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Performance Evaluation and Testing Of CI Engine with Bio-Diesel Blended with Coconut Oil

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***Abstract* - Need of a suitable sustainable fuel for existing internal combustion engines is being desperately felt these days, when petroleum reserves are soon going to vanish from the surface of earth. Biodiesel proposes one such option with its suitability as a replacement fuel for existing compression ignition engines, this paper presents the use of coconut biodiesel blend inside the 4-stroke CI engine and the performance curve in various parameters.**

***Keywords* -** Bio-diesel blend, thermal efficiency, performance parameters

I. INTRODUCTION

Biodiesel is made through a chemical process called transesterification whereby the glycerine is separated from the fat or vegetable oil. The process leaves behind two products-methyl esters (the chemical name for biodiesel) and glycerine (a valuable by product usually sold to be used in soaps and other products .Biodiesel is better for the environment because it is made from renewable resources and has lower emission compared to petroleum diesel.

The transesterification is achieved with monohydric alcohols like methanol and ethanol in the presence of an alkali catalyst. Biodiesel and its blends with petroleum-based diesel fuel can be used in diesel engines without any significant modifications to the engines. The advantages of biodiesel are that it displaces petroleum thereby reducing global warming gas emissions, tail pipe particulate matter, hydrocarbons, carbon monoxide, and other air toxics. Biodiesel improves lubricity and reduces premature wearing of fuel pumps.

II. METHODOLOGY

Feed stocks for production of biodiesels are vegetable oils (soybean, canola, palm, and rapeseed), animal fats (beef, tallow, lard, poultry fat, fish oils) or recycled grease (mix of the above two). All of the above feed stocks contain triglycerides, free fatty acids (FFAs) and other contaminants. The proportions vary in level depending on the feedstock and these variables affect the chemical reactions needed to transform the primary raw materials (feedstock and alcohol) to create the biodiesels. In order to form the biodiesel, a primary alcohol is coupled with the feedstock to form the esters. The most common alcohol is methanol but ethanol, iso-propanol and butyl (derived from butane) can also be used. The key quality parameter associated with the 16 process of transesterification is the water content. If the water content is high, it results in low yields, high levels of soap, and leftover FFAs/triglycerides.

III. RESULTS AND ANALYSIS

The properties of the methyl ester derived from coconut biodiesel and diesel has been determined and summarized in table given below:

PROPERTIES	COCONUT BIODIESEL	Diesel
Density at 15ºC (kg/L)	0.8830	0.8450
Viscosity at 40C (mm2/s)	2.656	3.0
Cetane Index	70	54.2
Flash Point (°C)	107	85
Pour Point (°C)	-11	-10
Carbon Residue (wt %)	0.18	0.17

Table 3.1 Properties of coconut biodiesel

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IV. Bio Diesel As a Fuel Additive

Biodiesel can also be used as a diesel fuel additive for the purpose of keeping the injectors, pumps and their combustion components clean. A 1-2% blend should be sufficient for this purpose.

FUEL PROPERTY	COCO NUT BIO-DIESEL
Fuel Standard	ASTM PS 121
Fuel Composition	C12-C22 FAME
Lowering Heating Value, BTU/LB	120.910
Kinetic Viscosity at 40°C	1.9-6.0
Specific Gravity, kg/L at 60°F	0.80-0.88
Density, lb/gal at 15°C	7.328
Water, ppm by wt	0.05 % max.
Carbon, wt %	77
Hydrogen, wt %	12
Oxygen by difference wt%	11
Sulphur wt %	0
Boiling Point, °C	182-338
Flash Point, °C	100-170
Cloud Point, °C	-3 to 12
Pour Point, °C	-15 to 16
Cetane Number	48-60

Table 3.2 Comparison of pure diesel with bio diesel

V. Engine Performance With Biodiesel

Many studies were conducted to study the performance (Engine performance is an indication of the degree of success with which
it is doing its assigned job i.e. the conversion of the chemical energy contained in the fuel into the useful mechanical work) of an engine with alternate fuels. Blended fuels and compare this performance with performance of engine working with neat fuel. Study of performance is done on the basis of some basic performance parameters they are following. Power and Mechanical Efficiency. Mean Effective pressure and Torque Specific Output, Volumetric Efficiency, Fuel-Air ratio, Specific fuel consumption Thermal Efficiency and Heat Balance Exhaust Smoke and other emission parameter. It is already illustrated that the alternate fuels are being used in day to day use of a common man so it is desperately needed to analyze the effect of a competent alternate fuel like biodiesel on performance of and engine with following performance parameters.

1. Power and Mechanical Efficiency
2. Mean Effective pressure and Torque
3. Specific Output
4. Volumetric Efficiency
5. Fuel- Air ratio
6. Specific fuel consumption
7. Thermal Efficiency and Heat Balance
8. Exhaust Smoke and other emission
9. Specific Weight

Though many workers have conducted performance tests with different biodiesel fuels like Peanut oil , Palm oil Rapeseed oil ,Sunflower oil ,Soya bean oil ,Cotton seed oil, Linseed oil, Caster oil etc .A brief literature survey will be presented.

A naturally aspirated direct injection diesel engine is more sensitive to fuel quality [4]. The main problem of using waste coconut oil in unmodified form in diesel engine is its high viscosity. It is necessary to reduce the fuel viscosity before injecting it in the engine. High viscosity coconut oil can be reduced by heating the oil using waste heat of exhaust gases from the engine and also blending the coconut oil with diesel [3].

Viscosity of waste vegetable oil and diesel was measured at different temperatures to find the effect of temperature on viscosity. A single cylinder, four stroke, constant speed, water cooled, direct injection diesel engine was procured for the experiments. The technical specifications of the engines are given in Power-star make electric dynamometer was used to measure torque or brake power. It consisted of an alternator to which electric bulbs were connected to apply load. The main components of the experimental setup are two fuel tanks (coconut Diesel blend), heat exchanger, exhaust gas line, and performance and emissions measurement equipment. The engine is started with diesel and once the engine warms up, it is switched over to coconut oil-Diesel

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blend. After concluding the tests with coconut blend, the engine is again switched back to diesel before stopping the engine until the Coconut-Diesel blend is purged from the fuel line, injection pump and injector in order to prevent deposits and cold starting problems. A heat exchanger was designed to preheat the blend using waste heat of the exhaust gases. The temperature of the blend was maintained within the required range by providing a by-pass valve in exhaust gas line before the heat exchanger. A thermocouple was provided in the exhaust line to measure the temperature of the exhaust gases. Exhaust smoke was measured with the help of 'Envirotech APM 700 Smoke meter.

VI. TEST PARAMETERS

These are to be entered every time engine testing has to be done. First load is selected and set then its results like temperature, fuel consumption ration, RPM etc for corresponding load to be entered Manually/Automatically.

PARAMETER DESCRIPTION

Fuel Consumption Rate

Air Intake Velocity

Load

Mean Efficiency Pressure

Actual Speed

Temperature Of water Inlet to Calorimeter

Temp. Of water Outlet From Calorimeter

Gas Inlet Temperature to Calorimeter

TECHNICAL SPECIFICATION OF ENGINE

MAKE: Kirloskar Oil Engine, Pune.

MODEL:- SV

TYPE: Vertical, Totally Enclosed, Compression Ignition Four Stroke Cycle, Water cooled engine.

NO. Of CYLINDER: ONE

BORE: 87.5 mm

STROKE: 110 mm

CUBIC CAPACITY: 662 CC

COMPRESSION RATIO:- 16.5**:** 1

RPM: 1800

RATE OF OUTPUT: 8 HP

VII. GRAPHICAL REPRESENTATION

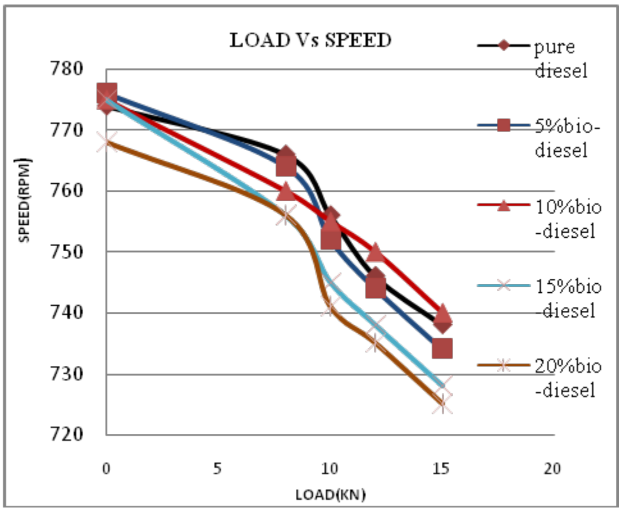

Fig. 7.1 Variation of speed with load for pure diesel and diesel blends with biodiesel

In Fig. 7.1 speed is plotted against the load for neat diesel and blends of bio-diesel speed decreases as load increases. In the beginning speed is nearly same for neat diesel and for blends at all loads, and have lowest value at 20% blend of bio-diesel.

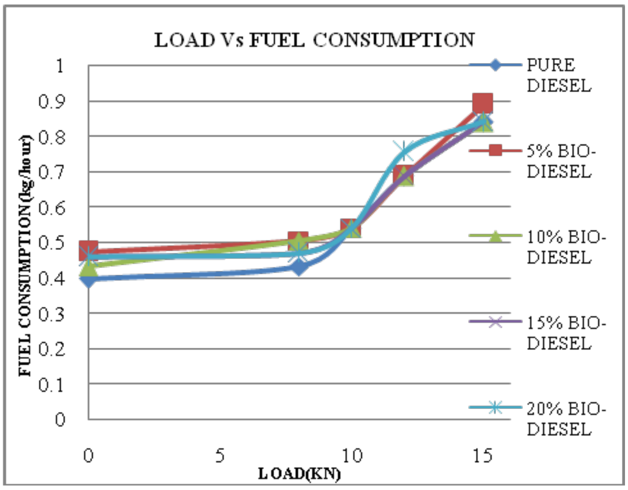

Fig. 7.2 Variation of fuel consumption with load for pure diesel and diesel blends with biodiesel

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Fig. 7.2 fuel consumption verses load is plotted for neat diesel and blends of bio-diesel, fuel consumption increases as load increases. In the graph fuel consumption is nearly same for neat diesel and blended diesel and has low value at all loads. At 12 kg of load for 20% blended of bio-diesel have 10% more fuel consumption as observed in comparison to neat diesel.

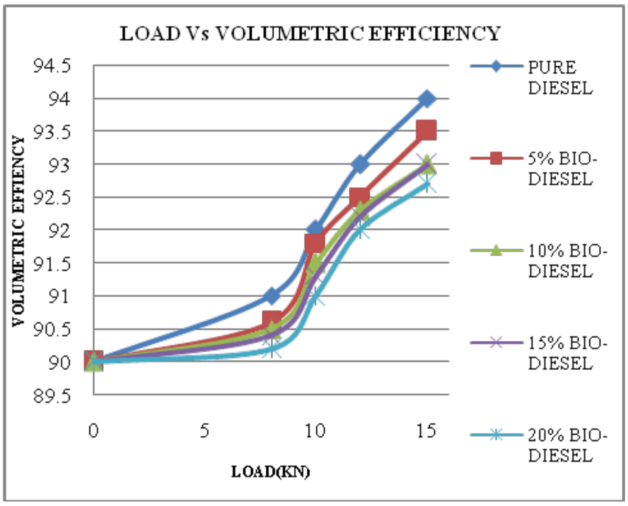

Fig. 7.3 Variation of volumetric efficiency with load for pure diesel and diesel blends with biodiesel

Fig. 7.3 air fuel ratio is plotted against the load for neat diesel and blends of bio-diesel, air fuel ratio decreases as load increases. In the graph air fuel ratio is nearly same for neat diesel and blended diesel at all loads and air fuel ratio for 20% bio-diesel blend have 13% lower value than neat diesel at 12 kg load, and neat diesel have greater air fuel ratio than blended biodiesel at all loads.

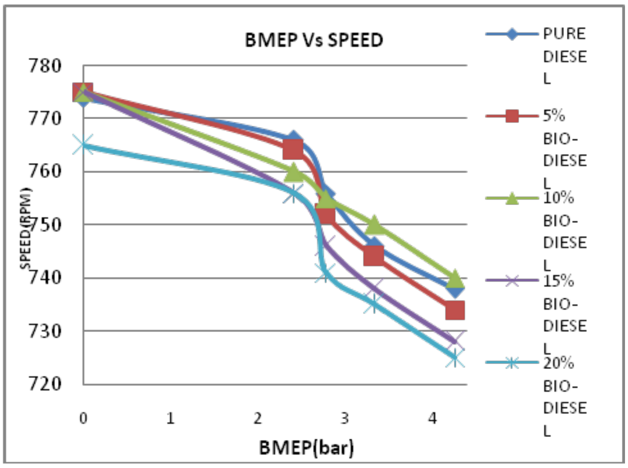

Fig. 7.4 Variation of speed with BMEP for pure diesel and diesel blends with biodiesel

Fig. 7.4 fuel consumption verses BMEP is plotted for neat diesel and blends of bio-diesel and fuel consumption increases as BMEP increases. In the graph fuel consumption is nearly same for neat diesel and for blends at all BMEP and have lowest value at all BMEP for neat diesel

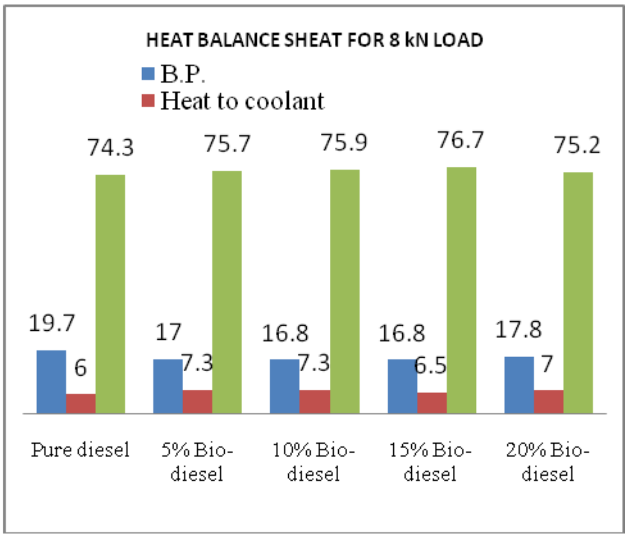

Fig. 7.5 Heat balance sheet for 8 kN Load

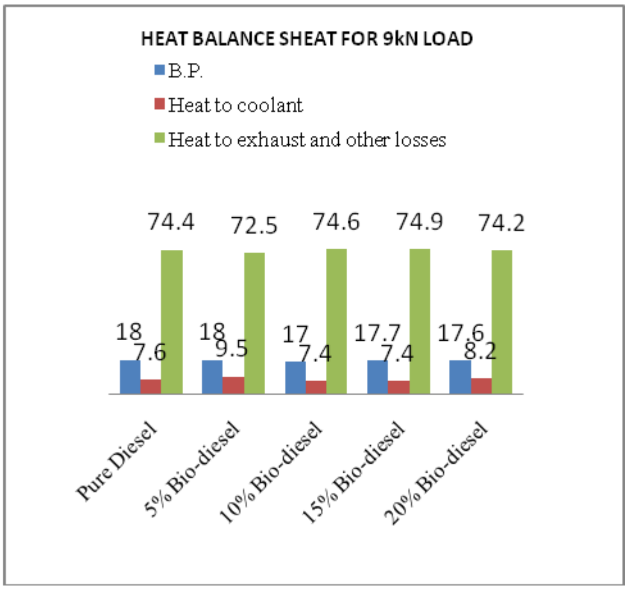

Fig. 7.6 Heat balance sheet for 9 kN Load

VIII. CONCLUSION

On the basis of the analysis of graphical plots following conclusions can be drawn-

1. In the beginning for smaller values of Brake Power and Load blended biodiesel consumption

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is higher than the neat diesel consumption which narrows down with higher values of brake power and load.

2. BSFC values for smaller load is higher for blended bio-diesel and this gap reduces later for higher value of load.

3. Brake power for neat diesel have higher values than blended bio-diesel at all loads and difference of brake power between neat diesel and blended bio-diesel decreases as load increases and brake power is minimum for 20% blend.

4. Brakes thermal efficiency is higher for neat diesels at all loads and lower for 20% blends of biodiesel and difference of brake thermal efficiency between neat diesel and blended bio-diesel decreases as load increases.

5. Volumetric efficiency variation with load is nearly same for these fuels. Volumetric Efficiency values are found always lower for blended biodiesel fuel for all the loads.

6. Air fuel ratio is higher for blended bio-diesel and increases as percentage of bio-diesel increases. Air fuel ratio decreases with increase of load.

7. Fuel consumption is nearly same for neat diesel and blended diesel at all BMEP and have lower value at all BMEP for neat diesel.

8. BSFC Values for smaller values of BMEP where much higher for biodiesel blends, this gap reduces later for higher values of BMEP.

9. Brake power with diesel fuel for all values of BMEP is found higher than that of blended biodiesel and nearly same for 5% blend of bio-diesel.

10. Brake thermal efficiency is higher for neat diesel at all BMEP and lower for 20% blend and the difference decreases as the load increases and brake power decreases to minimum.

11. Volumetric efficiency variation with BMEP is nearly same for these fuels. Volumetric Efficiency values are found always lower with blended biodiesel fuel for all BMEP.

12. Air fuel ratio is higher for blended bio-diesel and increases as percentage of bio-diesel increases. Air fuel ratio decreases with increase of BMEP.

13. Up to 20% blended biodiesel can substitute mineral diesel without any modification in the engine. Hence, these lean blends of biodiesel may be considered as diesel fuel substitutes.

IX. Future Scope Of Work

1. Analysis of composition of exhaust emission can be done with prolonged service with neat bio-diesel.

2. Performance of engine can be compared for various blends of biodiesel with neat diesel. Present study is focused only to blend biodiesel fuels.

3. By computation analysis performance parameters can be extrapolated and compared with experimental results.

4. Performance can be measured after with preheating fuels and/or mixing additives in them.

5. Design changes can be studies and can be proposed after studying the problems encountered after prolonged service of engines with these alternate fuels.

6. Emission studies can also be done.

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