Performance and Emission Analysis of Diesel Engine Fuelled with Blends of Canola oil Methyl Ester

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ABSTRACT

In this work performance and emission characteristics of canola oil methyl ester (COME) blends were studied as diesel engine fuel and compared with neat diesel fuel in a variable compression ratio (VCR) engine. Five blends; B5, B10, B15, B20, B25 were prepared with diesel for experimentation. The tests were done at a constant speed of 1500 RPM and compression ratio 18 at different loads. The maximum brake thermal efficiency obtained is about 31.06% for B15, which is pretty higher in comparison of diesel (29.87%) at full load. All COME blends show higher BSFC values in comparison of neat diesel fuel. From the emission tests, it was observed that HC emission is decreased and CO emission is increased along with the percentage of biodiesel, however HC and CO emission of all COME blends is lower than that of diesel fuel.

Keywords – COME, Engine Performance, Emission

I INTRODUCTION

Global energy demands are increasing day by day because of increase in world’s population. Limited amount of fossil fuels will be exhausted in upcoming years and hike in crude oil price are the main issues. Apart from these issues environmental problems like global warming, air pollution and ozone depletion due to burning of fossil fuels. To overcome these problems bio fuels are the ray of hope because of their renewable and environment friendly nature. Many researchers have done experiments on various biodiesel and its blend in diesel engine for evaluation of performance and emissions of the fuels. They found satisfactory reduction in emissions and comparable performance with diesel. Raheman and Phadatare [1] investigated Karanja methyl ester and its blends (B20 to B80) in diesel engine. At blend B20 and B40 increase in torque, brake power (BP), BTE, reduction in BSFC and reduction in exhaust emissions were found. Nair et al. [2] studied performance and emission characteristics of Neem biodiesel blends (B10, B20 and B30) on a single cylinder, 4-stroke diesel engine. They observed that B10 shows lower emissions and higher performance than the other blends and diesel. Perumal,and Ilangkumaran [3] studied Pongamia methyl ester as fuel and found considerable reduction in CO, HC and NOx. There was increase in BSFC and reduction of BTE. Anbarasu and Karthikeyan [4] investigated the engine performance and emission characteristics of the canola biodiesel by using single cylinder direct injection diesel engine. The BSFC and exhaust gas temperature are higher and BTE is lower for canola oil as compared to diesel fuel. HC and NOX pollutants are decreased along with the biodiesel percentage. A. Anbarasu & Karthikeyan [5] investigated canola emulsion fuel in a diesel engine under different operating conditions. He observed BTE of the B100 fuel is 2.4% higher than diesel fuel at full load. SFC values of Canola emulsions are higher than diesel fuel. HC emissions and NOX emissions are reduced for the blends compared to that of diesel fuel. Ramadhas et al. [6] analysed performance and emission characteristics of pure rubber seed oil, diesel and biodiesel in the compression ignition engine. The lower blends of biodiesel increase the BTE and reduce the BSFC. The exhaust gas emissions were decreased with increase in blend ratio. Kanthavelkumaran et al. [7] studied performance of Rubber Seed Oil and its blends (B20, B40, B60, B80, B100) with diesel in direct injection Diesel Engine. The results showed that the reduction in BTE, CO, HC and smoke density and decreased level of NOX emissions.

II. BIODIESEL USED AND ITS PROPERTIES

Oil content of canola seed is more than 43 percent, which is higher than many other oilseeds. So canola is an efficient feedstock for production of biodiesel. Canola has the lowest saturated fat level among all major vegetable oils. Canola oil has improved cold weather performance because of its low saturated fat content. Small solid crystals of pure canola biodiesel begin to form at the temperature of 3°C (37°F). Pure canola biodiesel also contains 10% oxygen by weight. This oxygenated nature leads to a reduction in emissions of hydrocarbons, toxic compounds, carbon monoxide and particulate matter [8]. Table 1 shows the properties of COME and diesel. With the increase in the COME percentage in the diesel blends, the viscosity and density increases and the calorific values are decreases.

III. EXPERIMENTAL DETAILS

In the present study a four stroke, single cylinder water cooled diesel engine, connected to eddy current type dynamometer for loading is used. The detail specifications of the engine used are given in Table II. Initially the experiments were conducted by using diesel fuel to generate performance and emission data of it. Thereafter, the tests were carried out by using the COME blends i.e. B5, B10, B15, B20 and B25. The performance tests were conducted at variable loads i.e. 2 kg, 4 kg, 6 kg and 8 kg at compression ratio 18 and at constant speed 1500 rpm. Performance parameters such as BSFC and BTE were observed. For measurement of HC and CO; AVL Di-Gas Analyzer was used which is used to measure the exhausts of an engine. The inlet manifold of the analyzer is connected to the exhaust valve of the engine so that the emissions can be measured.

Table I. Properties of Diesel and COME blends

S.No.	Properties	Diesel	Canola biodiesel
1.	K.Viscosity @40^{0}C (cSt)	2.71	5.12
2.	Density @15^{0}C (g/ml)	0.839	0.869
3.	Acid Value (mgKOH/gm)	-	0.065
4.	Gross Calorific Value (Cal./gm)	10356	9028

TABLE II. Engine Specifications

Make and model	Kirloskar, TV1
Type of engine	4 stroke, variable compression diesel engine
No. of cylinders	Single cylinder
Cooling media	Water cooled
Rated capacity	3.5 kW at 1500 rpm
Cylinder diameter	87.5mm
Stroke length	110mm
Connecting rod length	234mm
Compression ratio	12:1 to 18:1
Dynamometer	Eddy current dynamometer

IV. RESULT AND DISCUSSIONS

A. Brake thermal efficiency (BTE)

Figure 1 shows variation of BTE with load for different blends of COME and diesel fuel.

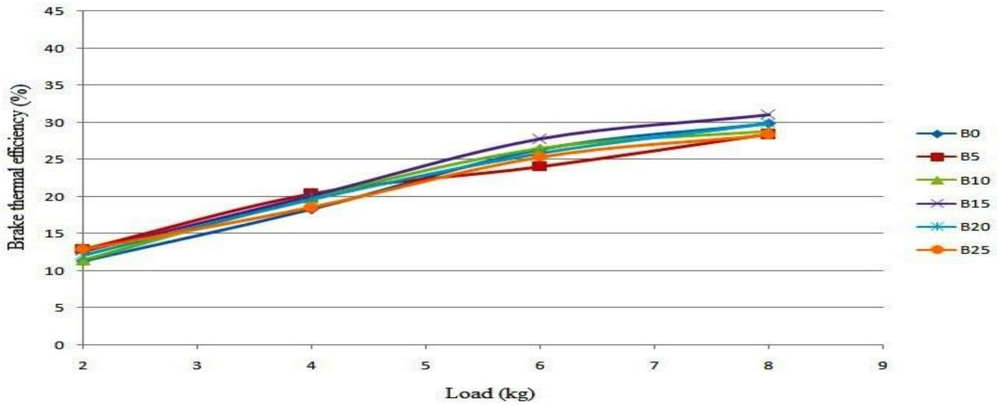

Fig.1 Variation of brake thermal efficiency with Load for different blends of COME

For all fuels, BTE is increased with the increase in load. This can be due to increase in brake power and decrease in BSFC with increase in load. The maximum BTE obtained is about 31.06% for B15, which is pretty higher in comparison of diesel (29.87%). The maximum BTE obtained while using B5, B10, B20 and B25 are 28.38, 28.84, 29.87 and 28.31% respectively. Initially the thermal efficiency of the engine is increasing with increase in blend ratio up to B15. The probable reason for this can be the additional lubricity of biodiesel and its oxygenated nature [6]. Oxygenated nature of biodiesel leads to improvement of the combustion process. After B15, BTE starts decreasing with the increase in the blend ratio. The reason behind this can be lower calorific value and increase in fuel consumption [4].

B. Brake specific fuel consumption (BSFC)

Figure 2 shows variation of BSFC with Load for different blends of COME. Brake specific fuel consumption of all fuel blends is decreased with the increase in load.

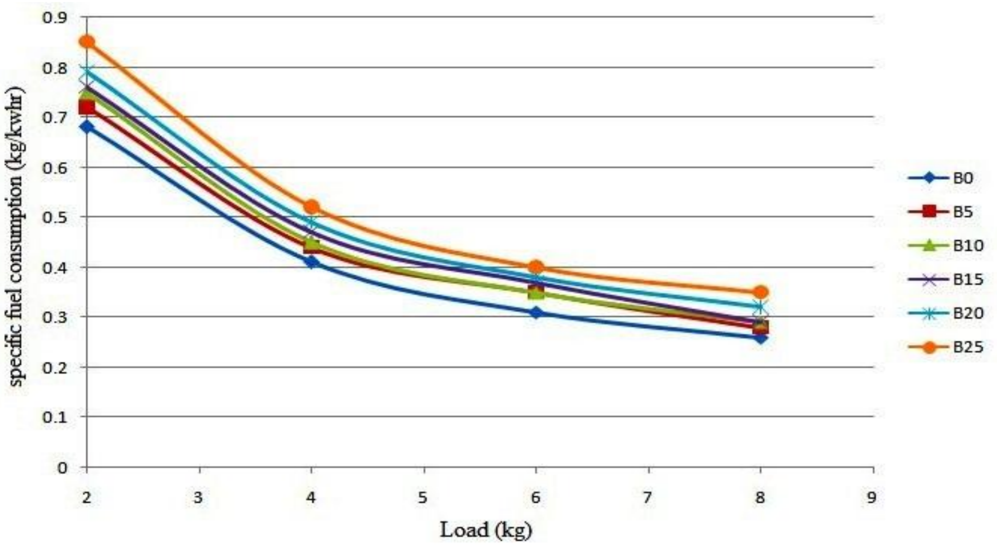

Fig.2 Variation of brake specific fuel consumption with Load for different blends of COME

The may be attributed to the increase in the brake power is more as compared to the increase in the fuel consumption with load. It can be observed that the BSFC values of COME blends are higher in comparison of diesel fuel because of the joint effects of lower heating value, higher viscosity and the higher fuel flow rate due to high density of the canola oil [5] because engine consumes more fuel with biodiesel blend as compared to diesel to develop the same power output due to the lower calorific value of biodiesel [9].

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C. Hydrocarbon emission (HC)

Incomplete mixing of fuel with air and inefficient combustion are the reasons of HC emissions.

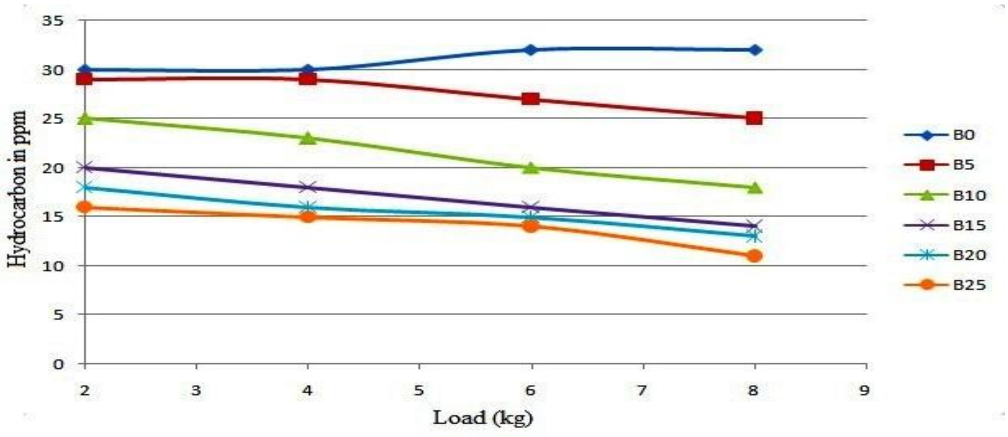

Fig.3 Variation of HC with Load for different blends of COME

Figure 3 shows variation of HC emission with Load for different COME blends. It indicates that the HC emission decreases with the increase in blend ratio of biodiesel due to its oxygenated nature which help enhance oxidation of unburned hydrocarbons. For diesel as the load increases the HC emission increases due to insufficient oxygen [3] but for different blends of biodiesel as the load increases the HC emission decreases because of better mixing of air and fuel due to higher evaporation at higher engine loads for higher in-cylinder temperatures [10].

D. Carbon Monoxide emission (CO)

Figure 4 shows the variation of CO emission with Load for different blends. CO emission is increased with an increase in blend ratio at all loads. However CO emissions of all biodiesel blends are lower than the diesel fuel. High loads will lead oxidation temperatures and reduced emissions.

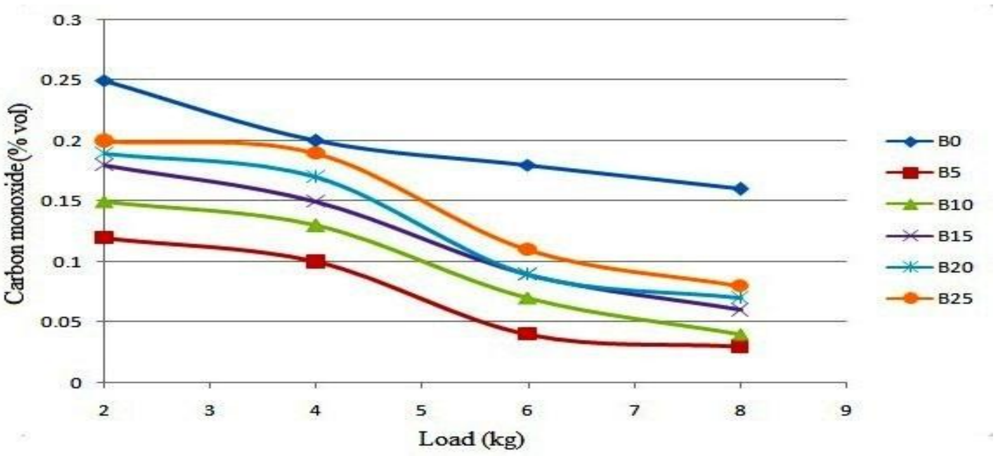

Fig.4 Variation of CO with Load for different blends of COME

With the increase in engine load, CO emissions are increased for all fuel blends and diesel. This is due to better evaporation and mixing of air and fuels at higher loads for higher in-cylinder temperatures [10]. Lower CO emissions of biodiesel blends are found in comparison of diesel due to more oxidation. Some of the CO might have been converted into CO_2 by taking up extra oxygen molecule of the biodiesel thus reduces CO formation [11].

V. CONCLUSION

The properties of the COME were investigated and found to be close to those of diesel fuel. An experimental investigation has been done to find the performance and emissions of biodiesel and its blends in a single cylinder constant speed compression ignition engine and compared with the baseline diesel fuel. The following conclusions obtained from the results:

1. The maximum brake thermal efficiency obtained is about 31.06% for B15, which is quite higher than that of diesel (29.87%) at full load.
2. The BSFC values of all COME blends are higher in comparison of diesel fuel.
3. HC emission of COME blends is lower than that of diesel fuel. HC emission decreases with the increase in blend ratio of biodiesel due to its oxygenated nature.
4. CO emissions of all biodiesel blends are lower than the diesel fuel. CO emission is increased with an increase in blend ratio at all loads.

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