Performance Analysis of Single Cylinder 4- Stroke Diesel Engine Using Diesel and Waste Cooking Oil Blend

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Abstract- *Biodiesel has become more attractive recently because it is made from renewable resources as well as it achieved desired emission standards. Waste cooking oil (WCO) disposal is also a problem because it cannot reuse for cooking, which causes undesirable affect on human health. The processing cost of biodiesel is the main issue to commercialization of the product. The production of biodiesel from waste vegetable oil offers significant benefits on economic aspect, environmental aspect and waste management of cooking oil. From an economic point of view; the production of biodiesel is very easy and simplified process. The study focuses on comparison performance parameters of diesel and waste cooking oil biodiesel on single cylinder engine, such technique is fuel blending. This paper investigated the performance parameters of waste cooking oil blends with diesel on a stationary single cylinder, four stroke compression ignition engine. The blends of 10B (combination of Diesel 90% by volume, Biodiesel 10% by volume) gave better brake thermal efficiency, lower total fuel consumption and lower brake specific fuel consumption other than blends (5B, 15B to 30B).*

Keywords- Diesel engine, waste cooking oil, Biodiesel, Performance parameters, Specific gravity, Calorific value.

I. INTRODUCTION

The depletion of world petroleum sources and increased environmental concerns has stimulated recent interest in alternative sources for petroleum based fuels. Biodiesel produced from vegetable oil or animal fats by transesterification with alcohol like methanol and ethanol is recommended for use as a substitute for petroleum-based diesel mainly because biodiesel is an oxygenated, renewable, biodegradable and environmentally friendly bio-fuel with similar flow performance and low emission profile. The used cooking oil has been classified as waste, while its potential as a liquid fuel through physical and chemical conversion remains highly interesting. It is increasingly attracting much interest because of its great potential to be used as a diesel substitute known as biodiesel. Direct process via transesterification of cooking oils will give biodiesel. One of the advantages of these fuels is reduced exhaust gas emissions. Experience has shown that vegetable oil based fuels can significantly reduce exhaust gas emissions, including carbon monoxide (CO), carbon dioxide (CO_2), and particulate matter (PM).

Because of their less concentration of sulfur, the sulfur dioxide greases cannot only reduce the burden of the government in disposing the waste, maintaining public sewers and treating the oily wastewater, but also helps in lowering the production cost of biodiesel significantly. Furthermore, biodiesel fuel has been shown to be successfully produced from waste cooking oils by an alkali-catalyzed transesterification process and can be considered as alternative fuel in diesel engines and other utilities. There is need to convert waste cooking oil from kitchen waste into biodiesel and transesterification is the most suitable process for this conversion. Present study is carried out to investigate performance and emission characteristics of blended waste cooking oil methyl esters with mineral diesel in different compositions.[2]

II. AIM AND OBJECTIVES

The aim of the present study is to production of biodiesel from waste cooking oil and evaluation of performance test of different blends of biodiesel with diesel in a CI engine. The following are the major objectives to fulfil the aim of present study.

1. Extraction of biodiesel oils by Waste cooking oil through transesterification process.
2. Performance evaluation of CI engine using different blends of Waste cooking oil biodiesel and diesel.

III. EXPERIMENTAL WORK

3.1 ABOUT THE TEST RIG:-

Engine-The engine is water cooled single cylinder four stroke constant speed diesel engine 5 HP Make Kirloskar.

Figure 1: Engine

Rope Brake Dynamometer-A rope brake dynamometer is supplied with the engine coupled with the flywheel of engine.

M.S. Base Frame-The engine and the dynamometer are mounted on a solid M.S. Channel Base Frame.

Load indicator-It indicates the load in kg range 0-20 kg Make Harrison.

Instrumentation for measuring various inputs/outputs- All instrumentation is incorporated on a control panel. The various factors to be measured are as follows:

- **Fuel measurement**: This is done by using burette which is mounted on the control panel. The fuel tank is mounted on panel. The fuel is supplied to engine using a fuel line to fuel injection system. The amount of fuel consumed is determined by the change in the readings shown on the burette. A three –way cock is used both to fill the burette and to allow the fuel to flow to the engine.
- **Air flow measurement:** Air flow is measured using an air box Orifice is fixed in the inlet of air box suction pressure difference across the orifice is read on the U-tube manometer mounted on the panel. The outlet of the air suction box goes to the engine through the flexible hose for air suction.
- **Temperature measurement:** For heat balance analysis the PT-100 sensors are connected at exhaust gas calorimeter and engine cooling.

Table 1: Engine Specifications

1	Items	Specifications
1	Model	KIRLOSKAR, AV1
2	Compression ratio	19:1
3	Method of starting	Hand starting
4	Type, no. of cylinders	Vertical – 4 stroke, 1 cylinder
5	Bore x stroke(mm)	87.5x110
6	Cubic capacity	624
7	Maximum power	5 Hp
8	Nominal speed	1500 rpm
9	Cooling system	Water-cooled
10	Fuel filter	Present
11	Lube oil filter	Present

3.2 MEASUREMENT OF TORQUE, SPEED AND POWER:-

Measurement of speed: Measurement of speed using a shaft encoder with analogue or digital display is in principle quite simple.

Measurement of power: It is the product of torque and speed raises the important question of sampling time. Engines never run totally steadily and the torque transducer and speed signals invariably fluctuate. An instantaneous snaps reading will not necessarily, or even probably, be identical with a longer – term average. Choice of sampling time and of the number of samples to be averaged is a matter of compromise. Under transient condition there may be no choice but to take snap readings.

Measurement of torque: The great majority of dynamometer use this method of torque measurement, the essential features of which is that the power absorbing (or power producing) elements of the machine is mounted on bearings coaxial with the machine shaft and the torque is measured by some kind of transducer acting tangentially at a known radius from the machine axis. The transducer consists of a combination of dead weights and spring balance.

3.3 MEASUREMENT OF FUEL

Specific fuel consumption and efficiency: In engine tests, the fuel consumption is measured as a flow-mass flow per unit time m. f. A more useful parameter is the specific fuel consumption (sfc) the flue flow rate per unit power output. It measures how efficiency an engine is using the fuel supplied to produce work.

Fuel consumption: Knowledge of the fuel consumed by an engine and the time it takes to consume this fuel is essential when assessing the quantities of the engine. For petrol and oil engines, the fuel is run through a special measuring device. This can take the form of a reservoir of fuel of known quantity, and the time for the engine to consume this measured quantity of fuel is taken. Alternatively, the fuel may flow through a special flow meter, which is calibrated to give the fuel consumed by direct reading.

3.4 EXPERIMENTAL PROCEDURE

- Fill the fuel tank with the fuel.
- Start the cooling water supply to the engine and the calorimeter.
- Fill the burette with the fuel.
- Switch on the control panel.
- Start the engine with cranking handle provided.
- Note down the readings in the observation table.
- Load the engine gradually by providing weights on the loading hanger.
- Note down the reading, for various load.

Figure: 2
Waste cooking oil

Figure:3
Biodiesel formed in Laboratory

Figure 4:
Engine setup

Figure 5:
Heating Mantle

Figure 6:
Tachometer

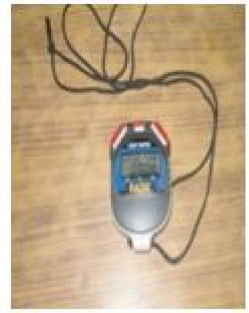

Figure 7:
Stopwatch

3.5 CALCULATION

Brake Power

$$BP = \frac{2\pi \times N \times [(D+d)/2] \times (W-S) \times 9.81}{60000}\ KW$$

The fuel consumption rate is noted for each loading and then brake specific fuel consumption is calculated as,

$$BSFC = \frac{TFC}{BP} \times 3600 \quad \text{kg/kw-hr}$$

The brake thermal efficiency of the engine is calculated as,

$$BTE = \frac{BP}{TFC \times CV} X\ 100$$

Total fuel consumption,

$$TFC = \frac{cc(ml)}{time} \times \frac{(specificgravity)}{1000}\ {}^{kg}/_{sec}$$

IV. RESULTS AND ANALYSIS

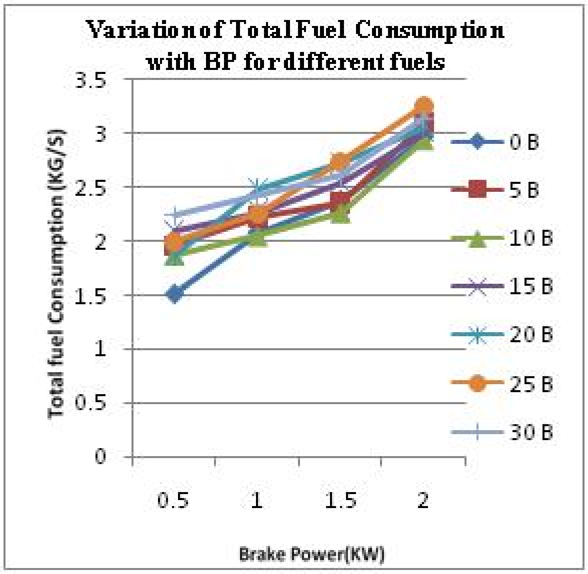

Figure 8: Variation of Total Fuel Consumption with BP for different fuels

FIGURE8, In above graph variation in total fuel consumption with BP for different fuels. It is observed that the value of the total fuel consumption is increased at 5B but decrease at 10B after that total fuel consumption increases from 10B to 30B, We get minimum total fuel consumption at 10B.

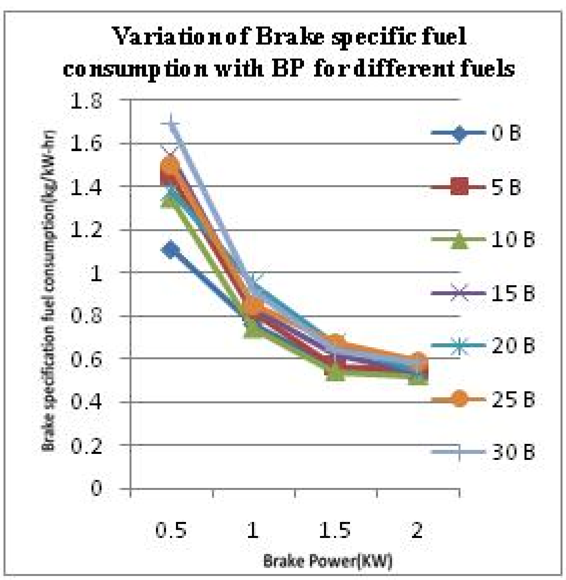

Figure 9: Variation of Brake specific fuel consumption with BP for different fuels

FIGURE 9, In above graph variation in Brake specific fuel consumption with BP for different fuels. It is observed that the value of the Brake specific fuel consumption is increased at 5B but decrease at 10B after that Brake specific fuel consumption increases from 10B to 30B, we get minimum Brake specific fuel consumption at 10B.

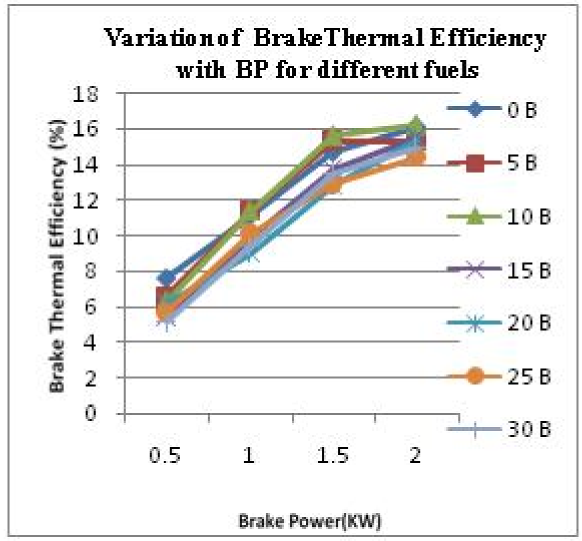

Figure 10: Variation of Brake Thermal Efficiency with BP for different fuels

FIGURE 10, In above graph variation in Brake thermal efficiency with BP for different fuels. It is observed that the value of the Brake thermal efficiency is decreased at 5B but increased at 10B after that Brake thermal efficiency decreases from 10B to 30B, We get maximum total Brake thermal efficiency at 10B.

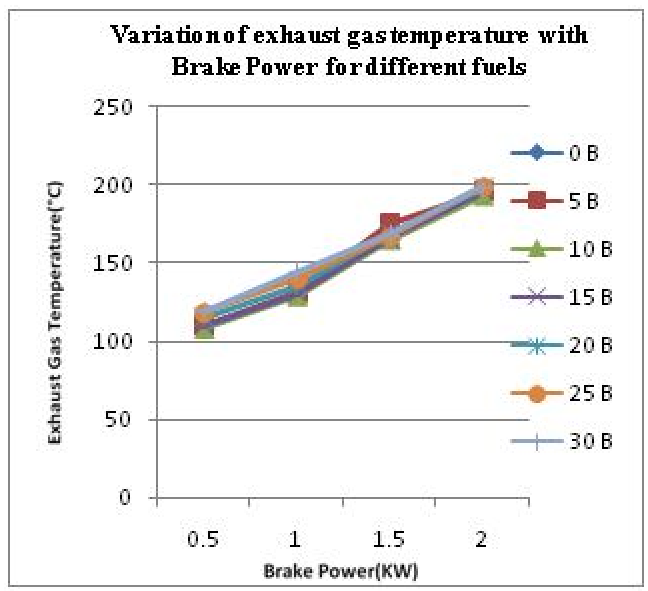

Figure 11: Variation of Exhaust gas temperature with Brake Power for different fuels

FIGURE 11, In above graph variation in exhaust gas temperature with BP for different fuels. It is observed that the value of the exhaust gas temperature is increased at 5B but decrease at 10B after that exhaust gas temperature increases from 10B to 30B, We get minimum exhaust gas temperature at 10B.

Table 13: Performance Analysis for calorific values of different composition of biodiesel

Vegetable oil Blend	Calorific Value (MJ/kg)
Pure Diesel	42.34
5 B	42.17
10 B	42.01
15 B	41.84
20 B	41.67
25 B	41.51
30 B	41.34

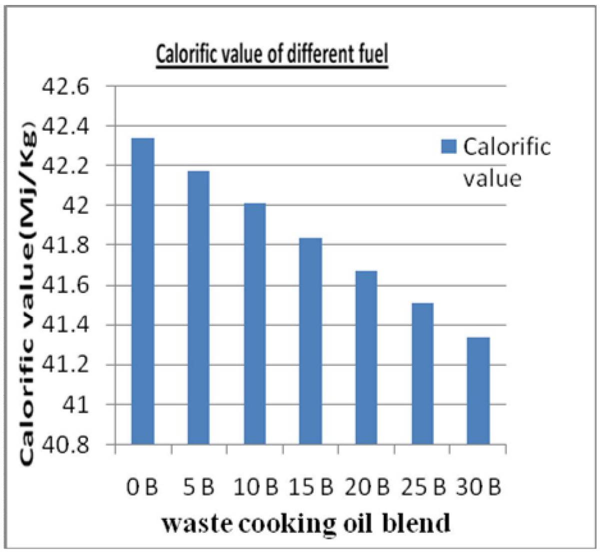

Figure 12: Graphical representation of Calorific values of different fuel

Running cost of engine with different blends

Fuel	Cost (Rs./lr.)
Diesel	66.00
Waste Cooking Oil	70.00
5 B	66.20
10B	66.40
15B	66.60
20B	66.80
25B	67.00
30B	67.20

V. CONCLUSIONS

5.1 CONCLUSIONS

The value of the total fuel consumption and Brake specific fuel consumption are increased at 5B but decrease at 10B after that total fuel consumption and Brake specific fuel consumption increases from 10B to 30 B, We get minimum total fuel consumption and Brake specific fuel consumption at 10B.

The value of the Brake thermal efficiency is decreased at 5B but increased at 10B after that Brake thermal efficiency decreases from 10B to 30 B, We get maximum total Brake thermal efficiency at 10B.
The value of the exhaust gas temperature is increased at 5B but decrease at 10B after that exhaust gas temperature increases from 10B to 30 B. We get minimum exhaust gas temperature at 10B.

In this research work it is observe that the blend of 10B (90% Diesel and 10% Biodiesel) can be used successfully in 4- stroke single cylinder diesel engine without any noticeable degradation in performance and without any alteration or modification in existing compression ignition engine.
The performance of diesel engine by using 10B (90% Diesel and 10% Biodiesel) is found very near to diesel engine.

5.2 FUTURE SCOPE

- Analysis of composition of exhaust emission can be done.
- Combustion Analysis can also be done.
- Thermal analysis of various elements of engine may also be done.

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