Implementation of Emission Control Techniques on 125KVA - 415V Bio-Diesel Generator Using Palm oil Methyl Ester (PoME)

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Abstract: The increasing fact of the environmental hazards and the alarming levels of air pollution have more limited regulations on engines emission control techniques in recent years. The dwindling resources and rising cost of crude oil had resulted in an reinforce search for alternate fuels. In the current studies bio-diesel palm oil methyl ester (PoME) blends with diesel was explore in a direct injection stationary diesel engine. The stationary engine test bed used consists of a single cylinder four stroke diesel engine, eddy current dynamometer with computer control data acquisition system and exhaust emissions analyzer. Results: Engine tests were conducted at constant speed using neat diesel fuel and various measure of Bio-diesel blends. The exhaust emissions such as CO, HC and NO_X were proportion using exhaust gas analyzer. Performance analysis like brake thermal coherence and specific fuel consumption were recorded. The differences in the measured emissions and performance of the Bio-diesel fuel blends from the baseline operation of the engine, i.e., when working with neat diesel fuel were resolved and compared. Conclusion: It is concluded that the lower blends of Bio-diesel increased the brake thermal coherence and reduced the fuel consumption. Bio-diesel blends produce lower engine emissions than diesel. From the result, it has been established that 20-40% of palm oil methyl ester (PoME) Bio-diesel can be use as a alternate for diesel without any engine modifications.

Key words: Alternate fuel, palm oil methyl ester (PoME), diesel engines, bio-diesel, emissions techniques, performance testing.

1. INTRODUCTION

Diesel engines are the significant source of transportation, power generation, marine applications, etc. Hence diesel is being used considerable, but due to the gradual depletion of fossil fuel reserves and the effect of environmental pollution, there is an urgent need for suitable alternative fuels for the use in compression-ignition (CI) engine. Accordingly, Vegetable oils have become more gorgeous recently because of its environmental interest and the fact that it is made from renewable resources. Vegetable oils are a renewable and capacity to develop inexhaustible source of energy with an energetic content near to diesel. Since hundred years ago, Rudolf Diesel tested vegetable oil as the fuel for his engine. With the advent of cheap petroleum, appropriate crude oil fractions were refined to serve as fuel and diesel fuel and diesel engines yield together. In the 1930s and 1940s vegetable oils were used as diesel fuel from time to time, but only in emergency situations. Recently, there has been a regenerate focus on use of vegetable oils and Bio-diesel fuel. Different kinds of vegetable oils and Bio-diesel have been tested in diesel engines. Its reducing characteristic for greenhouse gas emissions, its help on reducing a country’s reliance on crude oil imports, its nurturing characteristic on agriculture by providing a new market for domestic crops, it’s essential lubricating property that abolish the need of any lubricate additive and its wide acceptance by vehicle manufacturers can be listed as the most important advantages of the Bio-diesel fuel. There are more than 350 Oil bearing crops identified, among which only jatropha, ongamia, sunflower, safflower, soyabean, cottonseed, rapeseed and peanut oils are considered as potential alternative fuels for diesel engines.

2. METHODS AND ANALYSIS OF BIO-DISEL

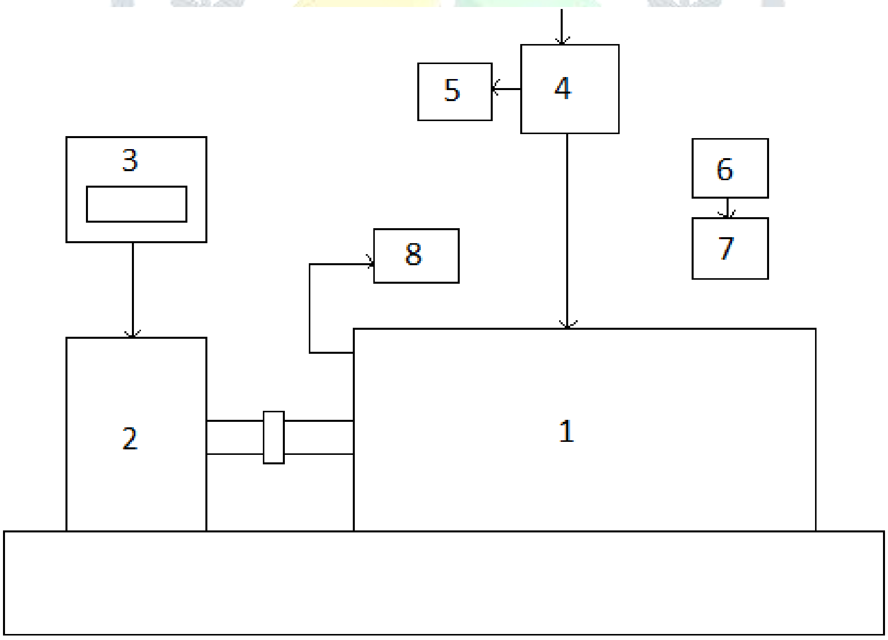
Bio-diesel is the ester of vegetable oils generated through a process called transesterification. Transesterification is a process of chemical reaction which occurs between triglyceride and alcohol, also called methyl alcohol in the presence of a catalyst like sodium hydroxide of potassium hydroxide. It consists of a series of three consecutive reactions where triglycerides are converted to diglycerides. The diglycerides are further converted to monoglycerides and followed by the conversion of monoglycerides to glycerol. In each step an ester is generated and the three molecules of ester are generated from one molecule of triglyceride. Palm oil is used in the present investigation was taken from the local market and removed by cheesecloth to filter the solid particles. The moisture content was filtered by heating the oil in an oven maximum to 110°C per hour. Now the oil is taken in a round bottom flask (RB-Flask) of volume 500 ml and heated around 50-60°C on a hot plate having magnetic stirrer setup. Then the methanol and sodium hydroxide (catalyst) are added to the oil. The mixture was stirred continuously. Alcohol to vegetable oil molar ratio is one of the most important factors that affect the conversion coherence of the process. The transesterification process, 3 molecule of alcohol is needed for each molecule of the oil. Although, in real time, the molar ratio should be greater than this theoretical ratio in order to steer the reaction towards completion in advance. After the completion of the process, the products are allowed to separate into two layers. The below layer contains glycerol and the upper layer contains ester which is separated and purified using distilled water. Hot distilled water (10% by volume) is sprayed over the ester and stirred gently and allowed to settle in the separating funnel. The below layer is discarded and upper layer that is purified Bio-diesel is separated. Bio-diesel also known as methyl esters of palm oil has several outstanding advantages among other new renewable and clean engine fuel alternatives. The properties of diesel and Bio-diesel (palm oil methyl ester) PoME used in the present investigation were compared with diesel fuel in Table 1.

Table 1 Properties of diesel and bio-diesel

Properties	Diesel	Bio-diesel
Calorific value (kJ/ kg)	42400.000	39070.000
Specific gravity	0.822	0.843
Viscosity at 40°C (c-s)	3.720	7.100
Flash point (°C)	62.000	108.000
Iodine value	38.300	71.440

Table 2 Specification of test engine

Engine Made	Ashok Leyland
Engine model	ALU 680/ 104
Engine HP	151 HP
Bore	104 mm
Stroke	113mm
Compression ratio	17.5 : 1
No. of cylinders	6
KVA/RPM	125/1500
Volts/Amps	415/173.9
Lubricant oil capacity	25 lit
Fuel tank capacity	900 lit
Ambient temperature	40 °C
Connection	Star connection
Phase	3 phase
Frequency	50 Hz
Alternator made	KIRLOSKAR



1. Diesel Engine
2. Eddy Current Dynamometer
3. Rheostat
4. Air Box
5. U Tube Monometer
6. Fuel Tank
7. Fuel Measurement Flask
8. Exhaust Gas Analyzer

Fig.1 Experimental Step-up

3. EXPERIMENTAL SETUP OF BIO-DISEL

A four stroke, six cylinder, water cooled, direct injection diesel generator was used for the performance and emission testing. The specification of the test generator is shown in Table 2. The experimental set-up diagram is shown in Fig.1 Experimental Set-up and Fig.2 Schematic diagram of Bio-Diesel and Combustion were carried out initially using neat diesel fuel to generate the base line data. After recording the base line data, testing were carried out using 7, 15, 20% bio-diesel blends. The engine testing was conducted at various loads starting from no load to full load and the parameters related to performance and emission characteristics were recorded.

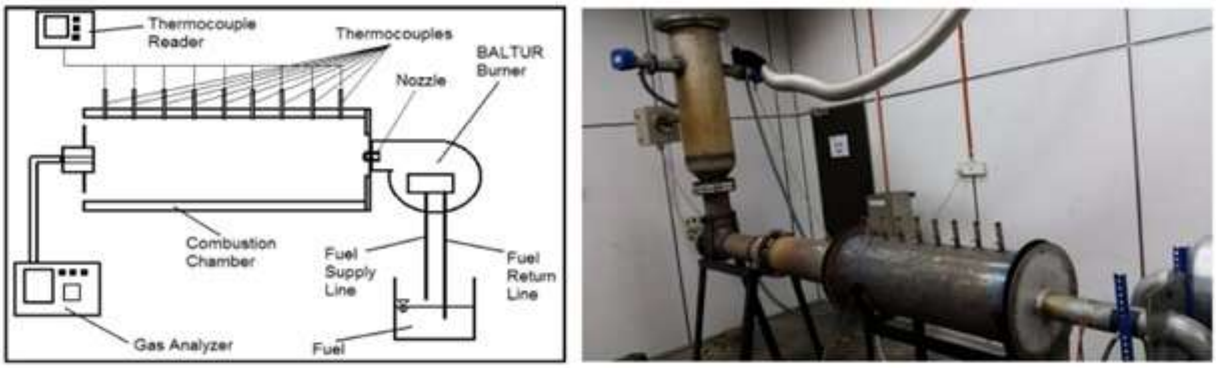


Fig.2 Schematic diagram of Bio-Diesel and Combustion

4. RESULTS AND DISCUSSION

The emission and performance implementation of the engine are presented for different percentages of load for diesel and bio-diesel blends. Fig.3 shows the variation of unburned hydrocarbon (HC) emission with respect to load. The unburned hydrocarbon emission gradually increases with increase in load. This is due to the increased amount of fuel injection at greater level of loads. At maximum load condition like B30, B40 and B50 blends generate17.54, 19.4 and 21.3% lower HC emission respectively than neat diesel fuel. This is due to the complete and stable combustion of the Bio-diesel, which contains more number of oxygen atoms. Fig.4 shows the variation of carbon monoxide (CO) emission with respect to different loads. The CO emission increases with increase in load. From the comparison results it is observed that the bio-diesel blend generates lower CO emission than diesel. At 50% load condition, like B30 and B40 produce 36.5 and 41.23% less CO emission than diesel. This is due to the complete and stable combustion of the bio-diesel, which contains more number of oxygen atoms.

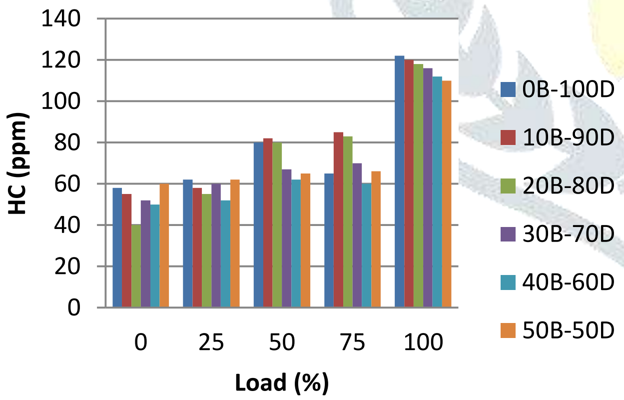


Fig.3 HC versus Load

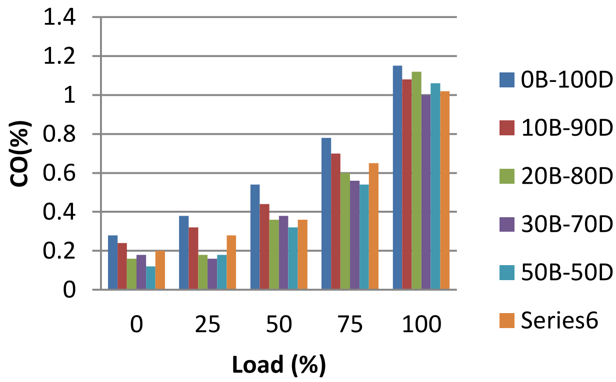


Fig.4 CO versus Load

Fig.5 shows the variation of NO_X emission with respect to load. From the figure, it was clearly observed that bio-diesel blend generates higher NO_X emission than diesel fuel at both full and partial loads. At maximum load, like B40 and B50 blend generate 19.6 and 22.13% higher NO_X emission than neat diesel fuel. For 50% load condition, these blends generate 18.46 and 29.05% higher NO_X emission than diesel fuel. This is because of greater temperature of combustion and the presence of fuel oxygen with the bio-diesel blends. Fig.6 shows the variation of brake thermal coherence with different loads for different bio-diesel blends and diesel. The brake thermal coherence is defined as the actual brake work per cycle divided by the amount of fuel for the chemical energy. From the figure it is observed that brake thermal coherence increases with increase of load. At maximum load, like B40 and B50 blends produce 8.95 and 12.85% lower brake thermal coherence than diesel. This reduction in brake thermal coherence with bio-diesel blends was due to greater viscosity, poor spray characteristics and lower calorific value. The greater viscosity leads to decreased atomization, fuel vaporization and combustion and hence the thermal coherence of the bio-diesel blends is lower than that of diesel. Specific Fuel Consumption (SFC) is used to measure by the coherence of the engine in using the fuel supplied to produce work. It is desirable to obtain a lower value of SFC meaning that the engine used less fuel to generate the same amount of work.

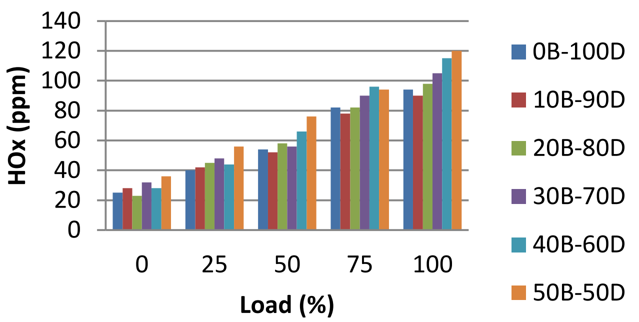


Fig.5 HOx versus Load

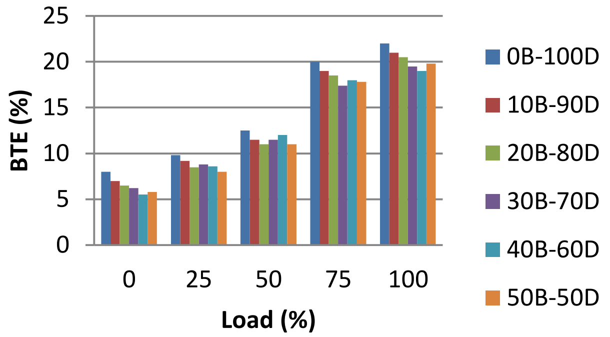


Fig.6 BTE versus Load

Fig.7 shows the SFC of PoME blends with diesel. The specific fuel consumption keeps on decreasing with increasing load. It can be seen from the figure that in case of bio-diesel blends, the specific fuel consumption values were obtained to be greater than that of neat diesel fuel. At maximum load condition, like B40 and B50 blends generate 7.9 and 13.04% are greater SFC than neat diesel fuel. This trend was clearly observed due to the fact that bio-diesel blends have lowered calorific value than neat diesel fuel and thus more amount of bio-diesel blend was required for the maintenance of a constant power output. Fig.8 shows the variation of exhaust gas temperature with different loads for different bio-diesel blends and diesel. The results show that the exhaust gas temperature increased with increase in load in all cases.

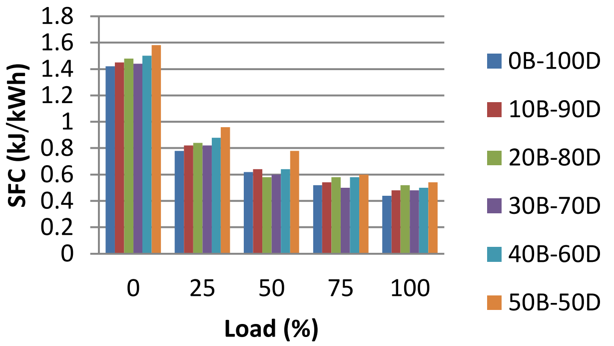


Fig.7 SFC versus Load

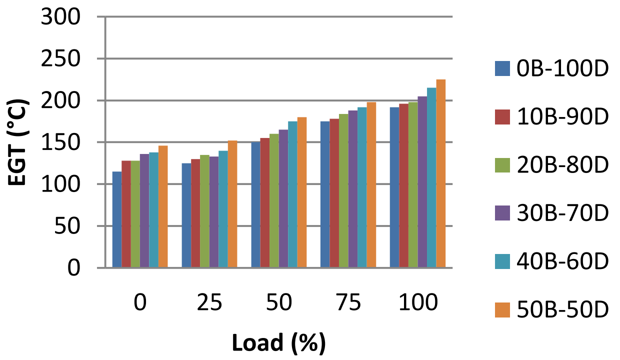


Fig.8 EGT versus Load

At maximum load condition, B50 generates highest EGT which is 28.05% higher than that of diesel. This could be due to higher quantity of fuel being consumed per hour for bio-diesel blends compared to that of diesel in each load setting of the engine. The Fig.9 and Fig.10 shows the front view of diesel generator set and stack chimney setup respectively.

Fig.9 Front View of Diesel Generator Set

Fig.10 Stack Chimney Setup

5. CONCLUSION

From the experimental setup and proposed methods of analysis for bio-diesel it was found that the blends of PoME and diesel could be successfully used with acceptable performance and better emissions up to a certain level. The result of this analysis was summarized as follows:

- The bio-diesel blends generate lower carbon monoxide and unburned hydrocarbon emission than neat diesel fuel due to the availability of oxygen content.
- Bio-diesel generates greater oxides of nitrogen than diesel because of the greater temperature inside the combustion chamber.
- Bio-diesel blend generates lower brake thermal coherence and greater specific fuel consumption than diesel because of the low calorific value.
- Bio-diesel blends generate greater exhaust gas temperature than neat diesel fuel.

6. FUTURE SCOPE

The World Commission on Environment and Development (WCDE) sates that sustainable development as the "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". In 1992, the United Nation (UN) highlighted the significance of sustainable development and declared that "the right to development must be fulfilled to equitably meet developmental and environmental needs of present and future generations". Since from 2002, the world summit on sustainable development established the target of sustainable development as the "access to reliable, affordable, economically viable, socially acceptable, and environmentally sound energy services and resources". Therefore, the application of sustainable energy usage involves a wise utilization of energy generated by clean technologies and derived from renewable sources, leading to no damage to the environment and society. In short, sustainable palm bio-diesel generation comprises legal and economic viable, appropriate to the environment, and is beneficial for the development of society and community.

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