Investigation of Performance and Emission of C.I. Engine using Palm Oil Methyl Ester as Fuel

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Abstract - In the present world it is essential to find an alternate fuel source due to the increased industrialization and depletion in natural resources. The method of obtaining biodiesel from various sources and blending them with diesel is adopted in many economically developed and developing countries around the world. The aim of this paper is to investigate the utilization of Palm oil Methyl Ester (POME) blends with diesel at various loads on CI engine. The performance and combustion characteristics of B10, B20, B30, B40 and B50 blends of palm oil with diesel at various loads on C.I. Engine are studied and study that the blends of biodiesel with diesel could be substitute in the place of pure diesel and be used as an alternate source of fuel in the near future, thus saving the natural resources for the future generation. Performance parameter like brake thermal efficiency, specific fuel consumption, brake mean effective pressure, brake power will evaluate and final conclusion will be drawn.

Keywords: Bio-diesel Blends (B10, B20, B30, B40 & B50), Brake Mean Effective Pressure, Brake specific fuel consumption, Brake power, Exhaust Gas Temperature, Palm Oil Methyl Ester.

I. INTRODUCTION

Dr. Rudolf Diesel was developed the first diesel engine which runs on vegetable oil. The vegetable oil used by the Dr. Rudolf Diesel was peanut oil. The viscosity of vegetable oil is so high as compare to diesel. Due to this he faced problems like injection problem and atomization factor, so the use of vegetable oil as fuel reached to near extinct. Now due to increased industrialization and depletion of natural resources we suppose to find the alternate fuel for diesel. As Dr. Rudolf Diesel was successfully runs the diesel engine on vegetable oil but due to the problems it was not possible to run on vegetable oil. By taking his concept, the biodiesel is made from the mixture of non-edible vegetable oils and diesel. Biodiesel is nothing but the mixture of fatty acid alcohol esters derived from edible and non-edible oils [1]. It is natural and biodegradable fuel, also as it is renewable resource biodiesel could be considered as mineral diesel substitute hat is having positive point like reduction of greenhouse gasses. Now in India the biodiesel is prepared form non-edible sources like Jatropha etc [2]. In other parts of world also the biodiesel is produced form various oils which is selected on the basis of weather and soil conditions. The biodiesel can be produced from various oils from chemical process called transesterification. The transesterification process usually carried out in the presence of catalyst which describes reaction between oil and alcohol. The transesterification process is needful because the extracted oil from the vegetables or seeds can't mix with diesel due to various factors. It has to be convert into readily usable form which is done by the transesterification. The use of biodiesel doesn't require any engine modification because the biodiesel is chemically altered vegetable oil [10]. The palm plant has the highest oil productivity per unit of land on earth. In terms of its usage, palm oil has various uses as a food (oils, margarines, bread, mayonnaise, feed, ice-cream, cookies etc.), in industry (soap, lubricants, detergents, plastics, cosmetics, rubber etc.), in steel making, the textile industry, pharmacology etc. The palm oil is becoming the good competitive for the other crops used for producing biodiesel. The palm oil blended with diesel is satisfying certain criteria, such as requiring minimum engine modification, offering uncompromised life and not being hazardous to human health and the environment during production, transportation, storage and utilization [3]. The properties of palm oil biodiesel are given in Table1.

Properties	Diesel	Palm oil	POME
Density@15oC, kg/m3	840	875.1	883
Viscosity at 40oC, mm2/s	2.5	4.1	4.5
Flash Point o C	75^o C	175^o C	185.6^oC
Pour point o C	-5^oC	-12^oC	-8^o C
Cloud point o C	-2^o C	Not Applicable	-1^o C
Calorific Value, kJ/kg	42.4	37254	39.783
Ash content	0.002%	0.001%	0.002%

Cetane number	45.55	52	62

Table 1.1. Properties of Palm oil and Palm oil biodiesel.

OBJECTIVES

1) Various thermo-physical of Palm oil and Palm oil Biodiesel are determined. The properties of Diesel, Palm oil and Palm oil Biodiesel are compared in the above table 1.
2) The performance parameters are found for Diesel and blends of Palm Oil Methyl Ester-Diesel like B10, B20, B30, B40 and B50 on the various loads (kg) like 0, 3, 6, 9 and 12 kg.
3) The emission parameters are also found for Diesel and blends of Palm Oil Methyl Ester- diesel for various loads (kg) 0, 3, 6, 9 and 12.
4) By comparing the above parameters the final conclusion will be drawn.

II. EXPERIMENTAL SETUP

The performance and emission tests were carried out on four stroke single cylinder direct injection water cooled Diesel engine. Load is varied with Eddy current type dynamometer. The specification of test rig are mentioned in Table No. 2. The engine used was a modified Variable Compression Ratio engine. The operating compression ratio used is 18.

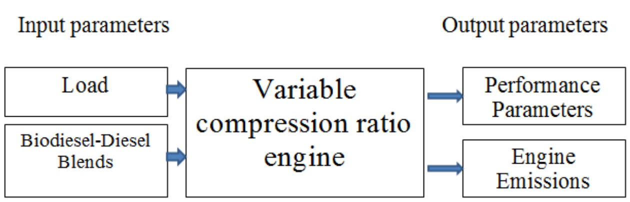

Fig.2.1 Experimental Setup [10]

Make and Model	Kirloskar Oil Engine, TVI
Type	4-stroke single cylinder, water cooled.
Bore and stroke	80mm and 110mm
Compression ratio	18:1; adjustable range 12-18
Maximum speed	2000 rpm
Exhaust Gas Analyzer Make	Indus Scientific Pvt. Ltd.
Software	Enginesoft LVI Engine performance analysis software
Measurable Gases	CO, CO_2, NO_x, SO_x, and HC

Table 1.2 Engine Specification.

The Output parameters like Performance parameters and Engine emission were obtained by varying the load in kg (0, 3, 6, 9, 12) and Blend Percentage of Plam Oil Methyl Ester by volume. The various blends of POME and diesel are used like B10, B20, B30, B40 and B50. The readings which were recorded at a constant compression ratio of 18, injection pressure of 200 bar and injection timing of 27o before Top Dead Centre (BTDC). The gas analyser used was 5- way in nature that can measure NOx, SOx, HC, CO, CO2.

III. PROPOSED METHODOLOGY

The step by step methodology that was followed is given below.

1. Selection of suitable varying compression ratio, single cylinder diesel engine to study the performance, emission and combustion characteristics.

2. Conducting experiments with diesel at various loads and measure the performance and emission characteristics.

3. Conducting experiments with Palm Oil Methyl Ester-Diesel blends at various loads and measure the performance and emission characteristics.

4. Compare the performance and emission characteristics between fuels, Diesel and POME-Diesel blends.

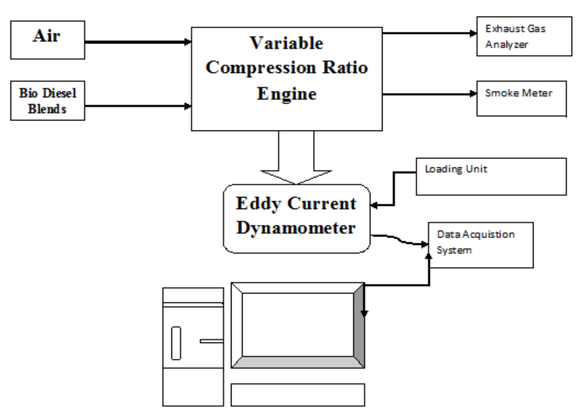

Fig.4.1 Block diagram of Experimental Procedure [10]

IV. SIMULATION/EXPERIMENTAL RESULTS

Effect on Brake Mean Effective pressure:

The below graph is Load applied and Brake Mean Effective Pressure (BMEP). It is observed that the BMEP increases as the load increases. The pressure for diesel is found slight lower than the blends of POEM-diesel. Also found that as the load increases the BMEP also increases. The compression ratio was kept Constant at 18 and the injection pressure was kept to a standard to 200 bars.

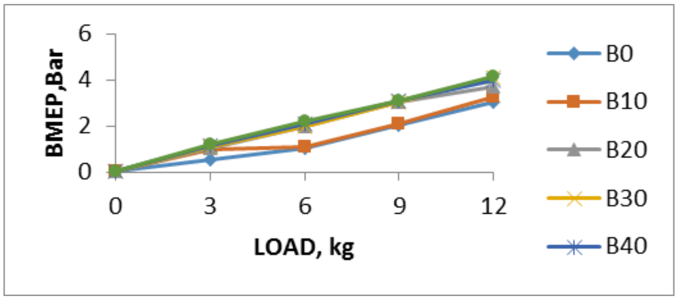

Fig.5.1 Load v/s Brake Mean Effective Pressure

The brake mean effective pressure is a factor of turbulence generated caused by effective combustion leading to higher BMEP. The BMEP has increased by 58% on an average with diesel fuel.

Effect on Brake Specific Fuel Consumption

The graph gives an idea which is useful to get amount of fuel consumed for getting 1kW of brake power. The graph describes that the Diesel is found to give a specific energy output with less quantity of fuel.

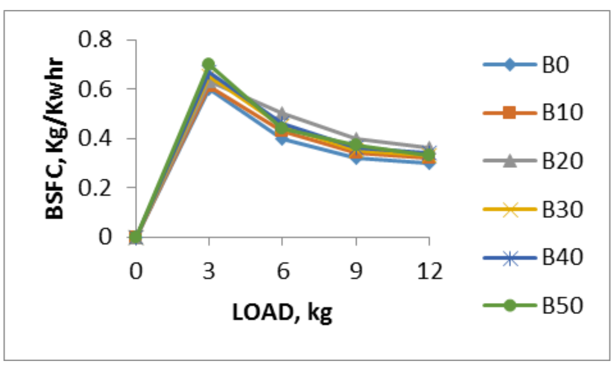

Fig.5.2 Load v/s Brake Specific Fuel Consumption

Also it is found that the Palm Oil Methyl Ester–Diesel blends tend to be on the higher side as the calorific value are lesser when compared with fossil diesel. We can see from the graph that as the load increases the brake specific fuel consumption (BSFC) decreases for the fuels and blends used in the engine. The brake specific fuel consumption of all blends of POEM-diesel is increased by average 16% to that of diesel fuel.

Effect on Brake Power:

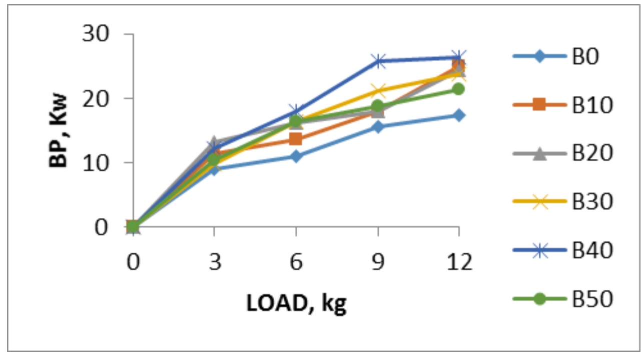

Fig.5.3 Load v/s Brake Power (B.P.)

The above graph is variation of Load v/s Brake Power. In the graph the brake power of diesel fuel is lower than all the blends of Palm Oil Methyl Ester- Diesel biodiesel. The B.P. of all fuel increases as the load increases. The max. B.P. is found for the blend B40. The B.P. for B40 increased by 54% compared to diesel fuel.

Effect on Exhaust Gas Temperature:

The exhaust gas temperature is the remaining heat carried by the exhaust which is left out to the atmosphere. The exhaust gas temperature is increases as the load applied on the shaft increases. It is found that the heat released is proportional to amount of exhaust gas temperature and release of heat to atmosphere means the complete combustion is takes place. All the readings are carried out at constant compression ratio (18) Injection pressure (200 bars), and Injection timing (270 before top dead centre TDC).

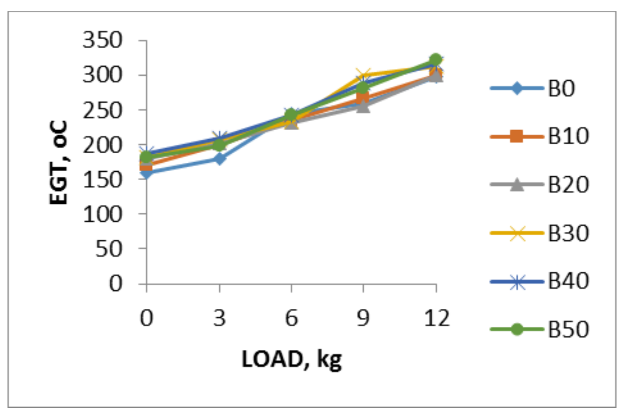

Fig.5.4 Load v/s Exhaust Gas Temperature

The amount of heat carried out by exhaust gas of biodiesel blend is not much differ from heat carried out by exhaust gas of diesel fuel. The heat carried away by B20 blend is increased by 2.2% compared to diesel fuel. The exhaust gas temperature of all blends of POME- Diesel biodiesel is increased by average 6% compared to diesel fuel.

Effect on Carbon Di-oxide emission:

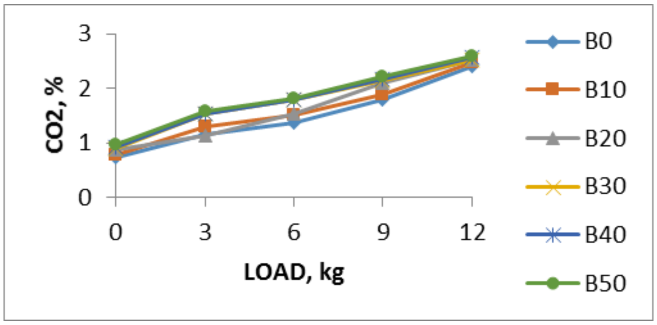

Fig.5.5 Load v/s Carbon di-oxide emission

The above graph plots signifies the load applied and the carbon-dioxide emission. It is observed that as load increases the CO2 emission. The CO2 emission found for fossil diesel is quit lower than blends of POME-Diesel biodiesel. The CO2 emission of biodiesel is increased by average 15% compared to diesel fuel. For B20 CO2 emission increased by 9%. More the CO2 emission, lesser the carbon monoxide emission which means that the combustion is complete and (greener) cleaner.

Effect on Carbon Monoxide emission:

The carbon monoxide (CO) emission gives the idea about the incomplete combustion and the basic two reasons for incomplete combustion either the oxygen is lesser or time available for combustion is lesser. But the plotted graph clears the fact for same injection timing 270 BTDC, the CO emission of Diesel fuel are found to be maximum. The graph also shows that the CO emission of biodiesel blends of palm oil methyl ester-diesel is much lesser than the Diesel fuel.

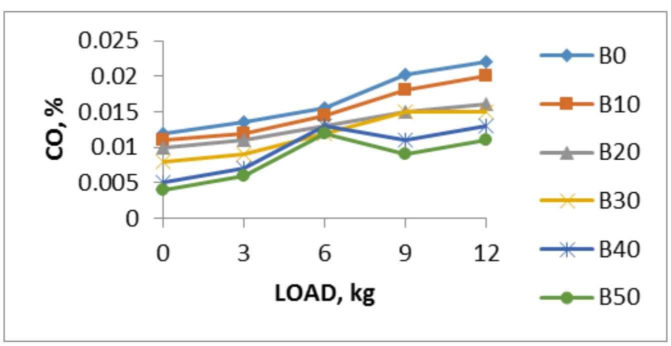

Fig.5.6 Load v/s Carbon mono-oxide emission

The biodiesel blends yields a reduction of 49% lesser than diesel and B20 gives carbon monoxide emission reduction of 22% on an average of all loads. The graph also signifies that as the load increases for a constant speed the fuel consumption also increases and also the CO emission increases.

Effect on Hydrocarbon emission:

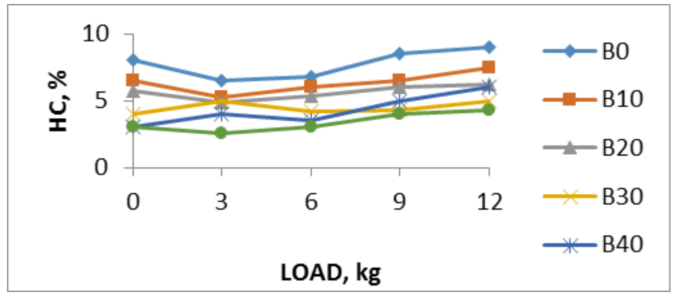

Fig.5.7 Load v/s Hydrocarbon emission

The higher emission of Hydrocarbon gives the idea of the incomplete combustion. The graph explains the fact that as load increases the emission of hydrocarbon also increases. The pure diesel fuels hydrocarbon emission is much more compared to biodiesel blends of POME-Diesel. The B50 blend of biodiesel gives the minimum emission of HC about 56%. The B20 blends HC emission is 27% reduction. The average reduction in HC emission for Biodiesel blends of POME-Diesel is 38%.

Effect on Nitrous Oxide emission:

The graph shows variation of Load v/s Nitrous oxide emission. It shows that as the load increases the NOx emission also increases. The NOx emission of diesel fuel is lower as compared to the all biodiesel blends of POME-Diesel. The relationship of load and NOx emission is linear increasing in manner. NOx emission of B50 increased by 40% and B20 by 23% when compared with fossil diesel.

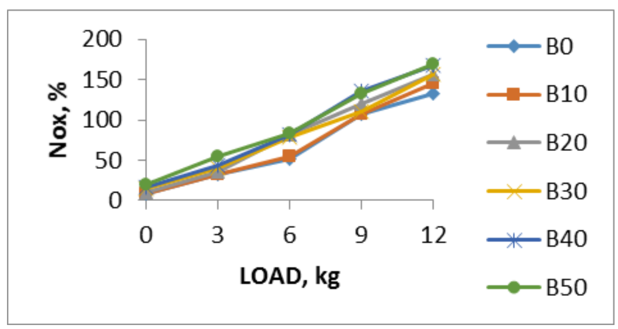

Fig.5.8 Load v/s Nitrous oxide emission

V. CONCLUSION

The Palm Oil Methyl Ester used in diesel engine at compression ratio 18 and at 200 bars injection pressure. The experimental analysis proved that the HC and CO emission lowers but the NOx emission were quiet high when compared to fossil diesel. The BSFC and the Brake Power was found better than diesel fuel. The exhaust gas temperature of all blends of Palm oil methyl ester-diesel were found increased by average 6% compared with diesel fuel. Also the Brake Mean Effective Pressure recorded for Palm Oil Biodiesel increased by 58%.

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