Experimental Research on Performance and Emission Characteristics of Country Borage Methyl Ester - Diesel Blend in a Compression Ignition Engine

Anbarasan B , Venkatesh J, Jamunarani M

Abstract—An Experiment has been conducted performance and emission and combustion characteristics of a single-cylinder by using country borage methyl ester (CBM) and diesel blend in a direct injection at a constant speed diesel engine. In the past few years, the investigation on the biofuels has been considerable interest by virtue of their unique physical and chemical properties. This experiment works involves the usage of country borage methyl ester and diesel blend, to study its effect on performance, combustion and emission characteristics. Diesel and country borage methyl ester fuel blends are 20%, 40%, 60%, 80%, 100%, and varying load of 25% increment from no load to full load. The experiment was carried out for engine performance parameter such as brake thermal efficiency (BTE) of CBM 20 blend was slightly higher 3% than that of diesel. And the engine emission parameters such as hydrogen emissions is reduced 22% for CBM 20 and 32.5% for CBM 40 blend. And NOx emission was slightly increased by 5% for CBM 20 and 8% for CBM 40.

Keywords: Biodiesel, Performance, Emission, Engine

I. INTRODUCTION

The fossil fuels are less expensive as compared to biofuels. The widespread use of biodiesel blend with diesel is used in CI engines. In recent years many kinds of research to determine the suitability of vegetable oil and its derivatives as fuel are additives to the diesel. Reducing emissions in the automobile sector is one of the most important issues, initiate to develop the biofuels such as the recent studies by Jatropa, Soaknut, Mahua oil, Kapok oil, Papaya seed oil and country borage oil were compared with standard diesel properties and using this biodiesel to study the emission of the engine. Misra and Murthy (2011) have investigated the blend of diesel and soaknut oil 10%, 20%, 30%, and 40% were used to conduct the performance and emission characteristics at varying loading in terms of 25% increment to no load to full load. In this test engine, the performance parameter is brake thermal efficiency, specific fuel consumption and exhaust emissions were recorded. Among the blends, SNO 10% has a better performance of BTE. The emission of HC is increased at 75% low and emission of CO is lower at full load. NOx emissions for all blend 35% reduction. Combustion characteristics were analyzed in CI engine fueled with diesel the maximum cylinder pressure the ignition delay, the premixed combustion duration and the fraction of heat released in premixed combustion phase will increase, while the diffusive combustion phase. SukumarPuhan and Vedaraman (2005) have studied the vegetable oil can be used in diesel engine in high viscosity low volatilities, poor cold properties have to lead to the various investigative derivatives. The biodiesel was tested in a single cylinder, four strokes, direct injection at a constant speed to evaluate the performance and emission of Mahua oil. The specific fuel consumption(20%) is higher than that of diesel and thermal efficiency(13%) is lower than that of diesel. The exhaust emission of CO is 30% reduced compared to the diesel, HC is 35% reduced, the smoke number is reduced by 11% and oxide of nitrogen by 4%. LeenusJesu Martin and Edwin Geo (2012). In this study the viscosity of cottonseed oil, which has been considered as alternative fuels for a compressive ignition engine. The blends of varying proportions of cotton seed oil and diesel were prepared and analyzed and compared with performance and emissions of the single-cylinder diesel engine. The performance was observed a neat cotton seed oil is slightly increased compared to standard diesel engine and emissions of CO, HC is reduced and NOx was increased. Muralidharan K, Vasudevan D et al (2011). In this study the performance and emission and combustion characteristics of a single-cylinder, four strokes variable compression ratio with waste cooking and its diesel blends. The performance parameters are analyzed with standard diesel it conforms considerable improvements in the performance parameters and exhaust emissions. The emission of CO, HC, CO2 were reduced and NOx emission was increased and combustion characteristics of waste cooking oil and, methyl ester and diesel blends were closely followed those of standard diesel.

1.1 Country Borage Oil

This oil is extracted from country borage leaves. It is available in our country. Its properties are approximately the

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same to diesel properties. Performance emission characteristics are to be tested using this oil is non-edible oil. This oil has been considered as an alternative fuel for the compression. And it has low viscosity oil compare than other biodiesel, moisture content also less in this oil.

The blends of varying proportions of country borage oil and diesel will be prepared, analyzed and compared with the performance of diesel fuel and studied using a single cylinder C.I. engine.

II. EXPERIMENT LAYOUT

The layout of the experimental setup is shown in figure 2.1 and the specification of the engine is given in table.2.1

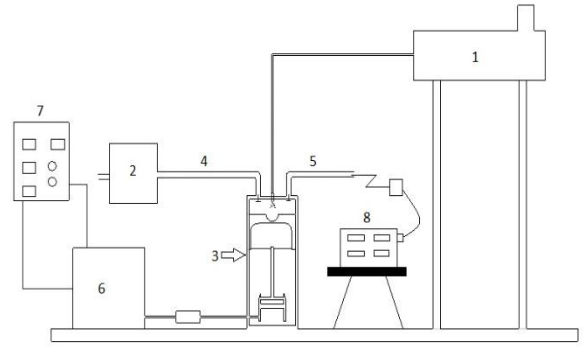

Fig 2.1 Schematic Diagram of the Experimental setup

1. Fuel tank
2. Surge tank
3. Engine
4. Inlet
5. Exhaust
6. Eddy current dynamometer
7. Load cell
8. Exhaust gas analyzer

Model	Kirloskar TAF-1
Type	Single cylinder, four strokes, direct injection
Piston Type	Bowl-in-piston
Capacity	660cc
Bore x stroke	87.5mm x 110mm
Compression Ratio	17.5:1
Speed	1500 rpm (constant)
Rated Power	4.4 kW at 1500 rpm
Dynamometer	Electrical type
Cooling system	Air cooling
Injection Timing	23°C Btdc
Injection Pressure	200 bar
Ignition	Compression-Ignition

Table 2.2 Properties of country borage oil

Properties	Indian borage oil
Density (kg/m^3)	910
Viscosity (at 40◦C) (cs)	5.2
Flashpoint (◦C)	95
Fire point (◦C)	110
Free fatty acid (%)	1.8
Moisture content (%)	10.8
pH value (at 25℃)	6.5

Table 2.3 Comparisons of fuel properties

Properties	Diesel	Country borage oil	Jatropha oil	Neem oil
Density (kg/m^3)	840	910	918	912
Viscosity (at 40◦C)	4.9	5.2	7.9	7.2
Flash point (◦C)	61	95	186	134
Fire point (◦C)	64	110	210	160
Free fatty acid (%)	0.2	1.8	5.31	0.5
Moisture Content (%)	Nil	10.8	15	14

III. RESULTS AND DISCUSSION

3.1 Performance Analysis

The variation of cylinder pressure with the crank angle for the country borage and its diesel blends. The cylinder peak pressure decreases as the proportion of country borage methyl ester in the blend increases but CBM 20 is slight increases compared to diesel and all other blends of cylinder pressure are lower than the diesel.

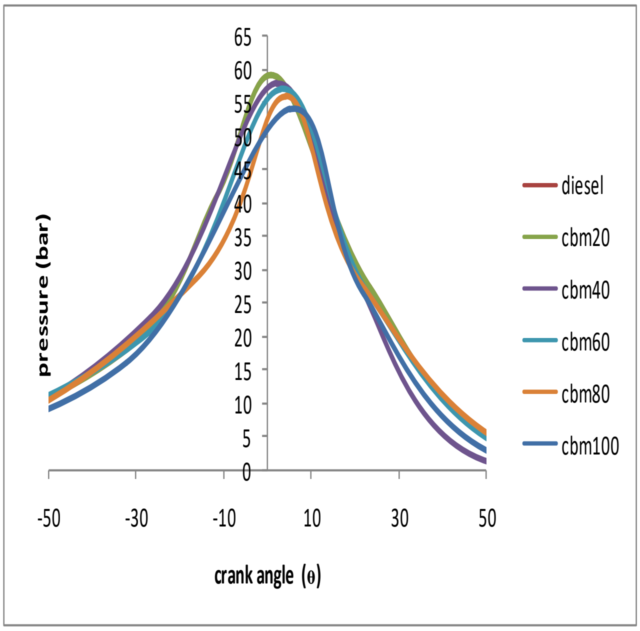

Fig.3.1.1 Variation of pressure with the crank angle at full load

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3.1.2 Rate Of Heat Release

Fig. 3.1.2 Shows the comparison of heat release of country borage and its diesel blends. Country borage methyl ester blends are lower in premixed heat release compared that of standard diesel because the lower heating value of CBM blend as the percentage of CBM blends increases. The maximum heat release rate decreases it is absorbed that the ignition delay of the CBM and its diesel blends are lower than that of diesel. As a result of high in-cylinder temperature during fuel injection, biodiesel may undergo thermal cracking as a result of this.

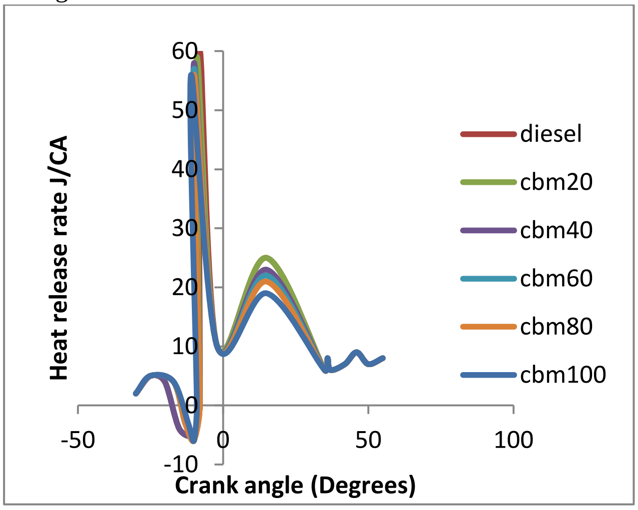

Fig. 3.1.2 Heat Release Rate with Crank angle.

3.2 Performance Analysis

3.2.1 Brake Thermal Efficiency

The brake thermal efficiency of country borage methyl ester and its diesel blend as shown in figure 3.2.1. The brake thermal efficiency for CBM 20 is 3% higher than the diesel and CBM 40 is near to diesel and remaining blends are lower than the diesel because it is an oxidation fuel so that combustion takes place completely. That's why BTE is increased. The decrease for brake thermal efficiency for higher blends due to lower heating value and higher viscosity of blends with a high proportion of methyl ester.

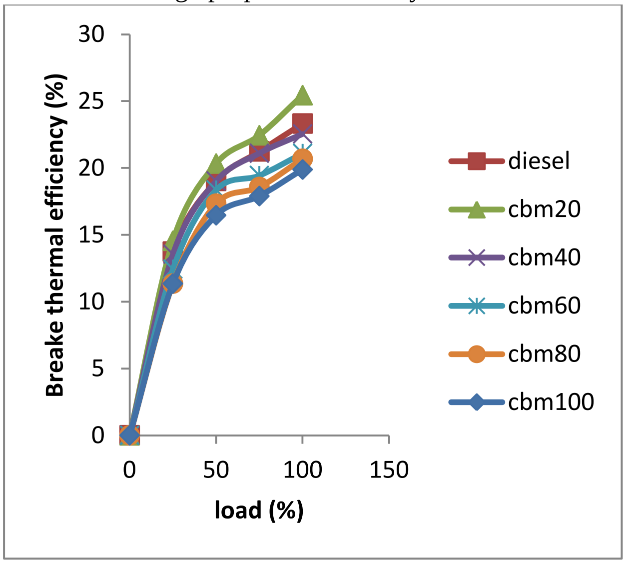

Fig. 3.2.1 Variation of Brake Thermal Efficiency with load

3.3 Emission Analysis

3.3.1 Carbon Monoxide Emissions

The CO emissions are increased in low load and higher load and decreased in medium load. In no-load high CO because the cylinder temperature is low. After that, the temperature is increased in the cylinder CO is reduced. In high load due to insufficient oxygen, so fuel is not burned completely, so the CO emission is high.

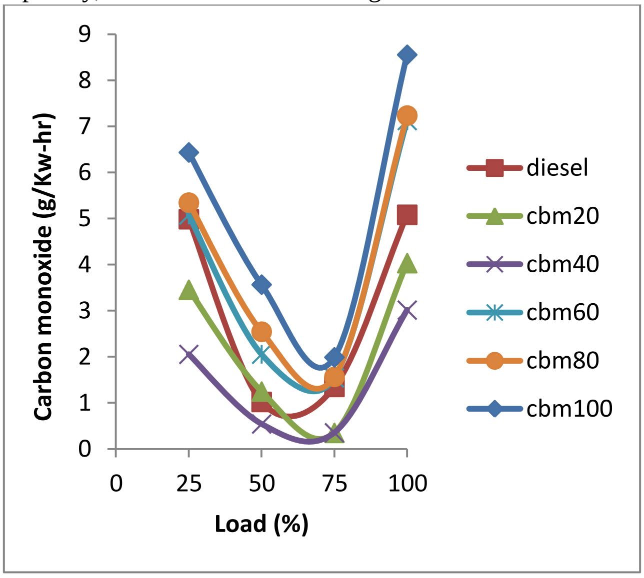

Fig.3.3.1 Variation of Carbon monoxide with a load

3.3.2 Hydro Carbon emissions

The variation of HC emission with a load is shown in figure 3.3.2. The HC emission is high at 25% and 100% load. In medium load, the HC is very low. The CBM 20 is lower than that of diesel. In no-load and high load combustion is not completely take place due to insufficient oxygen. In medium load, the combustion takes place completely because of sufficient oxygen. The effect of fuel viscosity and spray quality has been expected to produce some hydrocarbon increased. Due to the longer ignition delay, the combustion chamber may cause a higher HC emission.

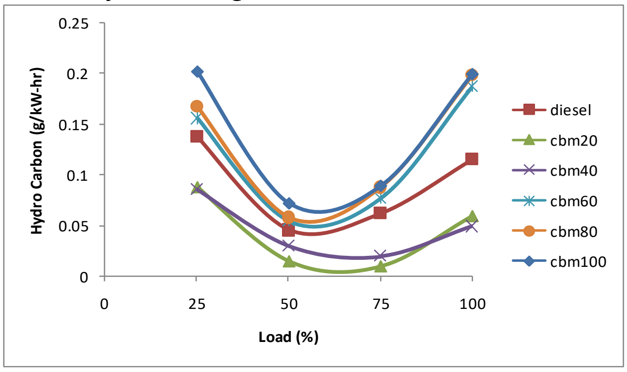

Fig.3.3.2. Variation of Hydro Carbon with a load

3.3.3 Oxides of nitrogen (NOx)

Variation of NOx emission with a load of country borage methyl ester and its diesel blends. It was observed that emission increased by 5% for CBM 40 and 8% for CBM 100 for a full load. In spite of higher viscosity of methyl ester and ignition delay to be lowered than that of diesel. The shorter ignition delay for biodiesel also may advance the start of combustion and contribute to higher NO_X emission, in addition, the oxygen present in the fuel additional oxygen for NOx emission. Thereby increase the NOx emission. The reason for higher NOx emission for the blend is due to the higher peak temperature.

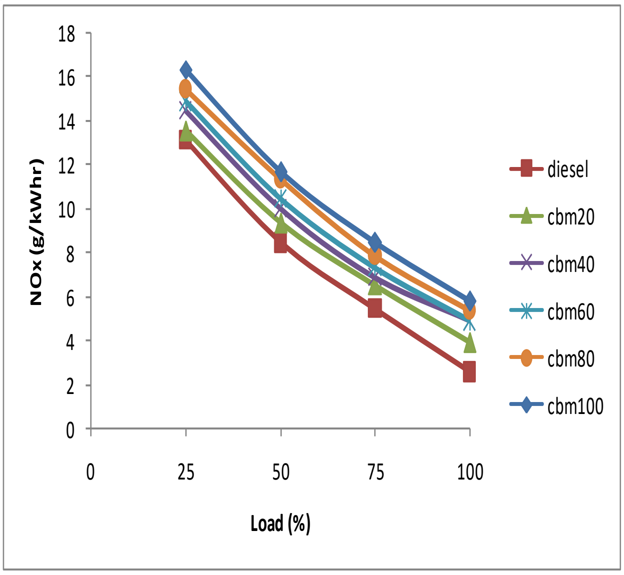

Fig 3.3.3 Variation of Oxides of nitrogen with a load

3.3.4 Smoke Opacity

The variation of smoke opacity is shown in figure 3.3.4. The CBM 20 is lower smoke opacity compared to that of diesel and CBM 100 is higher smoke opacity. The smoke opacity is gradually increased for all other blends due to insufficient oxygen, incomplete combustion takes place. This may be due to the presence of an oxygen molecule in the methyl ester, which enables more complete combustion.

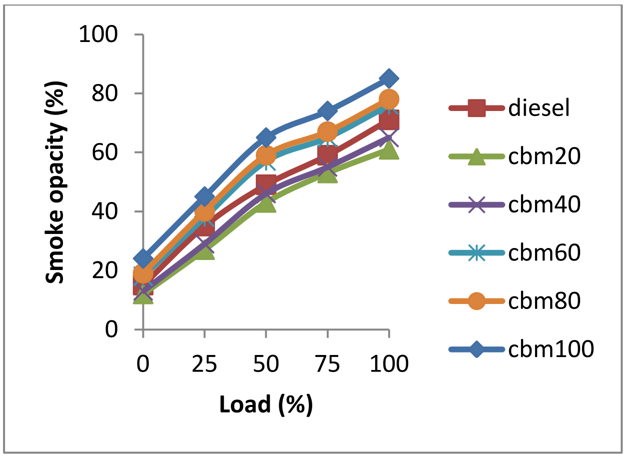

Fig 3.3.4 Variation of Smoke opacity with a load

3.3.5 Exhaust Gas Temperature

The variation of exhaust gas temperature with a load for country borage methyl ester and its diesel blend. It absorbed that as a proportion of methyl ester increase in a blend the exhaust gas temperature also increase for all the loads. In no-load the exhaust gas temperature is low. Increase the load the exhaust gas temperature increases due to more oxygen content in CBM which improves combustion and thus increase the exhaust gas

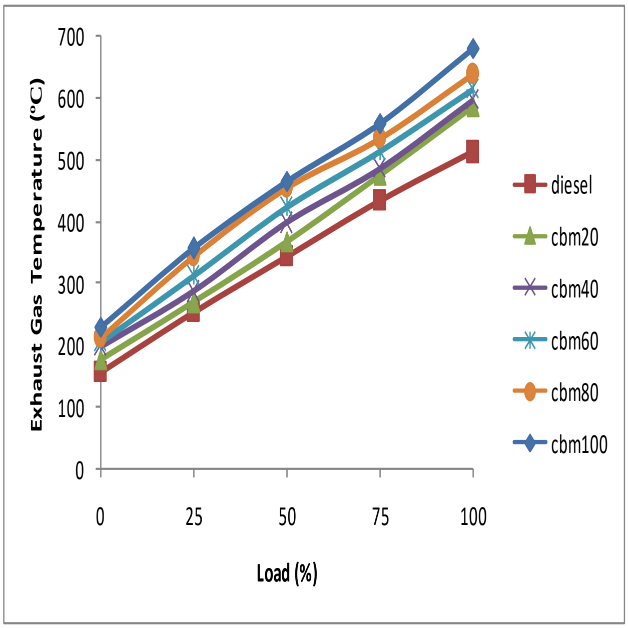

Fig.3.3.5 Variation of Exhaust gas temperature with a load

IV CONCLUSION

The performance, emission and combustion characteristics of a 4.4 kW DI compression ignition engine summer with cbm and its blends have been analyzed and compared to those of diesel fuel. The conclusion of the present work is summarized as follows.

- The BTE of CBM 20 blend was slightly higher 3% of standard diesel.
- The reduction of HC emission by 22% and 23% respectively were recorded for the CBM 20 blend and CBM 40 blend.
- The smoke emissions were reduced by 20% and 40% for CBM 20 and CBM 40 blend respectively.
- The slight increase of 5% and 8% of NOx emission is recorded for CBM 20 and CBM 40 respectively.
- The combustion characteristics of country borage methyl ester and diesel blends are comparable with those of standard fuels. For the above results, the CBM 20 blend is superior when compared to other blends.

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