Performance and Analysis of 4 – Stroke Diesel Engine Using Bio-Diesel

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Abstract- **Energy is a basic requirement for economic development. Rising prices of oil and gas and potential shortage in future lead to concern about the security of energy supply needed to sustain our economic growth. Increased use of fossil fuels also causes environmental problems. In view of fast depletion of fossil fuels, the search for alternative fuels has become inevitable, looking at huge demand of diesel in various sectors, the biodiesel is being viewed a substitute of diesel. The vegetable oils, fats, grease are the source of feed stocks for the production of biodiesel. Biodiesel is an engine fuel that is created by chemically reacting fatty acids and alcohol. This usually means combining vegetable oil with methanol in the presence of a catalyst (usually sodium hydroxide).Biodiesel is much more suitable for use as an engine fuel than straight vegetable oil for a number of reasons. The aim of the present project is to focus on the impact analysis of biodiesel on engine performance.**

I. INTRODUCTION

In the scenario of increase of vehicle population at an alarming rate due to advancement of civilization, use of diesel fuel in not only transport sector but also in agriculture sector leading to fast depletion of diesel fuels and increase of pollution levels with these fuels, efficient fuel utilization has become pertinent for the engine manufacturers, users and researchers involved in the combustion research. The world is on the brink of an energy crisis. The limited fossil fuel resources are unable to provide for the continuously increasing demand for energy. This, associated with increasing price of fossil fuel and the awareness of the impacts of environmental pollution and global warming, has forced a search for an alternative source of energy, which is renewable, safe and non-polluting. Since compression ignition (CI) engines are more widely used compared to spark ignition (SI) engines, greater attention is being devoted to develop an alternative source of fuel for the same. Since vegetable oils satisfy the major requirements, necessary for a diesel engine fuel, their suitability as alternative to diesel fuel has been a topic of active research. However, their higher viscosity and storage ability issues restrict their direct use as alternate fuels. Trans esterification is the method to reduce the viscosity of vegetable oil. In the present work, rice bran oil (RBO) is used for production of biodiesel. RBO is extracted from the rice bran, which is a by-product obtained during the grinding of paddy. Since rice is the staple food in a large part of India, there is a huge potential to produce and utilize RBO. Though India is the second largest producer of paddy, hardly 50% of the bran is utilized for producing RBO and only 19% of edible grade RBO is consumed as a cooking media. It is well known fact that about 30% of the energy supplied is lost through the coolant and the 30% is wasted through friction and other losses, thus leaving only 30% of energy utilization for useful purposes.

II. CONCEPT OF BIODIESEL BLENDING

Blends of biodiesel and conventional hydrocarbon-based diesel are produced by mixing biodiesel and petroleum diesel in suitable proportions under appropriate conditions. Much of the world uses a

system known as the "B" factor to state the amount of biodiesel in any fuel mix where,
A. 100% biodiesel is referred to as B100,
B. 20%biodiesel, 80% diesel is labelled B20
C. 5% biodiesel, 95% diesel is labelled B5
D. 2% biodiesel, 98% diesel is labelled B2.

III. EXPERIMENTAL SETUP

A. ENGINE: Engine used here is a Diesel engine which is used to convert chemical energy of Biodiesel Blend into mechanical work .

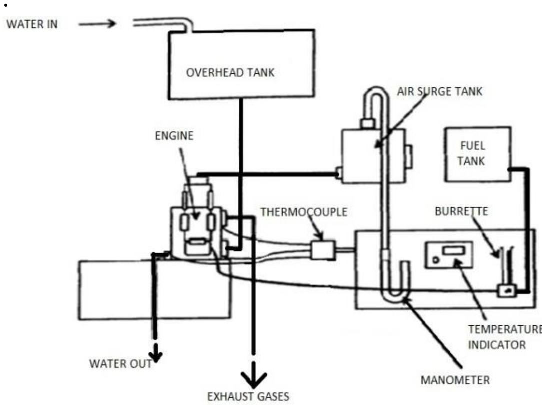

Fig.1 Schematic Diagram of Experimental setup.

B. Thermocouple: - Thermocouple is a device which is used to measure the temperature of the engine.
C. Temperature indicator: It is a device which is connected directly to the thermocouple, and it displays the temperature measured by the thermocouples.
D. Burette: Burette is used for fuel intake measurement. It is attached to the fuel tank so the fuel from the fuel tank enter into the burette and from there to the engine for combustion

IV. PROPERTIES OF BIODIESEL AND ITS BLENDS

A. B100: B100 is 100% biodiesel. It has a solvent effect and it can clean a vehicle's fuel system and release deposits accumulated from previous petroleum diesel use. The release of these deposits may initially clog filters and require filter replacement. It may require special handling and equipment modifications. To avoid engine operational problems, B100 must meet the requirements of ASTM D6751, Standard Specification for Biodiesel Fuel (B100). B100 use could also increase nitrogen oxides emissions, although it greatly reduces other toxic emissions.

Test Parameter (B100)	Result
Calorific Value, Kcal/Kg	8430
Kinematic Viscosity @ 27 °C, mm^2/s	15.0
Density @ 25 °C, $gm./cm^3$	0.832
Ash Content, %w/w	0.02
Carbon Residue, %w/w	9.9
Sulphur Content, ppm	30
Flash Point, °C	111
Water Content, %w/v	0.45

Table 1 Properties of 100% Rice bran biodiesel (B100)

B. B20: B20 (20% biodiesel, 80% petroleum diesel) is the most common biodiesel blend. B20 is popular because it represents a good balance of cost, emissions, cold-weather performance, materials compatibility, and ability to act as a solvent. Using B20 provides substantial benefits and avoids many of the cold-weather performance and material compatibility concerns associated with B100. Biodiesel contains about 8% less energy per gallon than petroleum diesel. For B20, this could mean a 1% to 2% difference, but most B20 users report no noticeable difference in performance or fuel economy.

Test Parameter (B20)	Result
Calorific Value, Kcal/Kg	9606
Kinematic Viscosity @ 27 °C, mm^2/s	4.0
Density @ 25 °C, $gm./cm^3$	0.814
Ash Content, %w/w	0.009
Carbon Residue, %w/w	1.5
Sulphur Content, ppm	7
Flash Point, °C	69
Water Content, %w/v	0.09

Table 2 Properties of 20% Rice bran biodiesel + 80% diesel fuel (B20).

C. B5: A B5 blend is 5% biodiesel and 95% petroleum based diesel. It is one of the most common blends associated with biodiesel because of the use of a B5 blend in state or municipal mandates. Most major engine manufactures have approved of the use of a B5 blend in their engines. The American Standard for Testing and Materials (ASTM) which sets the international standards for diesel fuel has revised its statements so that a B5 blend is treated the same as conventional diesel ASTM D975-08a, Specification for Diesel Fuel Oils, revised to allow for up to 5 % biodiesel content. This allows B5 blends to be treated the same as conventional diesel for testing purposes.

*D.*100% Diesel:

Test Parameter (100% Diesel)	Result
Calorific Value, Kcal/Kg	9957
Kinematic Viscosity @ 27 °C, mm^2/s	3.6
Density @ 25 °C, gm./cm^3	0.820
Ash Content, %w/w	0.002
Carbon Residue, %w/w	0.20
Sulphur Content, ppm	30
Flash Point, °C	55
Water Content, %w/v	0.01

Table 3 Properties of 100% Diesel fuel.

V. MATHEMATICAL FORMULAS

A. Brake Power:

The horsepower available at the crankshaft (for onward transmission to drive the vehicle) is called brake horsepower. Rating of automotive engine is done in term of bhp. Brake horsepower can be measured by a dynamometer.

$$\text{Load on dynamometer} = \frac{V \times I}{1000}\ \text{KW}$$

Where, V= Voltmeter

I= Current in Amp.

Assuming dynamometer efficiency 70% brake power of the engine.

$$B.P. = \frac{\text{Load on dynamometer}}{0.7}\ \text{KW}$$

B. Fuel Consumption:

$$F.C. = \frac{50 \times 3600 \times \rho}{t_f \times 1000}\ \text{kg/hr.}$$

Where, $f_{t.}$ = Time required for 50 ml fuel (sec.)

ρ = Density of diesel, gm./cm^3

C. Specific Fuel Consumption:

$$SFC = \frac{F.C.}{B.P}\ \text{kg/KWhr}$$

D. Mechanical efficiency:

Mechanical efficiency relates the power produced inside the cylinder and the power actually available at crankshaft.

$$\eta_{mech.} = \frac{B.P.}{I.P.} \times 100$$

E. Brake thermal efficiency: Thermal efficiency of an engine is determine from the relation between heat equivalent of power output and the heat energy of fuel burned to produce this power. It is obtained from

$$\eta_{bth} = \frac{\text{Heat equivalent to power output per unit time}}{\text{Heat energy supplied by fuel per unit time}}$$

As the power output may be indicated power or brake power, therefore thermal efficiency may be expressed as indicated thermal efficiency or brake thermal efficiency.

$$\eta_{bth} = \frac{3600}{m_{fb} \times C.V}$$

Where, m_{fb}= Brake specific fuel consumption (BSFC) in kg/KW.hr.

F. Indicated thermal efficiency:

$$\eta_{ith} = \frac{3600}{m_i \times C.V}$$

Where,

m_i = Indicated specific fuel consumption

$$= \frac{\text{Fuel consumption}}{I.P.}$$

VI. CONCLUSION

The performance characteristics of conventional diesel and rice bran oil biodiesel blends were investigated on a single cylinder diesel engine. The conclusions of this investigation are as follows.

A. The brake thermal efficiency of rice bran oil biodiesel blend is lower than diesel fuel .The brake thermal efficiency of B20 is near to the diesel fuel.

B. Fuel consumption is increased with blending percentage increased in the engine. The fuel consumption of rice bran biodiesel blends are higher than that of the conventional diesel fuel over the entire range of the brake power. Fuel consumption was increased 10-20 % with blending percentage increased with brake power.

C. HC emissions decreased with rice bran biodiesel percentage increased. HC emissions of B100 blends were lower than all fuel modes.

D. CO emissions of the rice bran biodiesel blends were lower than that of diesel fuel. The minimum Co emissions were observed with the B100 blend well below the diesel fuel.

E. The NOx emissions of the rice bran biodiesel blends were low at lower loads and high at higher loads compared with the diesel fuel. B100 blends were observed less NOx as compared to all fuel modes

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