonly used table salt.The advantages of biodiesel as diesel fuel are: it's Liquid nature-portability, Ready availability, Renewability, High Cetane number and Lower sulfur content.

2.2 Biodiesel Production

Esterfication of vegetable oil comprised heating of oil then addition of sodium hydroxide and alcohol, stirring of the mixture, separation of glycerol, and biodiesel. This esterfied vegetable oil is called biodiesel. Biodiesel properties are similar to diesel fuel as shown in the Table.1. After esterfication of Mahua oil the properties like density, cetane number, viscosity, and calorific value are improved. These parameters induce better combustion characteristics and performance of diesel engine. The biodiesel contain more oxygen and lower calorific value compare than diesel. which results in lower generation of hydrocarbon and carbon monoxide in the exhaust than diesel fuel. The properties like calorific value and density of Mahua biodiesel and their blends with diesel are measured as per Indian standards (IS) methods in fuel testing laboratory are tabulated in Table 1.

Table1. Properties of Biodiesel blends compared with neat diesel

Sr. no.	Fuel	Calorific value (kJ/kg)	Density (kg/m^3)
1	Diesel	42800	820
2	Mahua	36100	918
3	B05	42478	823
4	B10	41942	829
5	B15	41658	834
6	B20	41200	838
7	B25	41146	843
8	B50	39465	849

2.3 Biodiesel

This process involves heating the mahua oil, from which the biodiesel fuel is extracted. When the temperature of approximate 65 to70oC. The oil is held in that teperature for certain period of time exactly 25 minutes. In this preparation, for 1000 ml of mahua oil, 300 ml of methanol and 30g of potassium hydroxide are added. The mahua oil chemically reacts with alcohol in the presence of a catalyst to produce methyl esters. After this the whole mixture is stirred for 1 hour. After completing the mixing stage, a separating flask allows the mixture to settle down. Separating and settling can be done on a single flask. When allowing the mixture to be in the flask for 24 hours the settling takes place where the glycerin gets settled down and esters get separated up. After separation of the methyl eters, it is washed in order to get clear solution of methyl esters, obtained by the spraying of distilled water over the solution which has already been separated and the moisture is removed.

3 Experimental Setup

A four stroke, single cylinder, water cooled, direct injection diesel engine was connected to mechanical rope brake dynmometer, which is developing a power output of 5.2kW at a constant speed of 1500 rpm. The engine specifications are given as in table 2.

Table 2. Engine specifications

Engine	Single cylinder, vertical, direct injection constant speed, water cooled, four stroke diesel engine
Manufacture	Topland
BHP	5 HP
RPM	1500
Fuel	Diesel
Bore	80 mm
Stroke length	110 mm
Starting	Cranncking
Working cycle	Four stroke
Method of Cooling	Water cooled
Method of Ignition	Compression Ignition

A burette and a stop watch were used to measure the fuel flow rate on volume basis. The exhaust gas temperature was noted using thermocouple and digital display. All the experiments were conducted in the engine at the speed of 1500rpm. All the tests were repeated to get an optimum value. Initially, the engine was run on pure diesel. Then the engine was run on B05 (05% biodiesel + 95% diesel), B10 (10% biodiesel + 90% diesel), B15 (15% biodiesel + 85% diesel), B20 (20% biodiesel + 80% diesel), B25 (25% biodiesel + 75% diesel) and B50 (50%

biodiesel+ 50% diesel). This blend ratio was selected because it is practically viable to have this ratio because of low availability of biodiesel and also it is in line with the intention of the Government of India to blend up to 10% biodiesel with mineral diesel for the automobile sector.

4 *ENGINE PERFORMANCE TEST*

The Engine performance test with 100% Diesel, 5%, 10%, 15%, 20%, 25% and 50% blends of diesel and Biodiesel are as follows.

Table 3. Result and discussion table

Sr. no.	Parameters	B00	B00	B10	B15	B20	B25	B50
1	Brake power (kW)	3.3121	3.3121	3.2767	3.3667	3.3867	3.4442	3.4509
2	Indicated power (kW)	5.3621	5.3621	5.3267	5.4767	5.4369	5.4942	5.5009
3	Specific fuel consumption (kg/kW-hr)	0.2228	0.2228	0.2221	0.2286	0.2226	0.2372	0.2330
4	Volumetric efficiency (%)	73.13	73.13	71.91	72.16	72.06	72.06	69.84
5	Brake thermal efficiency (%)	37.74	37.74	38.63	37.79	39.23	36.87	39.13
6	Indicated thermal efficiency (%)	61.11	61.11	62.81	60.80	62.98	58.82	62.38
7	Mechanical efficiency (%)	61.76	61.76	61.51	62.15	62.29	62.68	62.73
8	Overall efficiency (%)	45.16	45.16	44.23	44.84	44.88	45.16	43.81

5 PERFORMANCE CHARACTERISTICS

Engine performance characteristics are the major criterion that governs the suitability of a fuel. This study is concerned with the evaluation of brake thermal efficiency (BTE) and brake specific fuel consumption (BSFC) of the biodiesel blends.

5.1 Brake Specific Fuel Consumption (BSFC)-

Figure 5.1 shows the variation of specific fuel consumption with load. From the graph it is observed that as load increases, specific fuel consumption decreases for all the fuels. The value of B20 fuel is 0.2226 kg/kW-hr approximates that of the diesel. The minimum specific fuel consumption for B05 fuel 0.2202 kg/kW-hr against 0.2228 kg/kW-hr of diesel. Specific fuel consumption for B10 is 0.2221 kg/kW-hr, for B15 is 0.2286 kg/kW-hr, for B25 is 0.2372 kg/kW-hr, B50 is 0.2330 kg/kW-hr against 0.2228 kg/kW-hr of diesel.

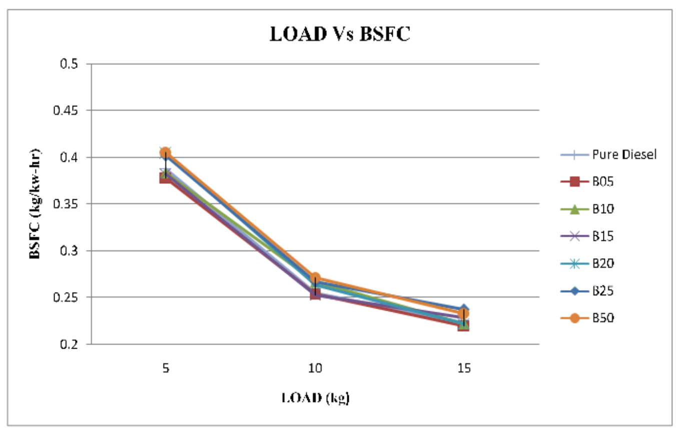

Fig.5.1 Load Vs Bsfc

5.2 Brake Thermal Efficiency

The variation of brake thermal efficiency with load is shown in figure 5.2. In all the cases brake thermal efficiency is increased with increase in load. The maximum efficiency obtained in this experiment was 39.33% (B20). The value of B15 fuel is 37.79% nearer to that of the diesel is 37.74%.

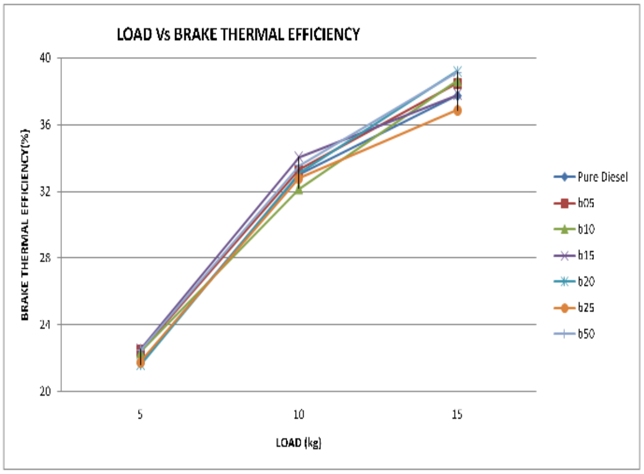

Fig.5.2 Load Vs Brake Thermal Efficiency

5.3 Mechanical Efficiency:

The variation of mechanical efficiency with load is shown in figure 5.3. In all the cases mechanical efficiency is increased with increase in load. The maximum efficiency obtained in this experiment was 62.73% for B50. The value of B05 fuel is 61.54% nearer to that of the diesel is 61.76%.

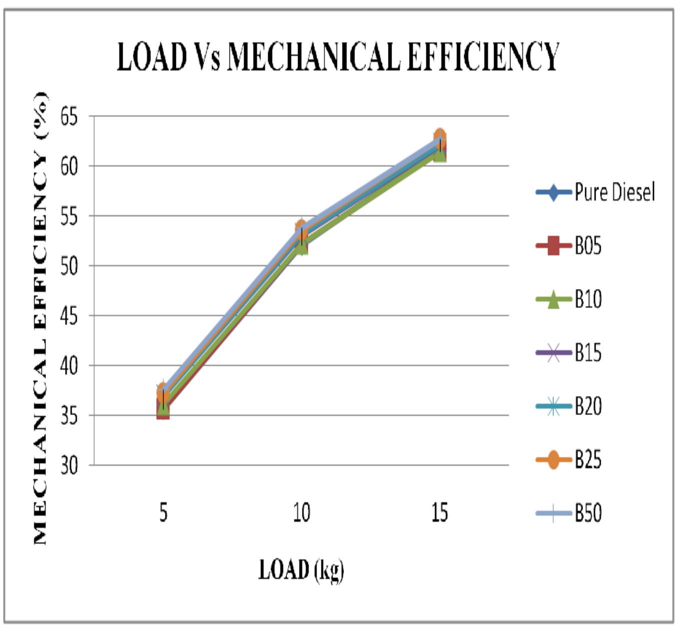

Fig.5.3 Load Vs Mechanical Efficiency

5.2.4 Indicated Thermal Efficiency

The variation of indicate thermal efficiency with load is shown in figure 5.4. In all the cases indicated thermal efficiency is increases and also decreases with increase in load. The maximum efficiency obtained in this experiment was 62.98 % (B20). The value of B15 fuel is 60.80% nearer to that of the diesel is 61.11%.

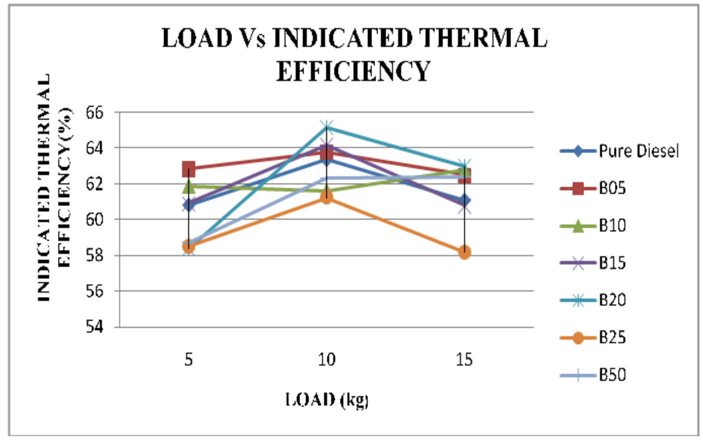

Fig.5.4 Load Vs Indicated Thermal Efficiency

5.5 Exhaust Gas Temperature (EGT):

Figure 5.5 shows the variation of exhaust gas temperature with load for various blends. The results show that the exhaust gas temperature increases with increase in load for all blends. At all loads, Petro diesel was found to have the lowest temperature and the temperatures for various blends show an upward trend with increasing concentration of Mahua Biodiesel in the blends. The biodiesel contains oxygen which enables the combustion process and hence the exhaust gas temperatures are higher.

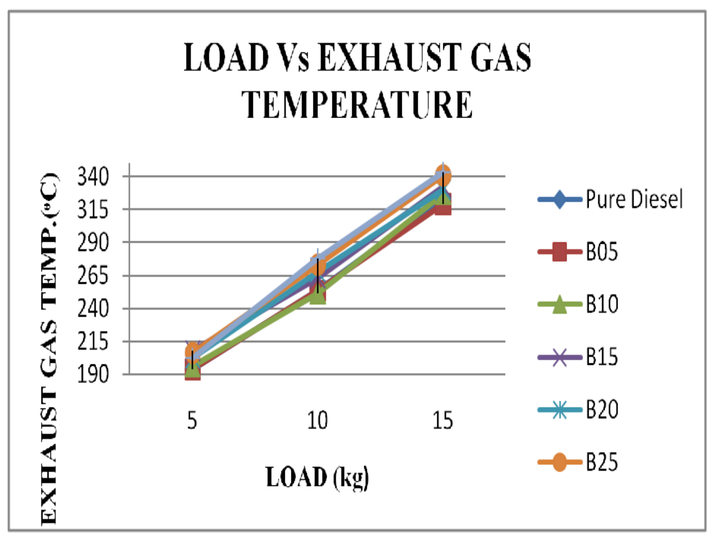

Fig.5.5 Load Vs Exhaust Gas Temperature

6 CONCLUSION

The experiments are carried out on a single cylinder diesel engine using biodiesel derived from mahua oil as an alternate fuel. The performance characteristics of blends are evaluated and compared with diesel. From the above results, the following conclusions are drawn. Fuel consumption using mahua biodiesel is less at low and medium loads. Brake thermal efficiency is high load. For B20 there is 3.79 % increase in brake thermal efficiency compared to diesel. Specific fuel consumption decreases for all the fuels. The value of B20 fuel is 0.2226 kg/kW-hr approximates that of the diesel. The maximum efficiency obtained in this experiment was 62.73% for B50.The present experimental results show that of mahua oil can be used as an alternative fuel in diesel engine.Biodiesel is a popular and promising environment friendly alternative fuel due to its renewable nature. Biodiesel is a promoter of the rural economy.

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