Performance Analysis and Investigation of Emissions of C.I.Engine Using Biodiesel as Blending Agent

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Abstract- The industrialization of the world has led to a sharp rise for the demand of petroleum products. The fast depletion in the petroleum reserve and uncertainty in supply due to political and economical reasons are causing hike in petroleum prices. Environmental pollution due to burning of these fuels has stimulated the search for alternative fuels to petroleum fuels. High dependance on non-renewable sources presents a window of opportunity for looking at alternative fuels. Biodiesel can be cosidered as one of the potential renewable energy sources for diesel engines. Biodiesel can be used directly or in blended form of diesel. In the present review, reports about engine performances and emissions using biodiesel published by journals regarding the effect of biodiesel on engine power and emissions of a four strokes compression ignition engine are surveyed and analyzed in detail. An experimental investigation was made to evaluate the performance and emission characteristics of a diesel engine using different blends of methyl ester of cottonseed oil and neemseed oil with mineral diesel. Cottonseed and Neemseed methyl ester were blended with diesel in proportions of 10%, 20%, 30% and studied under various load conditions and compression ratio in a compression ignition (diesel) engine. The performance parameters were found to be very close to that of mineral diesel. The brake power, brake thermal efficiency, specific fuel consumption and exhaust gas temperature were studied. Similarly the emission characteristics were also studied and levels of carbon dioxide, NOx found to be more than diesel.

Keywords-:*Cottonseed oil, Neemseed oil, VCR engine,Compression Ratio*

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I. INTRODUCTION

India depends mainly on imported fuels due to lack of fossil fuel reserves and it has a great impact on economy. India has to look for an alternative to sustain the growth rate. Bio-diesel is a promising alternative for our diesel needs. With vast vegetation and land availability, certainly bio-diesel is a viable source of fuel for Indian conditions. Recent studies and research have made it possible to extract bio-diesel at economical costs and quantities. The blend of biodiesel with fossil diesel has many benefits like reduction in emissions, increase in efficiency of engine, higher cetane rating, lower engine wear, low fuel consumption, reduction in oil consumption etc. It can be seen that the efficiency of the engine increases by the utilization of bio-diesel. This will have a great impact on Indian economy [1].

The concept of biofuel firstly came into the picture in 1885 when Dr. Rudolf Diesel built the first diesel compression ignition engine with full intention of running it on vegetative source and developed the first engine to run on peanut oil. There is an improvement in the engine performance when the modified vegetable oils are used instead of base vegetable oils. The neat oils can be converted into their respective Methyl esters (biodiesel) using transestrification process [2].

The energy consumption in India is the fourth biggest after China, USA and Russia. The total primary energy consumption from crude oil (29.45%), natural gas (7.7%), coal (54.5%), nuclear energy (1.26%), hydro electricity (5.0%), wind power, biomass electricity and solar power is 595 Mtoe in the year 2013. In the year 2013, India's net imports are nearly 144.3 million tons of crude oil, 16 Mtoe of LNG and 95 Mtoe coal totalling to 255.3 Mtoe of primary energy which is equal to 42.9% of total primary energy consumption. The rapidly increasing demand of crude oil coupled with increase in fuel demand has forced the countries to look for alternative to conventional fuels [8].

II. LITERATURE SURVEY

S.Kirankumar [1] conducted experiment on the four stroke single cylinder water cooled diesel engine at constant speed (1500 rpm) with varying loads by using cotton seed oil blends of C10, C20 and C30 by varying the injection pressures from 165 bar to 210 bar. The performance characteristics were observed better with blends when compared to the pure diesel operation. Maximum brake thermal efficiency observed was 34.01% with 30% blend at an injection pressure of 195 bar and lower specific fuel consumption observed was 0.258 kg/kw-hr with 30% blend at an injection pressure of 195bar.

K. Dilip Kumar *et al.* [2] carried out experimental investigations on C. I. engine with Bio Diesel blends of cotton seed Methyl Esters and Neem Oil Methyl Esters. Various Tests have been carried out to examine properties, performance of different blends (C05, C10, C15, and C20) of CSOME and NOME in comparison to diesel. C20 have closer performance to diesel and cotton seed methyl ester gives better performance compared to Neem methyl esters and also the emissions and smoke for these diesel blends were less as compare to the pure diesel.

M. Harinarh Reddy *et al.* [3] investigated the performance of a diesel engine using diesel fuel and cottonseed oil (CSO) biodiesel in terms of brake thermal efficiency and indicated thermal efficiency for conventional diesel, cottonseed oil, as well as for Jatropha oil. The study reveals that the use of cottonseed oil biodiesel improves the

performance parameters of CI engine compared to conventional diesel fuel.

M C Navindgi *et al*. [4] made an effort to determine the performance and emission characteristics of CNG and neem blends in CI engine. The engine showed very similar performance compared to diesel operation near up to 90% of rated load with up to 54% replacement of diesel by CNG being possible.

Lovekush Prasad et al.[5] conducted experiments with different blends (B10&B20) of neem oil and diesel as various loads. The results showed that the brake thermal efficiency of diesel is slightly higher at all loads followed by blends of neem oil and diesel, it has been established that 20% of neem oil biodiesel can be use as a substitute for diesel without any engine modification thus neem oil as non-edible oil can be a good renewable raw material for biodiesel production.

Yogesh Tamboli et al. [6] found that the brake thermal efficiency was reduced about 5% for Neem oil ester when compared to diesel. The brake specific fuel consumption is increased about Neem oil ester it is increased about 11% to 13% when compared to diesel fuel. The brake power is reduced about 12% for neem oil ester when compared to that of diesel. The carbon monoxide is reduced for Neem oil ester it is reduced about 16 % when compared to that of diesel. It is concluded that the carbon monoxide for vegetable oil ester is less when compared to diesel fuel.

III. EXPERIMENTAL SETUP

The setup consists of single cylinder, four stroke, VCR (Variable Compression Ratio) Diesel engine connected to eddy current type dynamometer for loading. The compression ratio can be changed without stopping the engine and without altering the combustion chamber geometry by specially designed tilting cylinder block arrangement [9].

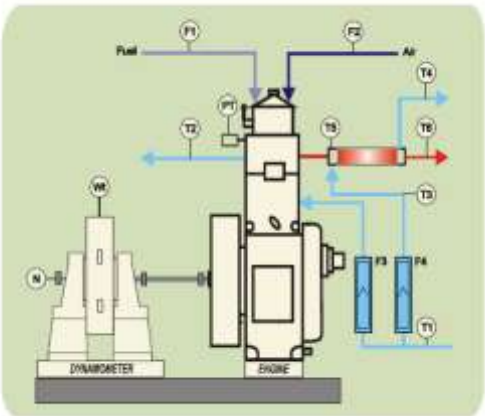


Figure1: Schematic Diagram of Experimental Setup

The experimentation is carried out on NOME and COME on VCR engine. The parameters for experiment were selected as shown in Table I. The experimentation was conducted on Kirloskar make single cylinder, 4- stroke, water cooled diesel engine having rated power 3.5 kW at 1500 rpm VCR engine at I. C. Engine laboratory of SCSMCOE, Ahmednagar.

TABLE I. Experimental Parameters

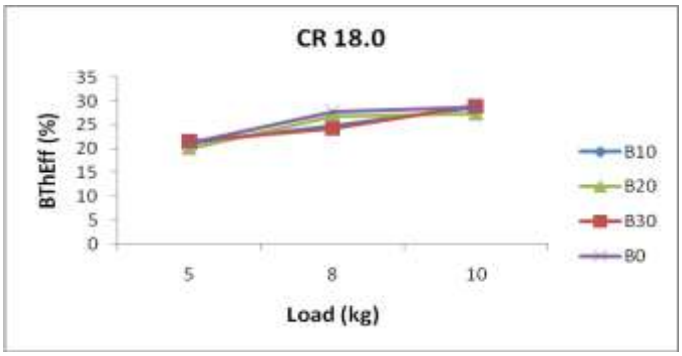
Blend	CR	Load (kg)	Blend	CR	Load (kg)	Blend	CR	Load (kg)
B10	18	5	B20	18	5	B30	18	5
		8			8			8
		10			10			10
	17.5	5		17.5	5		17.5	5
		8			8			8
		10			10			10

IV. RESULTS AND DISCUSSION

The performance and emission results are discussed below.

A. *Brake thermal efficiency:*

As the load on the engine increases, brake thermal efficiency increases because brake thermal efficiency is the function of brake power and brake power increases as the load on the engine increases.



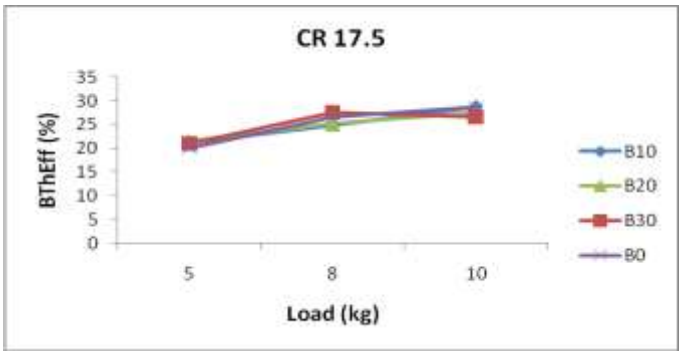
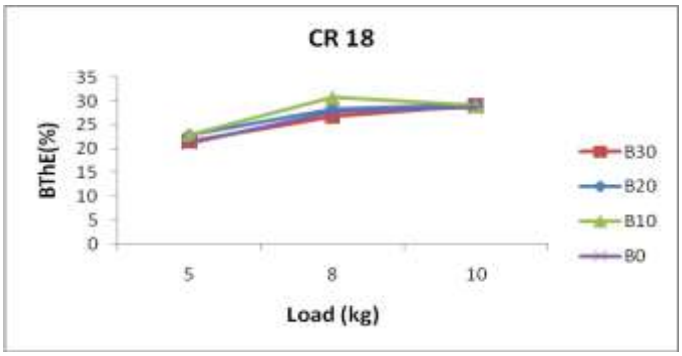


Figure2: Variation of Brake Thermal Efficiency with Load for NOME



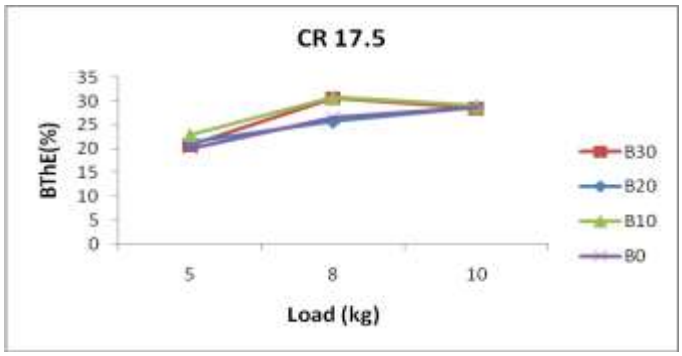
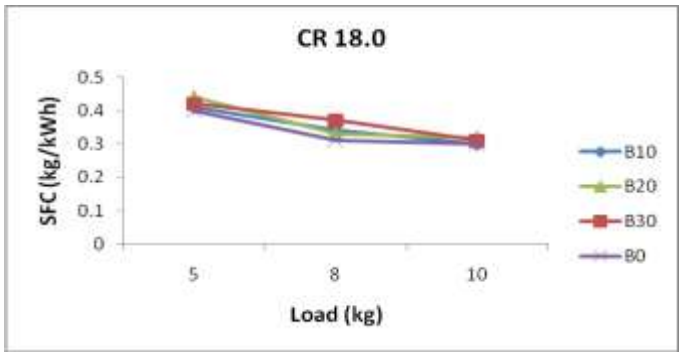


Figure3. Variation of Brake Thermal Efficiency with Load for COME

B. Brake Specific Fuel Consumption

Variation of BSFC for NOME and COME with B10, B20 and B30 at different loads and CR 17.5 and 18 is shown below.



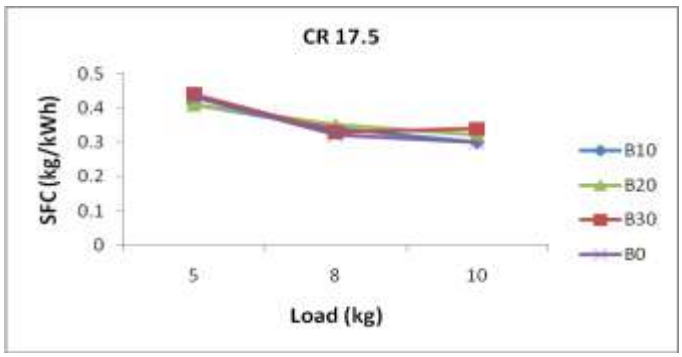
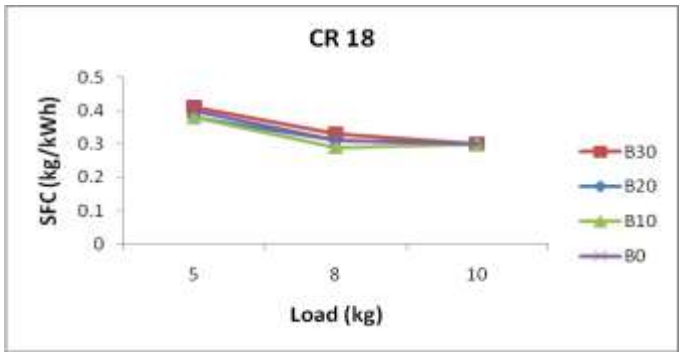


Figure4: Variation of Brake Specific Fuel Consumption with Load for NOME



SFC for diesel is lowest for almost all loading conditions and decreases continuously with increase in load. SFC for blends of NOME and COME is slightly higher than diesel except for B20 having very close to that of diesel.

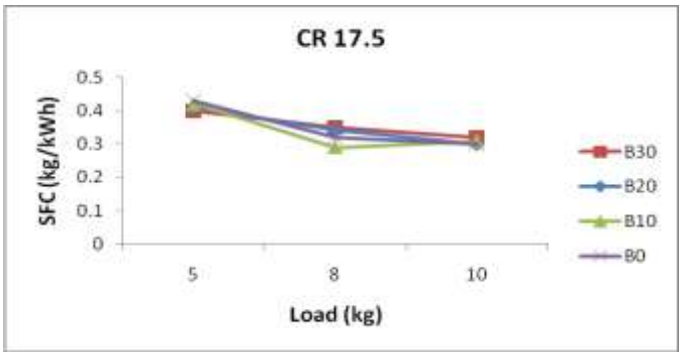
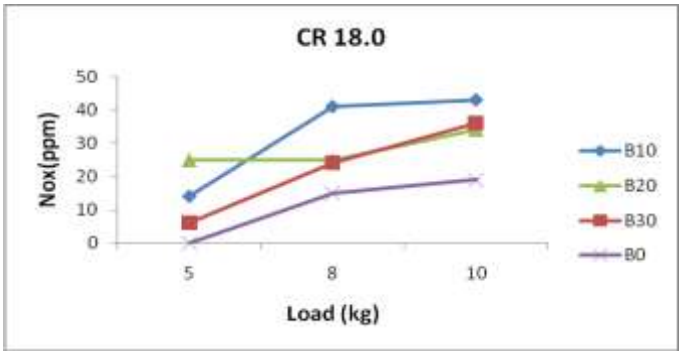


Figure5: Variation of Brake Specific Fuel Consumption with Load for COME

C. NO_x Emission

At higher temperature nitrogen will combined with oxygen and produce the oxides of nitrogen. Biodiesel gives more oxides of nitrogen as compared to pure diesel because of extra oxygen present in the blend which may lead to better combustion results higher temperature which is responsible for generating the oxides of nitrogen.



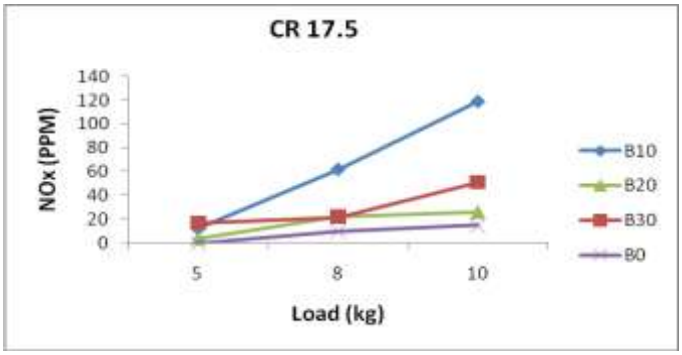
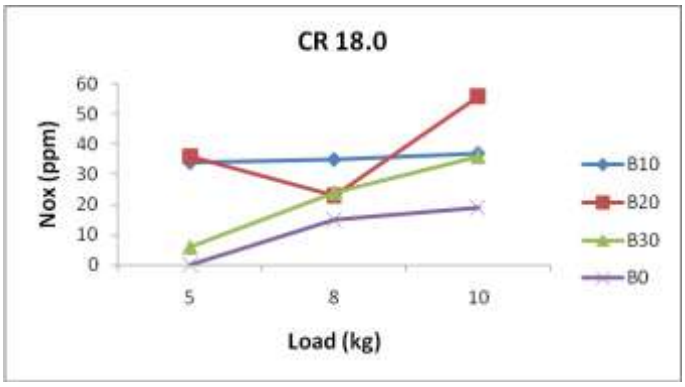


Figure6: Variation of NOx with Load for NOME



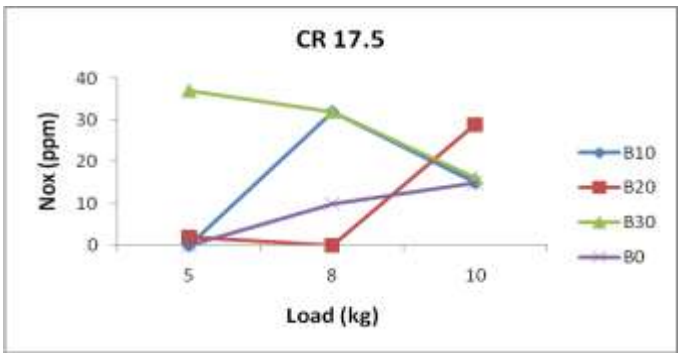
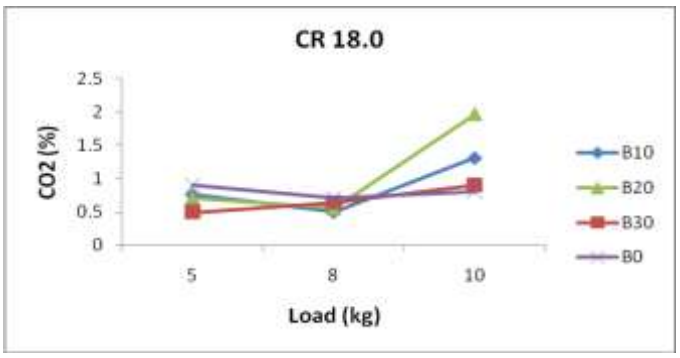


Figure7: Variation of NOx with Load for COME

One more reason for generating the oxides of nitrogen is after burning because in C.I. Engine combustion will continue till to the end of the expansion process. Those particles of fuel which are taking part in the combustion process at the end of the expansion process is not producing any work. This can generate higher temperature in exhaust where there is chance for generating the oxides of nitrogen.

D. CO_2 Emission

If the engine performs well than defiantly CO emission will be less. In the presence of less oxygen, CO will generate in the cylinder. Biodiesel produce less carbon monoxide than compare to pure diesel because of better combustion because extra oxygen present in the blend.



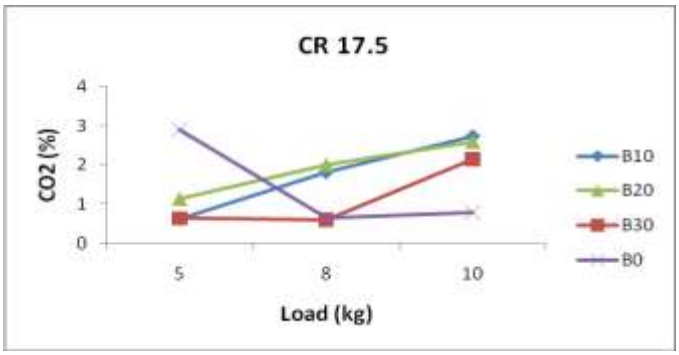
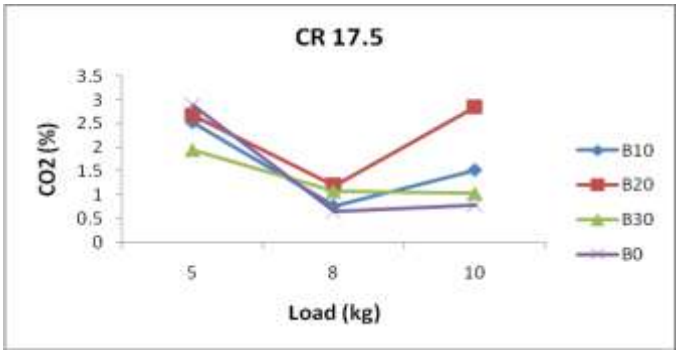


Figure8: Variation of CO2 with Load for NOME



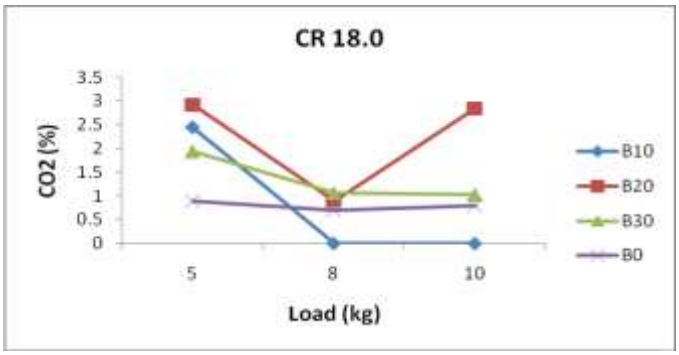


Figure9: Variation of CO2 with Load for COME

E. The Regression Equation

In general, the multiple regression equation of Y on X_1, X_2, …, X_k is given by:

$$Y = b_0 + b_1 X_1 + b_2 X_2 + \ldots\ldots\ldots\ldots\ldots\ldots\ldots + b_k X_k$$

The regression equations correlating the brake thermal efficiency, load and blend for NOME and COME for CR 17.5 and 18 are obtained by using Minitab software.

For NOME,

Bth = 14.16 + 1.413 Load – 0.004 Blend …… (1)

Bth = 13.99 + 1.511 Load – 0.028 Blend …… (2)

For COME,

Bth = 13.78 + 1.467 Load – 0.0032 Blend …… (3)

Bth = 15.52 + 1.412 Load - 0.0057 Blend …… (4)

F. Confirmation Test

By substituting different values of blends and loads, theoretical values are obtained. These values are compared with the actual values as given in Table II

Table II: Comparison between Theoretical and Practical Values of Bth

Sr. No.	Load	Blend	CR	Theoretical value of Bth	Practical value of Bth	Difference	% of Diff.
1	5	10	17.5	21.19	21.10	0.09	0.42
2	10	10	18	28.82	28.74	0.08	0.28
3	5	20	17.5	21.5	21.39	0.11	0.51
4	10	20	18	29.5	29.3	0.2	0.68

V. CONCLUSION

Biodiesel could be safely blended with diesel fuel up to 20% at any of the compression ratio tested for getting almost the same performance and emission as that with diesel fuel. An increase in bsfc has been found when using biodiesel at all loads and speeds in study. The brake thermal efficiency of diesel engines tested was reduced when substituting diesel by biodiesel in its blended form. On an average, the CO2 emission increased by 16%, CO emission reduced by 37.5% and NOx emission increased by 36.84% . In general, increasing the compression ratio improved the performance and cylinder pressure of the engine and had more benefits with biodiesel than with high pure diesel.

VI. REFERENCES

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