Performance and Emission Characteristics Of CI Engine Using Waste Cooking Oil As An Alternate Fuel

G. Deena Dayala Sharma, S. Senthil kumar, M. Thilak, R. Baskar

***Abstract*— In presence scenario,thegreatest potential represent as biodiesel production. The major drawbacks of the petroleum diesel, producing emission pollutants from the diesel engines to the environment. To avoid such problem, concentrating on alternate fuel. It plays an important role for the non-disturbance of the atmosphere. Waste cooking oil (WCO) was used to produce biodiesel fuel in order to reduce wastes polluting the environment. This paper deals on impact of biodiesel performance and emission characteristics of CI engine. But the larger viscosity of any waste cooking oil (WCO) is found major problem in use of an engine directly. The properties of fuel such as calorific value, flash point and cetane number of the biodiesel were to be analysed. The performance and emission tests were carried out by B25, B50, B75 and B100 blends of waste cooking palm oil at different loads and such results were compared with petroleum diesel at 200 bar and 230btdc and 210bar and 230btdc. This Performance results reveal that the biodiesel gives higher brake thermal efficiency and lower brake-specific fuel consumption with the different blending's. Emission results showed that in most cases, NOx is increased, and HC, CO, and PM emissions are decreased. Through this experimental test which type of blending was found the best suitable for engine. In this paper, various blends of waste cooking palm oil and varying the injection parameters such as injection timing, crank angle to increase the performance of an engine and mutually reduces the emissions without any modification of diesel engine.**

***Index Terms*— Waste Cooking Oil, NOx, HC, CO, and PM emissions**

I. INTRODUCTION

Oil (and its products) is one of those commodities which face inelastic demand despite price rise, which can be understood from the fact that despite 12% price rise the demand for oil and its products has risen by 15% per annum.

It is precisely due to these reasons (and some other minor reasons) that the government has taken all the liberty in deciding the oil prices at the behest of OMC (Oil manufacturing Companies). Currently state retailers control virtually all, about 93 per cent of retail trade.

Let us look at the history of oil pricing in our country. Immediately after independence the cost realization to the oil companies in the country was linked to the 'import parity' type of pricing, known as the 'Value Stock Pricing' (VSA). This mechanism was basically a cost-plus formula to the import price, which included added elements of all the costs such as shipping charges up to the Indian ports, insurance, transit losses, import duties and other Levies and charges.

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The VSA was followed by the Administered Price Mechanism (APM) which actually involved artificial price fixing by the government from time to time and hike or reduction in the prices become a political decision, rather than being a rational economic decision. The decision to dismantle the APM was aimed at gradually shifting from artificial pricing of petroleum products towards a situation where the price is determined by the market forces of demand and supply. Hence, as a conscious policy decision, the government brought into the Force a new pricing mechanism with effect from April 1, 2002.

The new mechanism was designed to partially insulate the prices of petroleum products in the country from volatile international crude oil prices. At the same time it was to ensure that the prices of certain products like kerosene and LPG remained subsidised as per the government policy. But despite the subsidies India is one those places where we have exorbitant petroleum prices.

II. TESTED ENGINE

Fig 1:TESTED ENGINE PHOTOGRAPH.

***FOUR STROKE, SINGLE CYLINDER VERTICAL WATER COOLED DIESEL ENGINE* Make & Model**	**Kirloskar TV-1**
POWER	**3.5 Kw**
SPEED	**1500 rpm**
BORE DIA.	**87.5 mm**
STROKE	**110 mm**
CR RATIO	**12:1-18:1**

Table 1: SPECIFICATIONS OF THE ENGINE

PROPERTIES	DIESEL	WASTE COOKING OIL
Density at 15 ºC, g/cm³	0.822	0.8835
Viscosity at 40 ºC, mm²/s	3.4	5.02
Flash point, ºC	71	150
Cetane Number	45	51

Table 2: PROPERTIES OF WASTE COOKING OIL BIODIESEL & DIESEL

TRANSESTERIFICAION

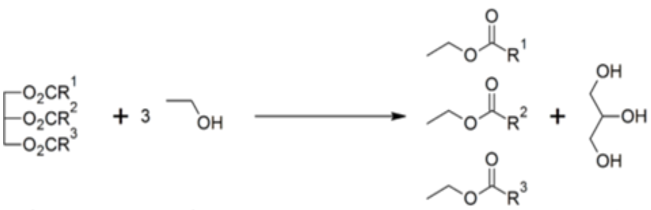
Animal and plant fats and waste cooking oils are composed of triglycerides, which are esters formed by the reactions of three free fatty acids and the dihydric alcohol, glycerol. In the trans esterification process, the added alcohol (commonly, methanol or ethanol) is deprotonated with a base to make it a stronger nucleophile. As can be seen, the reaction has no other inputs than the triglyceride and the alcohol.

Under normal conditions, this reaction will precede either exceedingly slowly or not at all, so heat, as well as catalysts (acid and/or base) will utilized to speedup the reactions. Consumption of acid or base are not used by the trans esterification reaction, thus they are not reactants, but catalysts. Common catalysts for trans esterification include sodium hydroxide, potassium hydroxide, and sodium meth oxide.

Almost all biodiesel is produced from virgin vegetable oils using the base-catalysed technique as it is the low cost process for treating waste cooking oils, require only low pressures and temperature and producing over 98% conversion yield (provided the initial oil moisture is low and free fatty acids). However, the production of biodiesel from other sources is much slower.

Since it is the predominant method for commercial-scale production, only the base-catalysed trans esterification process described below.

Triglycerides are reacted with an alcohol such as ethanol to give ethyl esters of fatty acids and glycerol .



1 2 3 4

Figure 2. R^1, R^2, R^3: Alkyl group

III. BIODIESEL PREPERATION

Biodiesel was prepared by taking one litre of waste cooking palm oil and such oil was heated at a constant temperature of 60º c. Then 2gms of KOH was mixed with 250 ml of methanol and the mixture was added to the preheated waste cooking palm oil and the solution was stirred at speed of 400 RPM and heated at a constant temperature of 60º C for 2 hrs. After that the solution was kept in a stagnant condition to separate the biodiesel and glycerine for 3 days. Then the biodiesel was washed with distilled water to remove the excess methanol, KOH. The biodiesel yield was about 85%.

IV. PERFORMANCE AND EMISSION ANALYSIS

Preparation of WCPO biodiesel was tested in the C.I. Engine in the blending ratio of B25, B50, and B75, B100 at CA 23 º btdc&200 bar injection pressure, and CA 23º btdc&210 barof injection pressures, and CA 23º btdc at a constant speed of 1500 RPM.

V. RESULTS & DISCUSSION

The analysisofperformance and emission for a CI engine at various loads using WCPO biodiesel and its various blends was carried out at 200 bar&23ºbtdc and 210 bar &23ºbtdc. The results were discussed below.

5.1. Performance Analysis at200 bar & 23º btdc
5.1.1 SpecificFuel Consumption (SFC)

The Specific fuel consumption decreases with increase in load. The SFC for biodiesel and its blends were lower than diesel at all loads. The minimum SFC (0.26Kg/Kw-hr) was observed at B100 which was slightly lower than that of diesel (0.28Kg/Kw-hr) at full load.

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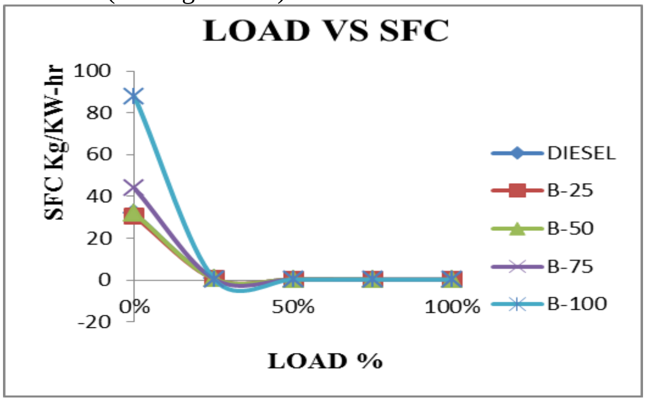

Figure 3. LOAD VS SFC AT 200 BAR & 23º BTDC

5.1.2. Brake Thermal efficiency (BTE) The higher brake thermal efficiency 34.33% for diesel at 100 % load andthe maximum brake thermal efficiency 32.64% for B100 at full load among the biodiesel blends were observed.

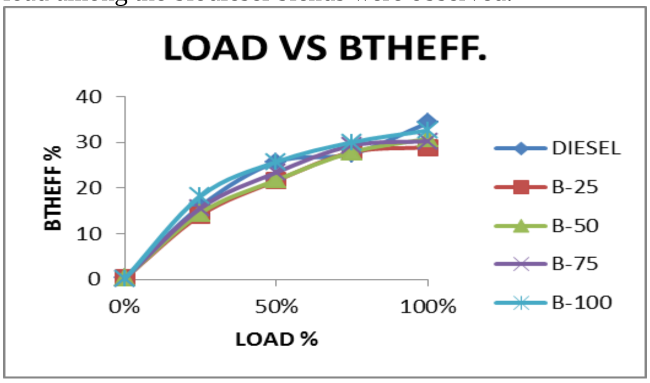

Figure 4. LOAD VS BTHEFF AT 200 BAR & 23º BTDC

The calculations of TFC, SFC, and Brake thermal efficiency were note in the graphs. The emission analysis were also been calculated by connecting the exhaust line with a five gas analyzer and a smoke meter and the values of CO,HC,CO_2,O_2,NO_X and smoke density were noted

5.2.Emission Analysisat200 bar & 23º btdc
5.2.1. Carbon Monoxide (CO)

The CO emission was lower for biodiesel and its blends than diesel at all loads. The minimum CO 0.073 % emission for B75 was noted.

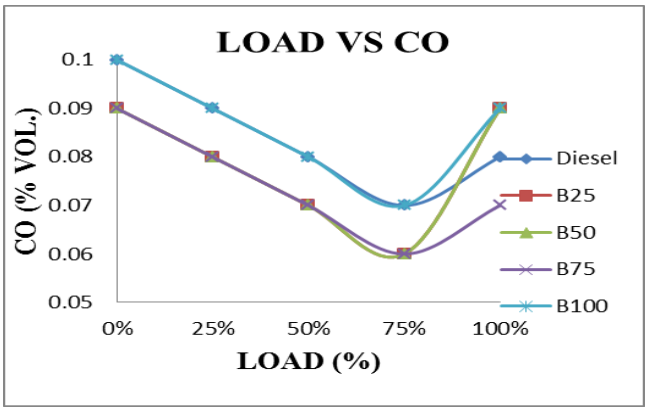

Figure5.LOAD VS CO AT 200 BAR & 23º BTDC

5.2.2. Hydro Carbon (HC) The HC emission was found to be higher for biodiesel and its blends than that of the diesel fuel. The maximum HC emission (68 PPM) was noted for B100 at full load.

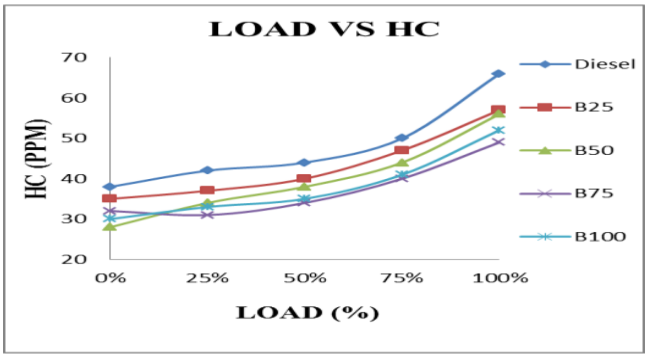

Figure 6.LOAD VS HC AT 200 BAR & 23º BTDC

5.2.3. Oxides of Nitrogen (NO_X) The maximum NO_X emission of biodiesel and its blends was higher than that of diesel for all loads. The maximum NO_X emission (1100 PPM) for B75 at full load was observed.

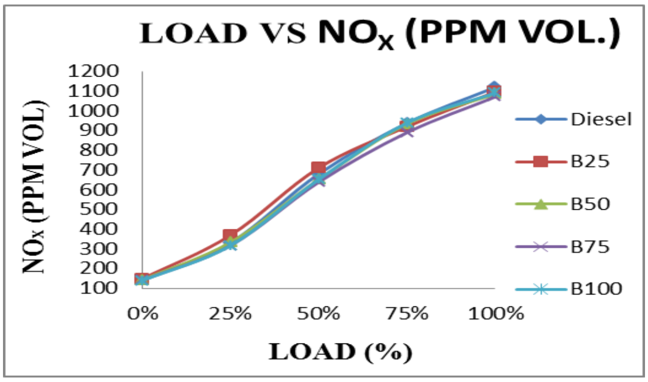

Figure7. LOADVS NO_XAT 200 BAR & 23º BTDC

5.3. Emission Analysis at 210bar&21 º btdc
5.3.1. Carbon-di-oxide (CO_2)

The maximum CO_2 emission (0.79%) was observed for B50. It was higher for diesel than biodiesel and its blends.

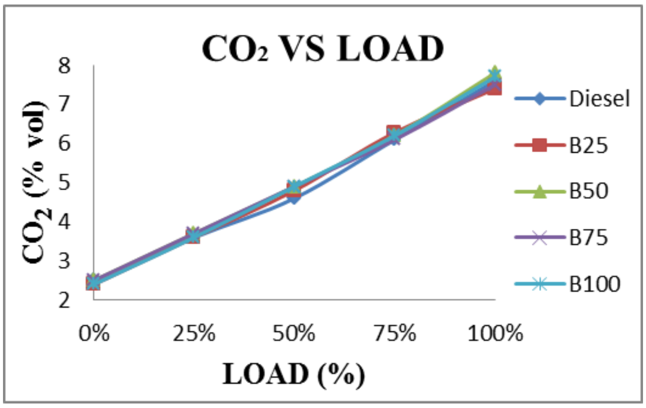

Figure8. LOAD VS CO_2 210 BAR & 21^0 BTDC

5.3.2. Oxygen (O2) The maximum O2 emission of biodiesel and its blends was higher than that of diesel for all loads. The maximum O2 emission for B100 at full load was observed.

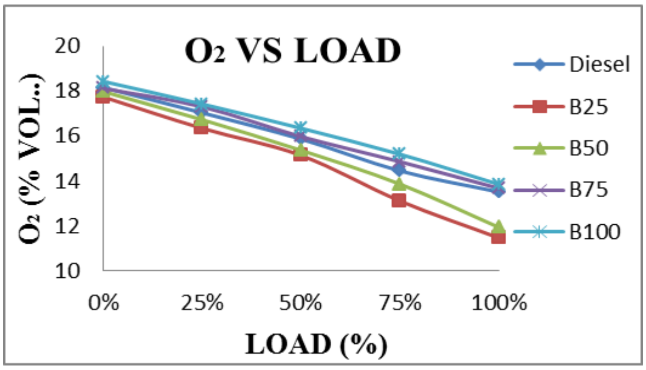

Figure 9.LOAD VS O_2 AT 200 BAR & 23º BTDC

VI. CONCLUSION

While completion of engine experimental test, the following conclusion were analysed from various parameters .

The maximum brake thermal efficiency in 200 Bar & 23^0btdc, 34.33% for diesel at maximum load and the maximum brake thermal efficiency 32.64% for B100 at maximum load among the biodiesel blends were observed.

Brake Thermal efficiency (BTE) The higher brake thermal efficiency 34.33% for diesel at 100 % load and the maximum brake thermal efficiency 32.64% for B100 at full load among the biodiesel blends were observed.

The Specific fuel consumption decreases with increase in load. The SFC for biodiesel and its blends were lower than diesel at all loads. The minimum SFC (0.26Kg/KW-hr) was observed at B100 which was slightly lower than that of diesel (0.28Kg/KW-hr) at full load.

The maximum NO_X emission of biodiesel and its blends was higher than that of diesel for all loads. The maximum NO_X emission (1070 PPM) for B75 at full load was observed. The CO emission was lower for biodiesel and its blends than diesel at all loads. The minimum CO 0.073 % emission for B75 was noted.

The HC emission was found to be higher for diesel and its blends than that of the diesel fuel. The minimum HC emission (49 PPM) was noted for B75 at full load.

At 210 Bar& 21º btdc, the NO_x emission was reduced and CO, HC emission were increased.

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