Experimental Investigation on the Performance and Emission Characteristics of Waste Cooking oil Bio diesel in DI Diesel Engine

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Abstract: With ever increase in fuel consumption & depletion of fossil fuels, the need for alternate fuel has found uptrend as the vehicle density is increasing day by day. Biofuel produced from Green matter has found a better alternative to fuel IC engines. The present work deals with the potential estimation of waste cooking oil bio diesel, Characterization of bio diesel, performance and exhaust analysis of Bio diesel blends in DI diesel engine. The best results in terms of performance and emission are obtained for B10 blend which resulted in highest brake thermal efficiency of 19.2 % at 80% loading. The NOx emissions are maximum for B20 blend. (378ppm)

***IndexTerms* -** Waste cooking oil, Performance Parameter. Transesterification.

I. INTRODUCTION

The maximum energy requirement of globe is fulfilled by fossil fuel. However, global energy demands seem to increase at a slower pace in recent years due to unprecedented efficiencies created by novel renewable energy technologies as well as the enforcement of stringent energy policies and environmental legislations. There is a dramatic shift in the energy pattern where the demand for energy harvesting from fossil fuels has declined since year 2014.

The current state of global energy is called 'The Grand Transition'. In this state, there is a strong demand for renewable energy due to the emergence of new technologies, greater environmental challenges, and swiftness in economics and geopolitical power. It is well-known that the burning of fossil fuels such as coal and oil leads to environmental problems and decarburization of energy systems (increasing the utilization of low carbon energy sources such as renewable energy) to address environmental issues such as climate change is one of the toughest challenges that require full commitment from all relevant parties. The carbon intensity contributed by the transportation sector in particular, plays a crucial role on environmental health. Hence, efforts are being made to diversify the fuels used by vehicles and it is believed that this approach is one of the efficient solutions to address environmental problems resulting from fossil fuel combustion. Biodiesels play an important role to fulfill the demand for alternative fuels, which will help reduce carbon emissions. Besides the prices of the raw materials, the technology used for biodiesel production is equally important in order produce biodiesel with competitive prices as those for diesel. Biodiesels produced from conventional alkaline-catalysed transesterification requires long reaction times (typically more than 60 min) due to the heat transfer from the heating surface to the oil by conduction, convention, and radiation. The mode of heat transfer between the surface and interior of the material is thermal conduction. The chemical reaction is dependent on the heat transfer efficiency, which is why conventional heating results in long reaction time in order to achieve a high conversion of crude oil into biodiesel.**Peter Adewale,et.al[1],** They have used the Non-edible feed stocks such as animal fat wastes Here they provide a comprehensive review trends and techniques in biodiesel production from AFWs. Therefore, AFWs are an excellent feedstock for biodiesel production, They are low cost, mitigate environmental damage and increase the quality of the resultant biodiesel fuel (low NOx emissions, high Cetane number and oxidative stability).**A Purandaradas et.al[3]**,In this review they used the low-cost feedstock such as rendered animal fats in biodiesel production. One of the low-cost feed stocks for biodiesel production from poultry feathers. Transesterification is one of the well- known processes by which fats and oils are converted into biodiesel. The reaction often makes use of acid/base catalyst. If the material possesses high free fatty acid then acid catalyst gives better results. The data resulted from gas chromatography (GC) revealed these percentages for fatty acid compositions: myristic acid, palmitic acid, stearic acid, oleic acid, linoleic acid and arachidonic acid. The biodiesel function group was analyzed by using FTIR. This study concluded that the rooster feathers have superior potential to process them into biodiesel than broiler chicken feathers fat because of fatty acid composition values and it has important properties of biodiesel. Generally B20 blend exhibits best results in terms of performance and exhaustemissions.[2],[5]

II. Materials and Methods

Potential estimation of waste cooking oil

A survey is undertaken to estimate the potential availability of waste cooking oil in the selected location. The waste cooking oil is collected from "SLN Grand" and "REVA university canteen". It is observed that all food processing units results in 15 percent waste cooking oil in comparison with total oil usage.

Table 1. Potential Estimation of availability of Waste cooking oil

Name	Total oil usage per day(ltr)	Total wastage of oil per day (ltr)
L J Iynger Bakery	15	2
Pooja sweets	12	2
Green Chily	10	2
Sadda adda	15	3
Shalimar	30	4
Total	82	13

Bio Diesel production

Figure 1 shows filtration of raw waste cooking oil. Filtration is done to separate solid waste present in the oil. First separate the larger particle by sieving through the micron size holes

Figure 1. Filtration of Raw waste cooking oil

After removing visible dust paticles, free fatty acid (FFA) in the oil is estimated and it is found to be 16.46 , which is too acidic hence two stage esteification is carried out.

To test the free fatty acid first weigh the waste cooking oil 1gm and mix with the 2 drops of prenolphthalein and 10 ml of propan-2- ol , Slowly open the valve mixture of Distilled water and KOH mixture after mixing the colour will change as shown in fig. For claculating FFA value used the below formula.

$$\mathrm{FFA} = \frac{28.2 * (0.1) * (0.5)}{1.03} = 1.36$$

Fig 2. Free Fatty Acid

Add 200ml of methnol 10ml of sulphuric acid to 1.5lts of waste cooking oil and is maintain at 55-60°C for 3hours to carry out esterification process . Once again test The FFA value the value should be less than <2.5 if it is not less than given value then same procedure for next process. Same process is called Esterification in the time of second time Esterification Process use same oil by mixing with 150ml methanol and 3ml of Sulphuric acid leave complete process for three hours. use the same oil for FFA test the final value of FFA test shown in above the final calculated value of FFA is 1.36 the value is to be less then <2.5 then the next procedure is to an Transesterification process by adding 150 ml methanol and 5 gm of potassium hydroxide pellets the pellets mixing is depends on the value Of FFA and then heat the biofuel maintaining of 60◦c temperature for complete 3hours after this shift the oil to settling flask leave for 3 to 4hrs.

Fig 3. Batch Reactor

After the settling of biodiesel, take certain quantity of water 60◦c and mix the water with biodiesel to remove glycerin, excess catalyst, dirt, grime, flour particles, soap contents in the biodiesel **.**wash the biodiesel 6to8 time. After washing, the biodiesel is heated to a temperature in the range of 100°c **-**125°c for 30 minutes to remove the water content in the biodiesel.

Fig 4. Water Wash

Fig 5. Bio diesel filtration

Filtration is done to remove dust particles present in the biodiesel. Filtration is improves the Properties of the biodiesel and it gives better performance to the engine

Characterization

In order to check the quality of the desired oil and biodiesel, finding their physical and chemical properties needed. According to predefined calibration standard, normally referred by ASTM standards the properties were determined. In this present study, the properties of castor, sunflower, diesel and their blends were determined mainly the properties like density, kinematic viscosity, calorific value, flash and fire point were found out here.

Table 2. Properties of Bio diesel

Properties	
Flash point	190°C
Fire point	195°C
Density	0.905gms/ml
Calorific value	9360 cal/gm

METHODOLOGY

The methodology followed in the present work is mentioned below.

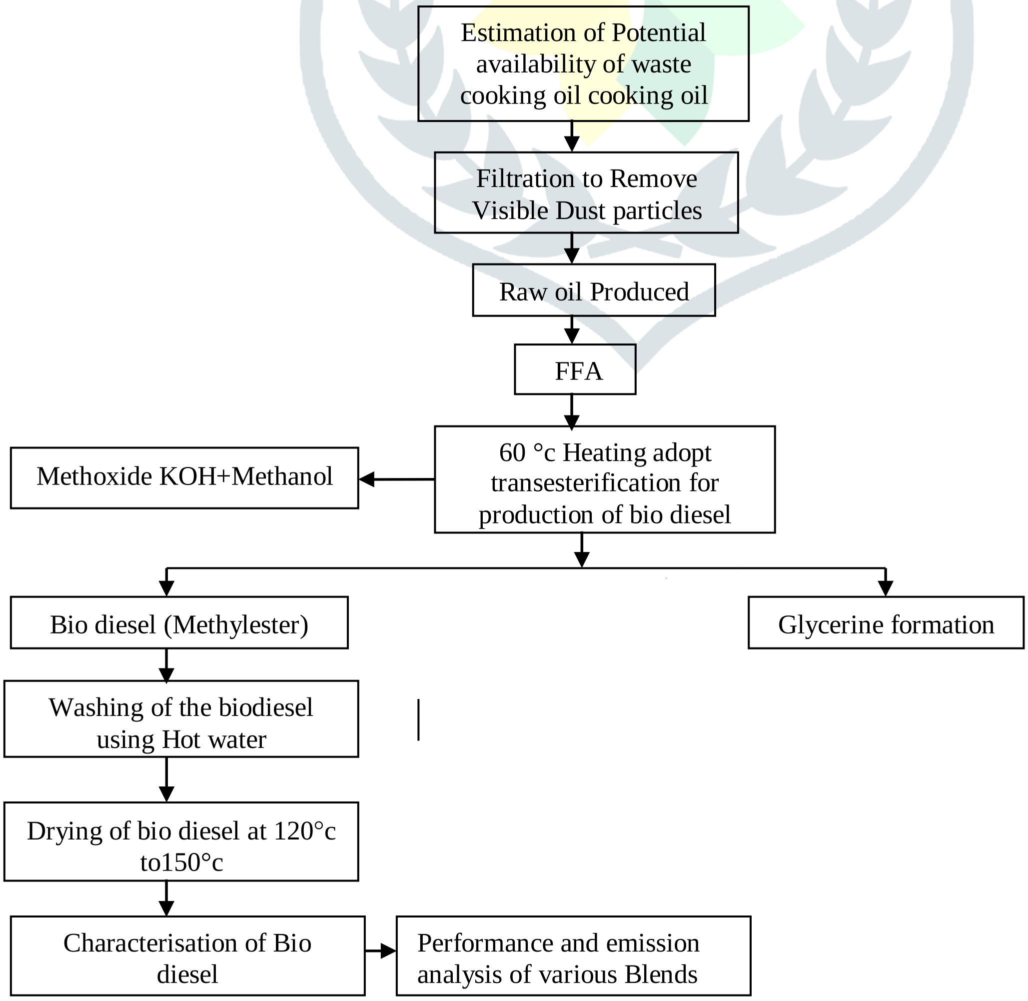

Fig 6. Block Diagram of Methodology

Engine Specifications

Table 3. Engine Specification

Computer Interfaced Four Stroke Single Cylinder Diesel Engine	
Make	Kirloskar
Capacity	3.7 kw
Compression ratio	16.5:1
Cylinder	80mm
Stroke	110mm
Cylinder Capacity	553 cc
Cooling	water cooled

III. Results and discussion

Performance analysis

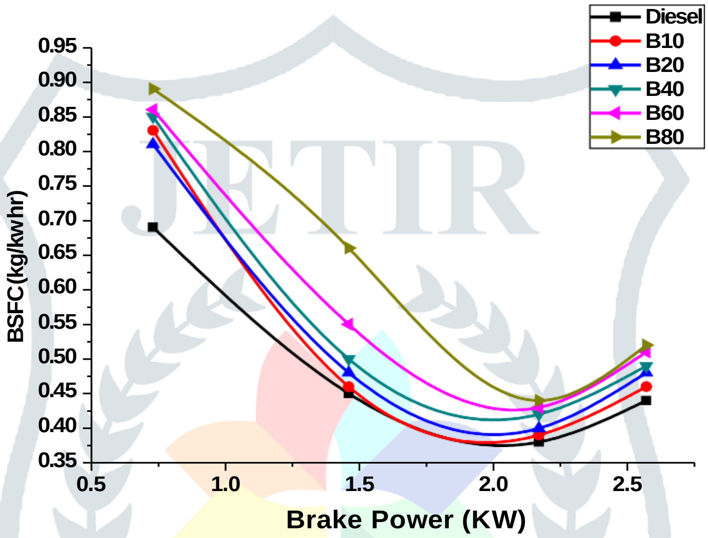

Fig 7. BSFC vs BP

BSFC vs BP

The experimental are conducted on single cylinder DI engine using different blends of bio fuel with diesel.In general BSFC deceases with Brake Power upto 80-90% loading and their after it decreases .The results for the blend B10 and B20 follow the same trend and are almost close to Diesel at higher loads this is because of better combustion.

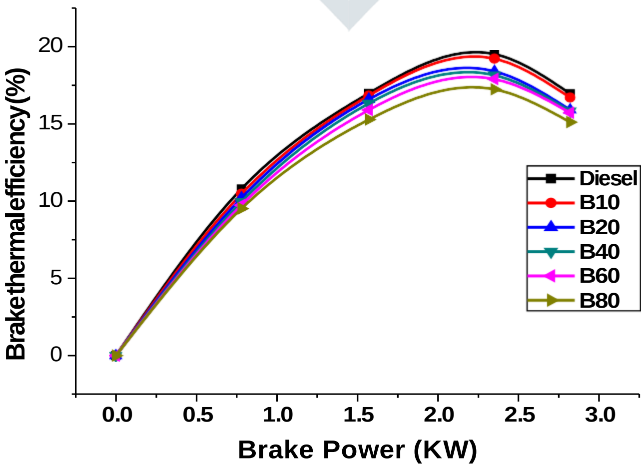

Fig 8. Bake Power vs BTE

BTE vs BP – Brake thermal efficiency increases with increase in load as well as Brake power up to 80% loading and their after it follow down tend

3.2 Exhaust Analysis

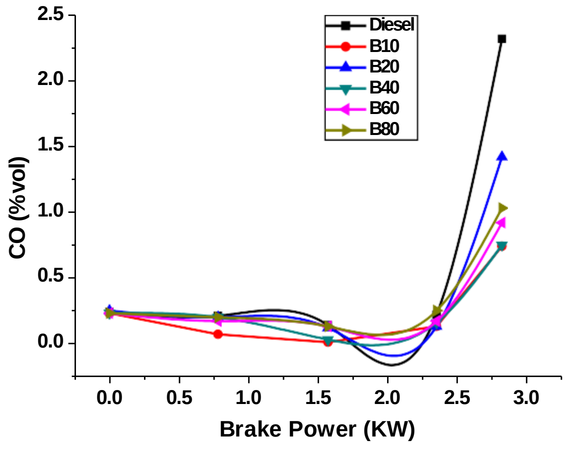

Fig 9. CO vs BP

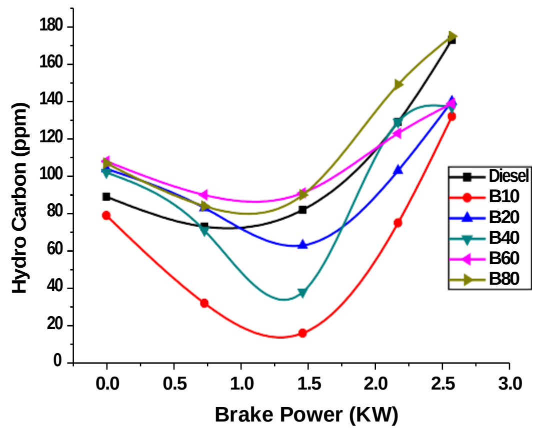

Fig 10. HC vs BP

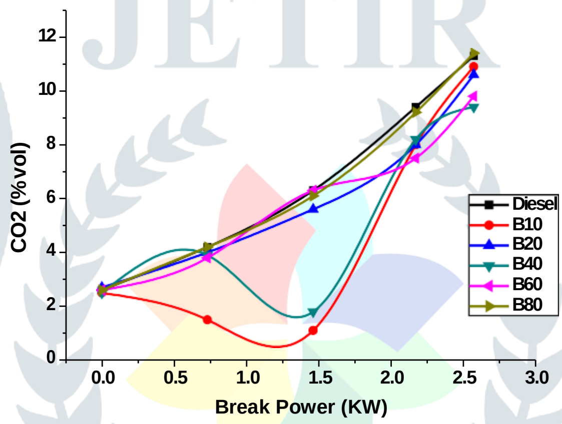

Fig 11. CO_2 vs BP

Since bio fuels has oxygen content it helps is supply stoichiometric mixture, Which results better combustion hence forth has emission CO,HC and CO_2.

3.22 NO_X vs BP:

The NOx emission from the engine depends on combustion temperature. Since higher heat release has occurred for B10 and B20 blend and the same is reflected in NOx emission analysis.

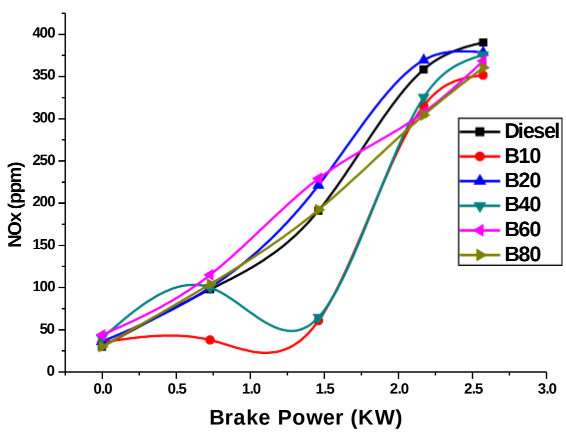

Fig 12. Nitrogen Oxide vs BP

IV CONCLUSION

The biodiesel blend B10 produced from waste cooking oil exhibits similar properties in comparison with diesel. The highest brake power of 1.75 KW is obtained for B10 blend at 80% load. It is also observed that the BTE increases with increase in load upto 80% as a result of better combustion. B10 blend resulted in less emission of Carbon monoxide, Carbon dioxide and unburned hydrocarbons but resulted in higher NOx emission due to higher heat release rate.

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