Performance Study of Used Cooking Oil Bio Diesel Blends on Peugeot Engine

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Abstract: This paper presents performance study of Peugeot MM540 diesel engine using biodiesel prepared from used cooking oil. Transesterification process is followed to produce bio diesel and is blended with diesel in different proportion of 22:78 and 24:76 by volume and named as blend B22 and B24 respectively. Engine was run at different loads (0, 15, 30, 35, and 40kg) with constant speed of 1000rpm separately on each blend and on pure diesel. Comparing the performance graphs of specific fuel consumption and brake thermal efficiency, it is observed that blends of B22 and B24 agree very closely with the performance characteristics of the engine when run on pure diesel. Thus it is recommended to use biodiesel blends in Peugeot MM540 C I engines for better fuel economy.

Keywords: Peugeot XDP, Transesterification, used cooking oil.

I. INTRODUCTION

Peugeot Diesel Engine was manufactured by Mahindra and Mahindra in the year 1986 for the vehicle model MM540 CJ5. Even today this model is hitting the roads as a multi utility vehicle in most parts of Southern India. Due to the recent developments in diesel engine technology these power horses are being replaced by more fuel economic engines. The Peugeot XDP4.90 C 4 cylinder inline water cooled engine with 2112 cubic capacity having 62 horse powers at 4500rpm has a fuel economy of 7 kilometers per liter of diesel. This fuel economy is leading towards the replacement of Peugeot engines by either DI or CRDI engines.

Every new technology comes with a price tag leading to undue burden on the end user. Thus there is immediate requirement for modification of the presently running engines which is not an viable option. Looking at the current scenario it is felt that a cheaper fuel would be an alternate solution to safeguard the interest of the common man.

Used cooking oil which goes as a waste can be converted as fuel for diesel engines by transesterification process [1]. A lot of research has already been carried out to use waste cooking oil as alternative fuel to diesel [1],[2],[3]. Different blends of bio diesel with pure diesel have been studied by different authors on various vegetable oils and have recommended togo with a range of 20% to 30% blends for optimum performance of diesel engines. [6]
B22 and B24 blends were tried to explore the possibilities to increase the biodiesel percentage blend in the biodiesel.

In the present work bio diesel is produced from, used cooking oil (sunflower oil) by alkaline-catalyzed transesterfication process [1]. Performance characteristics of 4 cylinder inline Peugeot engine was carried out using blends of used cooking oil and diesel for blend ratios of 22:78 and 24:76 by volume. The performance parameters were compared with the engine run on pure diesel.

II.MATERIALS AND METHODS

The used cooking sunflower oil (UCSO) was obtained from college hostel of Coorg Institute of Technology campus, oil obtained is pre heated upto 120^0 C for removing any moisture present and filtered for food residues. The USCO was subjected to free fatty acid (FFA) test to determine the FFA content. The test was as follows:

- Take 10ml of Isopropyl alcohol in a conical flask with the addition of 3 to 4 drops of indicator phenolphthalein.
- 1 ml of base oil is added to the conical flask
- Add the solution in the burette into the conical flask slowly and gently swirl
- Phenolphthalein will indicate end of reaction by turning out to pink in color figure 2. when sodium hydroxide (NaOH) is used as titrate (0.1g) with 100ml of distilled water.
- Record the quantity of solution used from the burette.
- Repeat the above procedure at least 3 times to get a constituent value for the given sample.
- When quantities are known the FFA content can be calculated as

$$FFA\ Content = \frac{28.2 \times (normality\ of\ NaOH) \times (titration\ value)}{(Weight\ of\ oil)}$$

On following the former procedure it is found that the titration value for the considered used cooking oil turned out to be 10, hence

$$FFA\ Content = \frac{28.2 \times 0.1 \times 10}{10} = 2.82$$

As the value of FFA content is less than 5% alkaline-catalyzed transesterfication is followed to produce bio diesel.

A.Transesterfication

It is the process by which free oils fatty acids are removed, various methods are used:

- Neutralization with alkaline solution: in this process the acids are removed in the form of soaps.
- Esterification with glycerin: seeks to regenerate the triglyceride.
- Extraction by solvents: where it is used ethanol in proportions 1.3 times the amount of oil.
- The distillation of fatty acids, this method requires a high energy cost.
- Removal of fatty acids with ion-exchange: a resin of strongly basic character for the removal of free fatty acids and the color of the oil is used.

Method that provides greater account of productivity in the removal of free fatty acids is the neutralization by caustic soda, since it not only are obtained high relations, but also helps in the bleaching of the oil, because made soaps help dragging the color generators. There are basically two procedures:

1. Neutralization with dilute alkali: are used concentrations of 0.75 to 2 N.
2. Neutralization with concentrated alkali, where the concentration of caustic soda vary between 2 and 5 N.

In each of the procedures mentioned above neutralization is carried out hot, with oil at a temperature between 50 - 60 °C and addition of caustic soda between 70-80 °C. [5]

B. Catalyst preparation [2]

Sodium Methoxide, CH_3ON_a catalyst was prepared by dissolving sodium hydroxide pellets in methanol in a standard flask and stirred well. Since it is an exothermic reaction it should be allowed to cool down.

$$CH_3OH + NaOH \rightarrow CH_3ON_a + H_2O$$

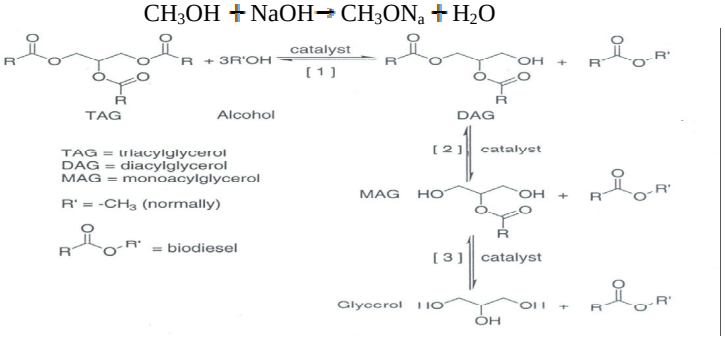

Figure1. Transesterification of triacylglycerols to yield fatty acid alkyl esters (biodiesel) [4]

III. BIO DIESEL PRODUCTION

The filtered vegetable oil is taken in a glass beaker and placed on magnetic stirrer cum heater Figure 3. The oil was heated to 60^0 C temperature. Once equilibrium temperature is attained, the prepared catalyst is added gradually and stirred. The temperature was maintained constant for two hours and the mixture is transferred into a separating funnel and allowed to settle for overnight Figure 4. Once settled two separate layers of the product was found one with honey colour floating on the top while the denser one being soap and glycerol settling at the bottom of the funnel Figure 5. On separation of biodiesel from glycerol, biodiesel is washed with warm water to remove residual catalyst or soaps, dried and stored. This is normally the end of the production process resulting in a clear amber-yellow liquid with a viscosity nearly equal to petroleum oil. The yield of biodiesel from 1 litre of used cooking oil was 930ml.

Blends of B22 Figure 7 and B24 Figure 8 were prepared with ratios of bio diesel and diesel being 22:78 and 24:76 by volume.

Figure2. Phenolphthalein indication

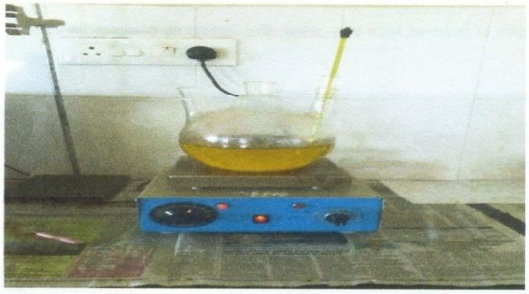

Figure 3. Heater cum magnetic stirrer

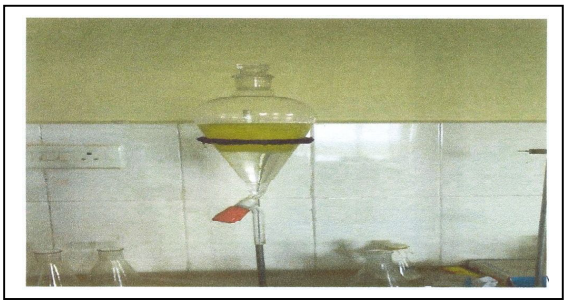

Figure 4. Settling funnel arrangement

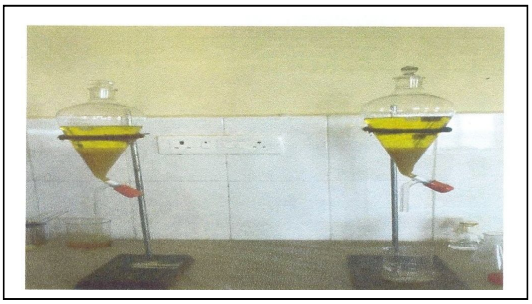

Figure 5. Separate layers of bio diesel and soap.

Figure 6. B100

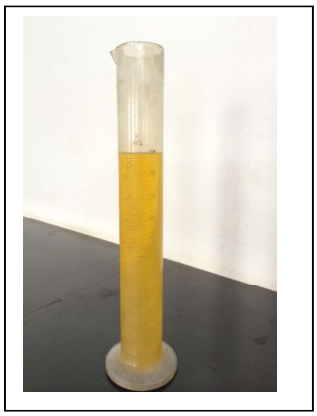

Figure 7. B22

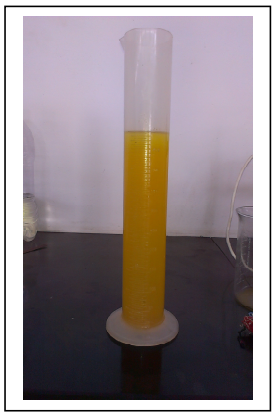

Figure 8. B24

IV. EXPERIMENTAL SETUP

The setup is as shown in the Figure 9 and the specification are tabulated in Table 1

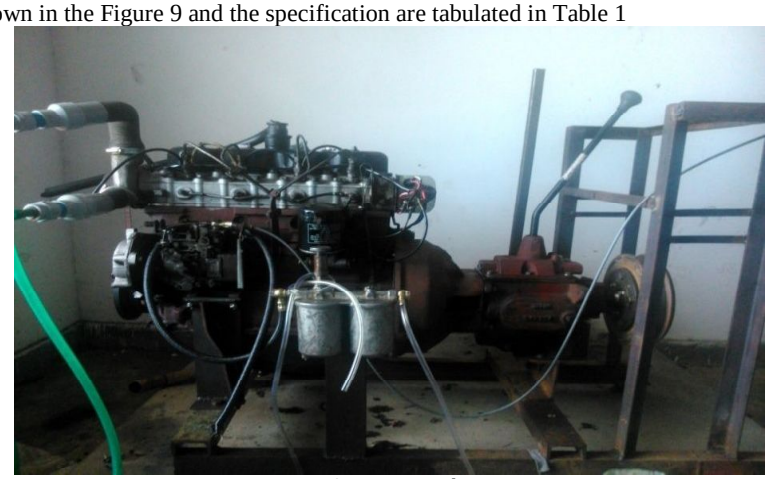

Figure 9. Experimental setup

Table 1: Engine Specifications

Parameters	Specification
Engine	Diesel XDP 4.90c
Type	4 stroke:4 cylinder,inline
Manufacturer	Mahindra
Make	Peugeot
Bore/Stroke	90mm/93mm
Capacity	2112cc
Maximum horse power	62@4500 rpm
Maximum torque	12.3kgm@2000 rpm
Weight of engine	184 kg
Compression ratio	22.4 : 1

Cooling system	Water cooled
Fuel injection system	Distributor pump
Dynamometer Type	Rope Dynamometer

V. RESULTS AND DISCUSSIONS

Comparison of Physical and Combustion Properties of biofuel blends (USCO with transesterfication) and pure diesel as tabulated in Table 2

Table 2 : Physical and Combustion properties of B22, B24 and Diesel.

Properties	**Unit**	**Diesel**	**Biodiesel**	
			B22	**B24**
Density at35^{0}C	kg/m^3	825.9	840.2	840.4
Specific gravity	----	0.83	0.90	0.902
Kinematic Viscosity at 35^{0}C	mm^2/sec	3.96	5.71	5.72
Dynamic Viscosity at 35^{0}C	cP	3.27	4.78	4.81
Calorific Value	MJ/kg	44	42.6	42.3
Flash point	^{0}C	72	80	80
Fire point	^{0}C	210	97	104

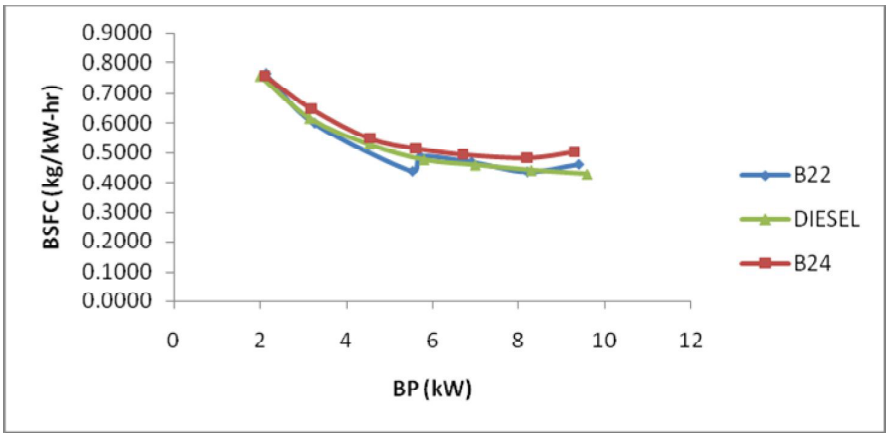

Figure 10. Variation of Brake Specific Fuel Consumption (BSFC) with Brake Power (BP) for Bio diesel blends and pure diesel.

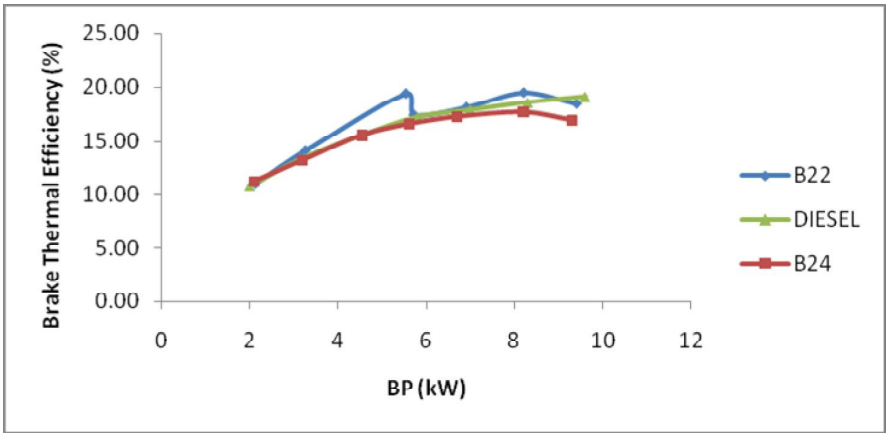

Figure 11.Variation of Brake Thermal Efficiency with Brake Power for Bio diesel blends and pure diesel.

Figure 10 shows the variation of BSFC with BP, B22 blend agrees with diesel very closely at smaller loads and increases with the increase in load. Blend B24 also agrees with diesel at lower loads but deviates more compared to B22 blend as the load on the brake drum increases. Since blend B24 deviated more in increased load the blend percentage was stopped for further testing.

Figure 11 shows the variation of Brake Thermal efficiency with Brake power, Blend B22 shows initial increase in thermal efficiency but as the load increases the efficiency starts dropping down. B24 blend shows thermal efficiency lower than B22 blend.

A. Cost Analysis

The present cost of running Peugeot diesel engine is Rs 8.2 per kilometer having diesel cost of Rs 57 per liter. Production cost of blend B22 and B24 is Rs 51 per liter (cost of sodium hydroxide is Rs 12, methanol Rs 12 and used cooking oil is free of cost)

VI. CONCLUSIONS

In regard to the present experimental work on Peugeot diesel engine bio diesel produced from used cooking oil can be blended up to 22% with pure diesel and used as a economic fuel, where the engine working shows the same performance characteristics. As the fuel cost is brought down the per kilometer running cost of the vehicle also comes down. Hence we conclude that used cooking oil can be utilized for providing cheap fuel to Peugeot Diesel Engines for better economy and sustainability. Availability of renewable catalyst can further cut down the cost of producing bio diesel using used cooking oil.

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