Investigation on Performance of 4-Stroke Diesel Engine by Using Waste Cooking Oil Based Biodiesel

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ABSTRACT: There is a rapid increase in the pollution level as the global demand for fossil fuels increases. Burning fossil fuels leads to the release of greenhouse gas and other toxic pollutants into the environment, and that level has reached the limit. For the last few decades, scientists worldwide have been looking for a safe, eco-friendly alternative energy source. One of the prime alternative forms of energy is green bio diesel**.** Biodiesel is analternativefuelthatcanbeuseddirectlyindieselengineaspureorblendedwithdieselfuel. The present work is the production of the biodiesel from utilizing waste cooking oil by using transesterification reaction, methyl alcohol and glycerol as catalyst. Hear tested for different properties (density, viscosity, calorific valve, flash and fire point) for waste cooking oil. The effect of biofuel in the performance characteristics examined in diesel engine. Performance parameters like break power break thermal efficiency, break fuel consumption will be calculated with different blends and exhaust emissions like carbon dioxide, NOx, Sulphur dioxide, smoke and particulate matters.

Key words: Diesel Engine, Bio Diesel, Transesterification, Performance Parameter, Waste Cooking Oil.

1. INTRODUCTION

As the petroleum-based fuel resource are depleting day -by day it is necessary to replace alternative fuels for using in diesel engines. Vegetable oil Vegetable oil esterase receiving increasing attention as nontoxic,biodegradable, and renewable alternative diesel fuel. These esters have become known as biodiesel. Biodiesel contains alkylmonoesters of fatty acids, which are environmentally friendly and obtained through transesterification process of triglycerides.

However, vegetable oil has highviscosityandlowvolatility, which Lead stopoor combustion in diesel engines. Transesterification is the process of removing glycerides and mixing oil esters of vegetable oil with alcohol it the viscosity value, which is comparable with diesel, maintains high heating. Value and increases the cetane number and here by improving performance characteristics with in a diesel engine such as

fuel relative to petroleum diesel fuel.The differences in chemical composition and structure between the fuels manifest such differences in engine processes, which ultimately lead to differences in engine parameters (i.e., combustion,performance and emissions).

- Vegetable oil esters are known as biodiesel.
- Transesterification process to reduce the viscosity of fuel.

- Differences in chemical composition and structure lead to differences in en gine parameters.
- Combustion of biodies el fuel in dieselengines results in lower PM, COand HC emissions while the Brake thermal efficiency is either unaffected or is improved.

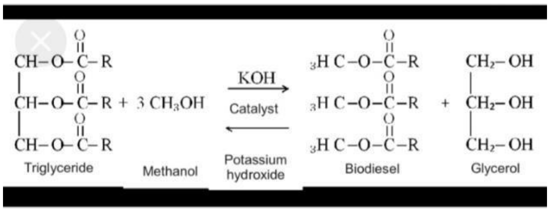

Fig 1: chemical reaction of bio-fuel

Transesterificationreactionforbiodieselp roductionfromwastecookingoilusingcalc iumethoxideas catalyst.

- Transesterification reaction using calcium ethoxide catalyst with methanol at 60 °C for two hoursproduced high yield of biodiesel

Fig2: Redwood viscometer

Fig3: flash and fire point apparatus

2. FUELPREPARATION

Biodiesel is prepared from natural, renewable sources, such as new and used vegetable oils and animal fats, for use in a diesel engine. Itsphysicalpropertiesareverysimilartopet roleum-deriveddieselfuel, whereas its emission properties are superior to that of diesel. It substantially reduces emissions of un burned hydrocarbons, carbon monoxide, Sulfates, polycyclic Matic hydrocarbons, nitrated polycyclic aromatic hydrocarbons, and particular atemitter.

One of the most used renewable energies is biodiesel which is the most common biofuel in Europe. It is produced from oils or fats using transesterification and is a liquid similar in composition to mineral diesel. Its chemical name is fatty acid methyl ester (FAME). In this study, oils are mixed with potassium hydroxide KOH as catalyst and methanol and the chemical reaction produces biodiesel (FAME) and glycerol. One part glycerol is produced for every10partsofbiodiesel.

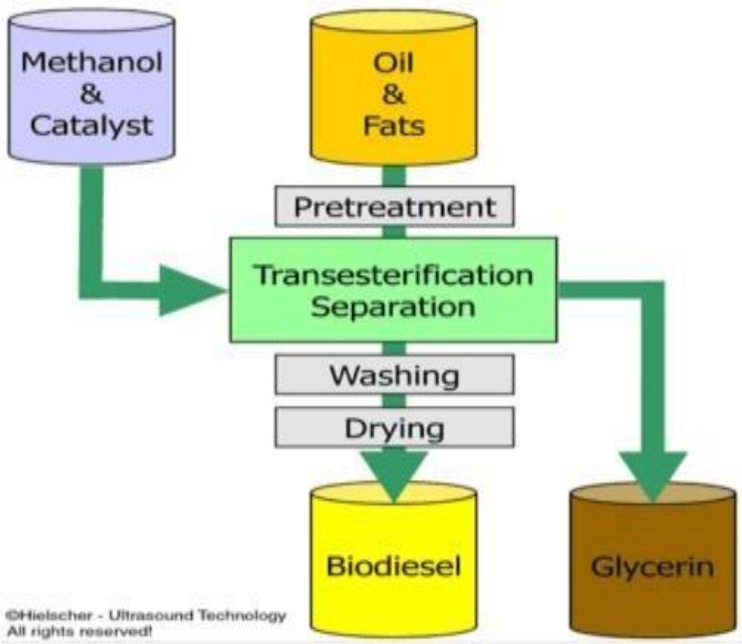

Fig4: preparation of bio-diesel

3. Blends preparation

This pure bio-fuel is mixed with pure diesel in proportion and required blends are obtained. Initially 25% of bio-diesel and 75% of pure diesel (B25) taken in to

Diesel tank and find out the performanceparameters and similarly take the (B50)

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and (B100) and find out the performanceparameters and note down the readings

Table1: properties of bio-fuel

S.No.	Property	Units	Bio-diesel	B 75	B 50	B 25	Diesel
1	Density;15°C	Kg/m^3	860	853.25	846.5	839.75	833
2	Viscosity;40°C	mm^2/S	4.9	4.375	3.85	3.325	2.8
3	Flashpoint	°C	101	91.5	82.5	73	64
4	Cetanenumber	---	51	53	54	56	57

3. EXPERIMENTALSETUP Initially the test rig of diesel engine is in spected for the working specification of engine as shown in Figure. Then the fueltank is made empty and filled with thepure diesel initially. Then load test isheld withvarying loads. Aftercomplete experiment, the fuel tank ismade empty and the newfuel blend B25 is filled into tank and the nthe procedure is repeated and corresponding readings are tabulated.After B25blend fuel,withB50andB75alsoprocedure is Madera peatlandcorresponding values are tabulated.After Experiment using the readingfuel consumption, mechanicalefficiency, brake thermal efficiency,specific fuel consumption, etc., arecalculated by using relevant formulae.

Fig5:4-stroke single cylinder engine dieselengine setup

Fig6: loading and unloading of bio-fuelTable2: speciation of engine

Engine	KirloskarDieselengine
Speed	1500rpm
Numberofcylinders	1
Compressionratio	16.5:1
Orificemeter	20mm
MaximumH.P	5 H. P
Stroke	110mm
Bore	80mm
Type	Water cooled
Methodofloading	Ropebrake

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4. PERFORMANCECALCULATIONS

As a part of performance calculations initially the load is applied on the engine and spring balance reading not down the fuel consumption for 10cc for each loading condition is noted then the important performance characteristics are calculated using the following equations.

4.1. BRAKE POWER

$$BP = \frac{2\pi N(W-S)((D+d)/2)9.81}{60,000} \text{......k. w}$$

Where, N = rpm of the engine,

w = dead weight added to hanger,

S = spring balance reading in kg,

D=diameter of brake drum in m =0.33

d= diameter of rope in m =0.02

4.2. MASS OF FUEL CONSUMED.

$$m_{fc} = \frac{X\times 0.82\times 3600}{1000\times T} \text{......kg/hr}$$

Where, X = burette reading in cc

0.82 = density of diesel in gram / ccT = time taken in seconds.

4.3. SPECIFIC FUEL ONSUMPTION.

$$s_{fc} = \frac{mfc}{BP} \text{.........Kg/KW hr}$$

4.4. ACTUAL VOLUME OF AIR SUCKED IN TO THE CYLINDER.

V_a= Cd×A×$\sqrt{2gH}$×3600……m^3/hrWhere,

H = h* δw/1000* δa ………meter of water.

A = area of orifice = Π d^2/4

h = manometer reading in mm

δw = density of water =1000 kg/m^3 δa = density of air =1.193 kg/ m^3 C_d = co-efficient of discharge = 0.62

4.5. SWEPT VOLUME

$$V = \frac{\pi d^2}{4} \times \frac{L\times N}{2} \times 60$$

Where, d = dia of bore = 80 mmL = length of stroke = 110 mm

N = Speed of the engine in rpm

4.6. BRAKE THERMAL FFICIENCY

$$\eta_{bth} = \frac{BP\times 3600}{m_{fc}\times cv} \times 100 \text{........\%}$$

Where, CV = calorific value of diesel = 42500 KJ / kg,

BP = Brake Power

Frictional torque = mass moment of inertia x angular deceleration

$T_F = I_f \times Ad_1$.........

Frictional power

$$IF = \frac{2\pi NT_f}{60} \text{......}$$

4.7. Indicated power:

I.P = B.P + F.P

4.8. Mechanical efficiency:

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

5. RESULTSANDDISCUSSION

After calculating the performance characteristics analysis done comparison of mechanical efficiency, break thermal efficiency and specific fuel consumption for different samples.

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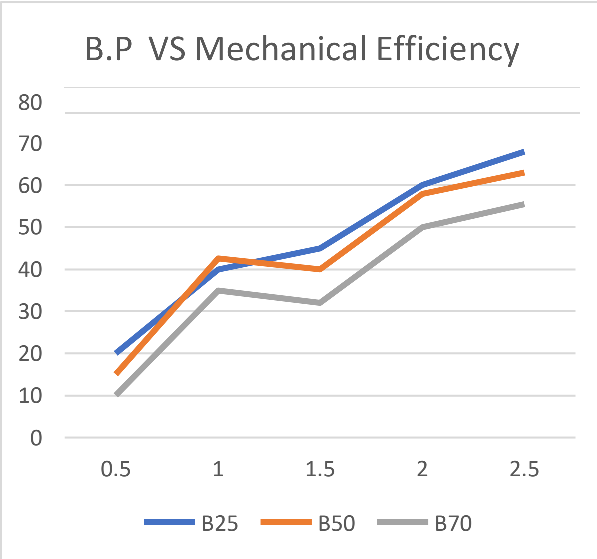
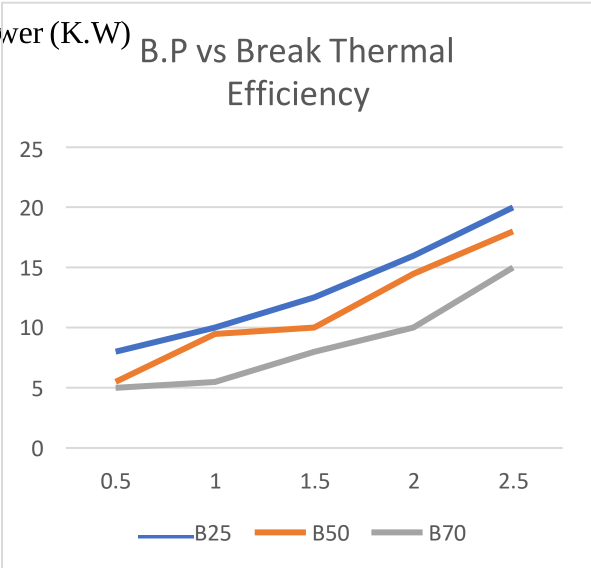
Mechanical efficiency %

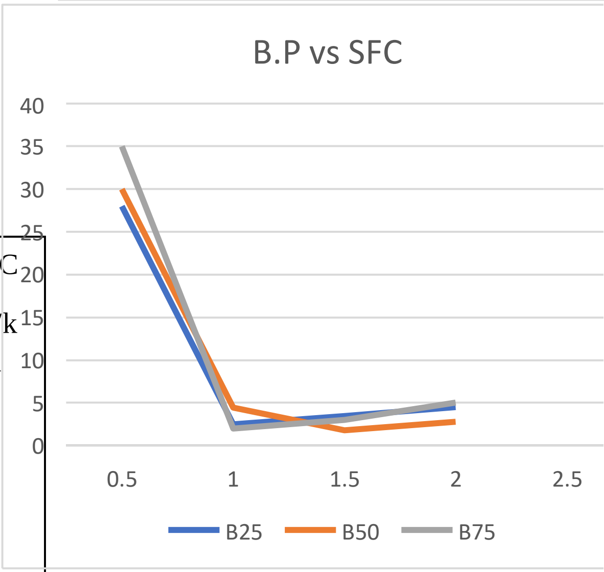


Break power (K.W)

Break thermal fficiency %



SFC kg/kwh



6. CONCLUSION

The experimental investigation was carried out for different blends of west cooking oil and the performance was evaluated and compared with diesel. West cooking oil-based methyl esters (Biodiesel) can be directly used in Diesel engines without any modifications. The engine has-been tested with two different oils blenders partly. The Thermal efficiency of the engine is comparatively more.

ItisobservedthatamongtheblendofB25per formedbetterintermsofengineperformanc e, compared to the other blends of WCO blends. Even through the viscosity of the WCO74 is low and is economically friendly. Considering the thermal efficiency, the WCO blend (B25) is preferable as it shows good characteristic curve.

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