

Performance Analysis of Emissions using Biodiesels as Fuel for different Compression Ratio

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ABSTRACT: The rapidly increasing consumption of fossil fuel and petroleum products has been a matter of concern for the many countries which imports more crude oil. Because it causes huge foreign exchange out-go on the one hand and increasing exhaust emission on the other. Therefore it is necessary for the development of renewable energy sources. Vegetable oils have become more attractive recently because of their environmental benefits and it is made from renewable resources. Bio-diesel commands crucial advantages such as technical feasibility of blending in any ratio with petroleum diesel fuel, use of existing storage facility and infrastructure, superiority from the environment and emission reduction angle, its capacity to provide energy security to remote and rural areas and employment generation. There are more than 350 oil bearing crops identified, among which only sun flower, sunflower, soybean, cottonseed, rapeseed, Jatropha curcas and peanut oils are considered as potential alternative fuels for Diesel engines. Smoke reduces as compression ratio increase. When compared with diesel fuel the smoke increases for all blends for lower CR while for higher CR smoke reduces drastically. As compression ratio increases the NO_x increases for neat diesel while NO_x decreases for lower blends. CO was not changed with compression ratio for all the blend of fuel. Brake specific fuel consumption decreases with the compression ratio increases. Brake thermal efficiency increase with the compression ratio for all fuel. Exhaust gas temperature increases with compression ratio for all blends.

KEYWORDS: Jatropha Oil, Mahua Oil, Blends, Compression Ratio

I. INTRODUCTION

With the Modernization and industrial growth in the world, the consumption of the petroleum resources is increasing day by day but these resources are limited, it is widely acceptable that these natural petroleum resources are likely to be depleted in 100 years from now. Thus in the favour of this experimental data there is a requirement of alternative sources to replace these petroleum resources without a wider change in the conventional engines and which are renewable and easily achievable in the nature and Also should be available at low cost.

Biodiesel will be the best alternative over the diesel because it is renewable, environment friendly and easily produced in rural area. It can produce same power as the conventional diesel fuel in the conventional diesel engine. It is non toxic and produced less CO₂ and CO on the combustion. Biodiesel is derived from the vegetables like Sunflower, Neem, Jatropha, Mahua, curcas, corn and canola etc. In recent years many efforts have been taken by the several researchers in making the Biodiesel suitable. There is Number of Countries which are working on different aspect of producing Biodiesel, for example in Philippines research on coconut oil, USA research on the soybeans oil. European country research on sunflower oil.

In the all non-edible Tree Bearing Oil (TBO) seeds, *Jatropha* is considered as most favourable plant for the production of biodiesel, because it can be harvest in the non agricultural land and also in the area of low rain fall (~27 cm) as well as heavy rain fall. It can be used directly after the extraction (without refining) in the conventional diesel engine. *Jatropha curcas* can grow in the variety of agro-climatic conditions. Thus it ensures the reasonable production at the low input. *Jatropha* Biodiesel can be used or mixed in any ratio with the diesel. But preferred ratios between 5 to 20%.

Two species of the genus *madhuca* *indica* and *madhuca* *longifolia* are found in India. *Mahua* is known as *Illupaimaramin* Tamil and *Hippiin* Kannada, which can be successfully grown in the wastelands and dry lands. The seeds of the tree, popularly known as `Indian butter tree. The specific gravity of mahua oil was 9.11% higher than that of diesel. The kinematic viscosity of mahua oil was 15.23times more than that of diesel at temperature of 40c. The kinematic viscosity of mahua oil reduced considerably with increase in temperature to 80c and by increasing the proportion of diesel in fuel blends.

Table: Comparison of properties of *Jatropha* Oil and Mahua Oil

Properties	Diesel	<i>Jatropha</i> Oil	Mahua Oil
Density gm/cc	0.840	0.918	0.918
Calorific Value MJ/KW-hr	42.39	39.774	38.863
Cetane Number	45.55	45	38
Viscosity @ 44°C	4.59	49.9	68.51
Flash Point °C	75	240	238
Carbon Residue	0.1	0.44	0.4215
Fire Point °C	78	244	244

Modification: The problems associated with viscosity can be reduced by heating the oil before entering into the engine.

1. Further the fuel injection problem can be increasing the injection pressure.
2. The problems associated with late/slow burning can be avoided by advancing fuel injection and preheating the fuel.
3. All the above problems can be eliminated up to certain extent by blending vegetable oils with diesel (Transesterification).
4. Low problems can be eliminated by winterization (popular technique for reducing high melting point by freezing them over a prescribed time period and drawing the liquid portion off separately)

Biodiesel production is the process of producing the bio fuel, biodiesel, through the chemical reactions transesterification and esterification. This involves vegetable or animal fats and oils being reacted with short-chain alcohols (typically methanol or ethanol). The alcohols used should be of low molecular weight, ethanol being one of the most used for its low cost. However, greater conversions into biodiesel can be reached using methanol. Although the transesterification reaction can be catalyzed by either acids or bases the most common means of production is base-catalyzed transesterification. This path has lower reaction times and catalyst cost than those posed by acid catalysis. However, alkaline catalysis has the disadvantage of its high sensitivity to both water and free fatty acids present in the oils.

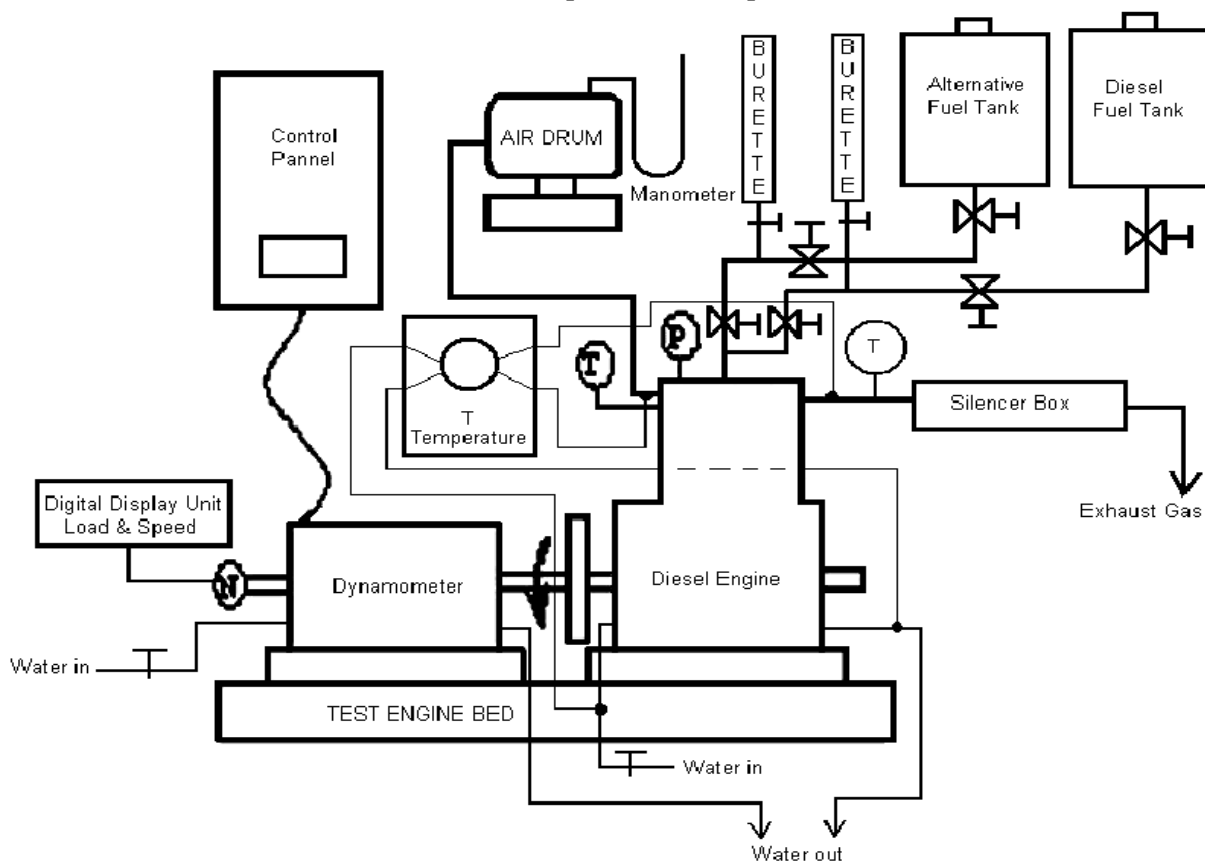
Transesterification:

In organic chemistry, **transesterification** is the process of exchanging the organic group R'' of an ester with the organic group R' of an alcohol. These reactions are often catalyzed by the addition of an acid or base catalyst. The reaction can also be accomplished with the help of enzymes (biocatalysts) particularly lipases (E.C.3.1.1.3).



Strong acids catalyse the reaction by donating a proton to the carbonyl group, thus making it a more potent electrophile, whereas bases catalyse the reaction by removing a proton from the alcohol, thus making it more nucleophilic. Esters with larger alkoxy groups can be made from methyl or ethyl esters in high purity by heating the mixture of ester, acid/base, and large alcohol and evaporating the small alcohol to drive equilibrium.

II. Experimental Setup:



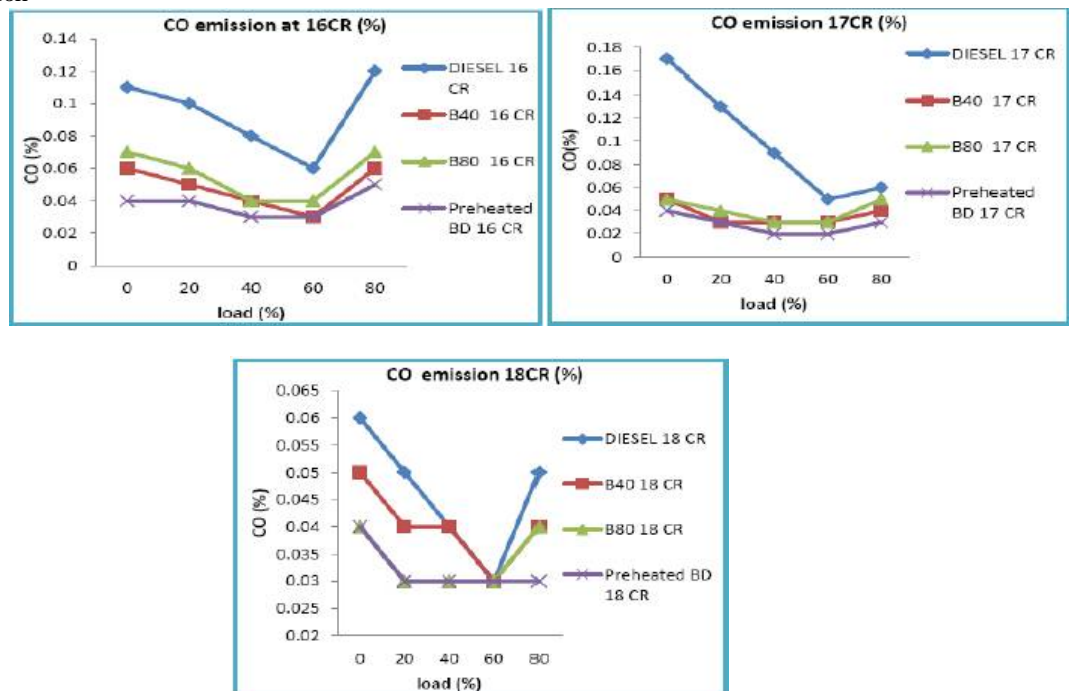
Engine Specification:

Sr. No.	Engine Parameters	Constant Values
01	Fuel Density	830 kg/m ³
02	Fuel Calorific Value	42000 KJ/Kg
03	Compression Ratio	12-18
04	Cylinder Dia.	0.0875 m
05	Stroke length	0.11 m
06	No. Of Cylinder	1
07	Specific Heat Of Exhaust	1.542 KJ/Kg-K
08	Rated power	5bhp at 1500rpm
09	Dynamometer Type	Eddy current, water cooled, with loading unit
10	Piezo sensor	Range 5000 PSI, with low noise cable
11	Crank angle sensor	Resolution 1 Deg, Speed 5500 RPM with TDC pulse
12	Data acquisition device	NI USB6210, 16 -bit, 250kS/s

III. EXPERIMENTAL RESULTS

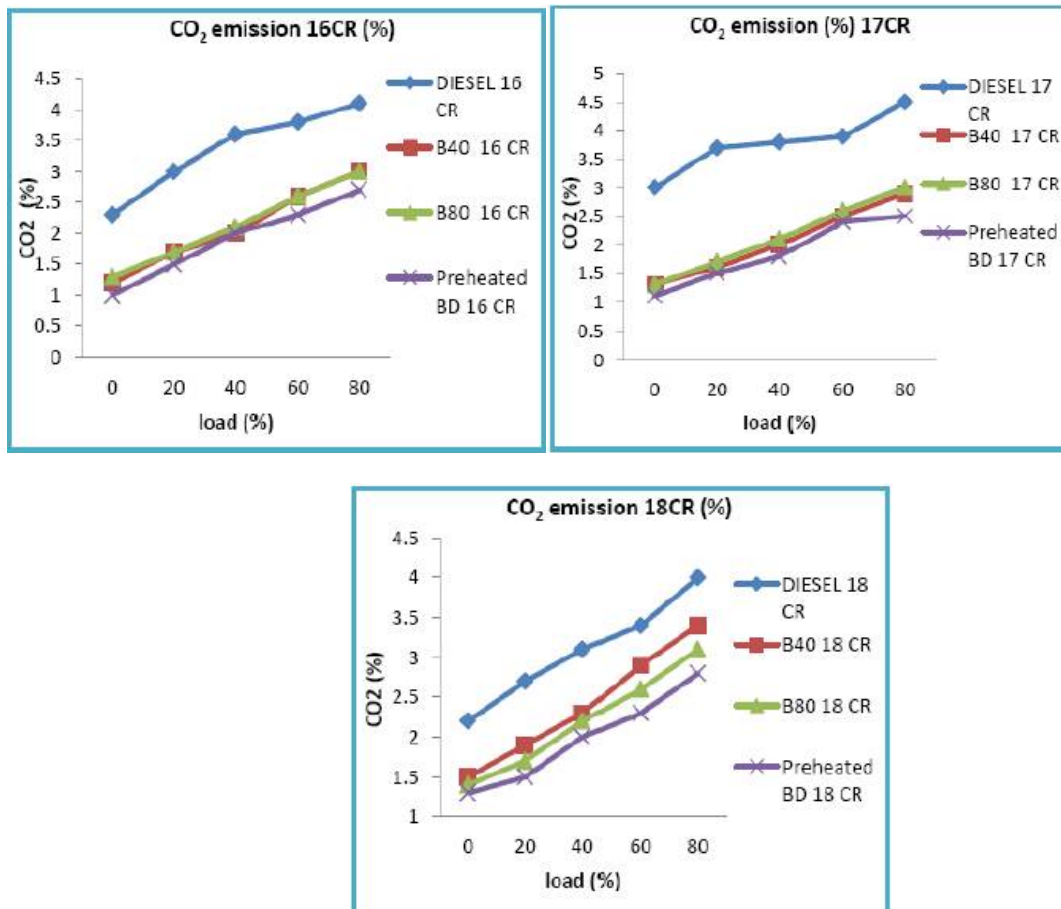
Emission Analysis:

1) CO Emission



As shown in graphs that CO emissions for the Diesel is higher than that of the blends of Jatropha biodiesel. The increase of CO emission as load decrease was an indication of improve combustion efficiency was in correlation to the change in brake thermal efficiency BTE under change in load. But at the 80% load CO emission rapidly increase it is due to that at higher load fuel consumption is high and combustion process also high this increase incomplete combustion, resulting in rapid increase in the CO emission. The emissions of CO increase with increasing load. Higher the load, richer fuel air mixture is burned, and thus more CO is produced due to lack of oxygen. As we discussed above that co emission in the blends of the biodiesel is lower than that of the diesel due to the less carbon content in to the biodiesel blends, but as in graph that CO emission for the B80 is slightly higher than that of the B40. Its reason may be the improper atomization and high viscosity of the Biodiesel blend, which leads to the improper combustion and lead to increase emission of CO. In the this is case of preheated Jatropha oil the CO emission is less in comparison to all blends this is due to the pure biodiesel which have less carbon content and also due to preheating of the biodiesel, leads to decrease it viscosity and improve atomization and proper combustion and resulting in the less CO emission.

2) CO₂ Emission:

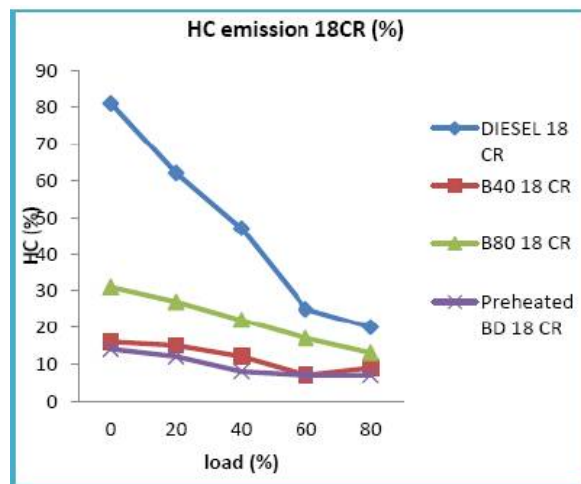
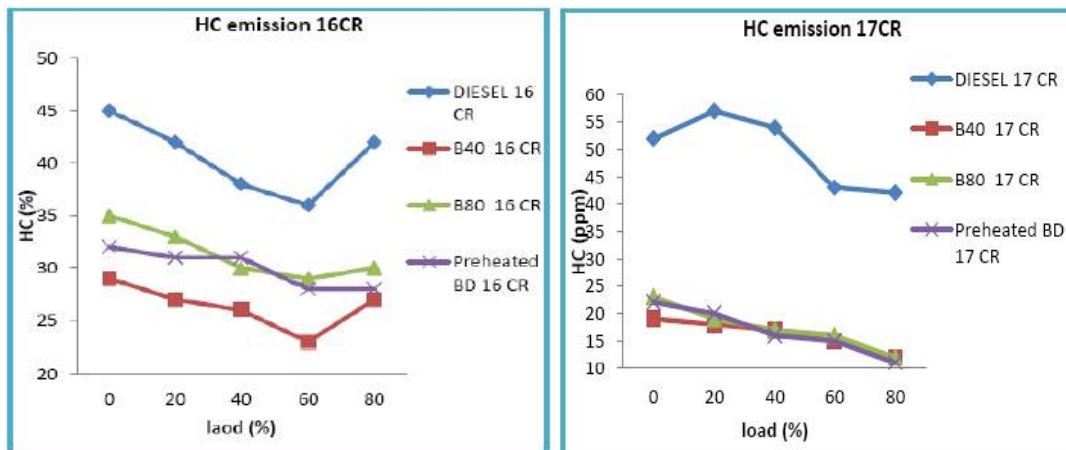


The carbon dioxide emission from the diesel engine with different blends is shown in graphs. The CO₂ increased with increase in load conditions for diesel and for biodiesel blended fuels. The carbon dioxide emission from the diesel engine with different blends is shown in graph. The CO₂ increased with increase in load conditions for diesel and for

biodiesel blended fuels. The Jatropha biodiesel followed the same trend of CO₂ emission which was higher than in case of diesel. Since biodiesel is produced from plant oils or animal fats, it has been promoted as means for reducing emissions of carbon dioxide that would otherwise be produced from the combustion of petroleum-based fuels. Carbon dioxide is considered by many to be an important component in global warming, though other pollutants can also play a role. The total impact that biodiesel could have on global warming would be a function not just of its combustion products, but also of the emissions associated with the full biodiesel production and consumption lifecycle. We perform the experiment for the B40 and

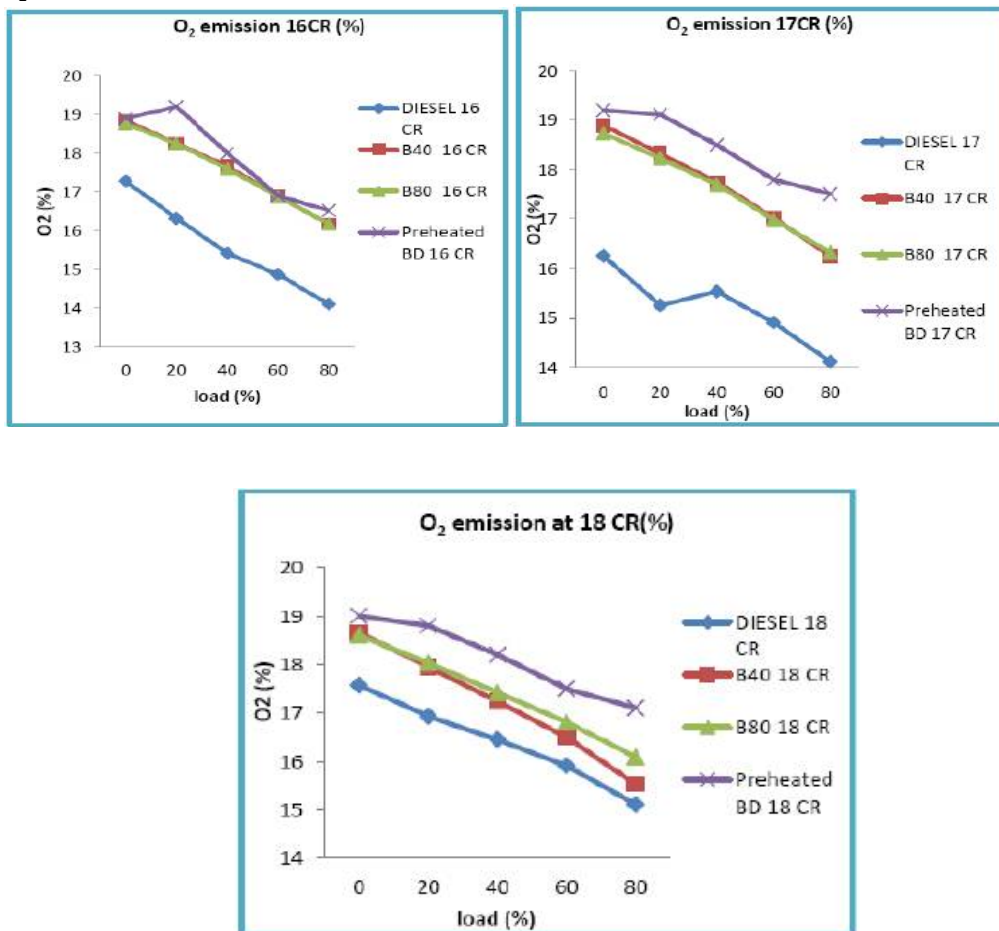
B80 blends of the biodiesel and compare it with Diesel in the diesel engine. Thus we can see in the graphs that CO₂ emission for the diesel is higher than that of the any blends of the biodiesel this is due to that diesel contain carbon content in high quantity in comparison of biodiesel. And also emission of CO₂ for the blends is nearly same, but that for preheated biodiesel is lower than the blends, this may be because pure biodiesel with any mixing of the Diesel very low carbon content.

3) HC Emission:



HC exhaust emissions are shown in the graphs. For all of blends, the HC emissions were less than that of the diesel fuel. Biodiesel contains oxygen in its structure. When biodiesel is added to diesel fuel, the oxygen content of fuel blend is increased and thus less oxygen is needed for combustion. However oxygen content of fuel is main reason for better combustion and reduction in to the HC emission. On the other hand, the reduction of HC is due to the oxygenated fuel of biodiesel, it leads to a more complete combustion. The higher cetane number of biodiesel fuel reduces delay period leading to lower HC emissions. Thus, the higher oxygen content and cetane number of biodiesel-diesel fuel blends tend to reduce HC emissions when compared to conventional diesel. Diesel engine performance showed that the biodiesel blend offered lower engine power output, higher specific fuel consumption, and lower mechanical efficiency. Consequently, the biodiesel producing cleaner emission with the significant drop in CO, and HC emissions compares to the conventional diesel.

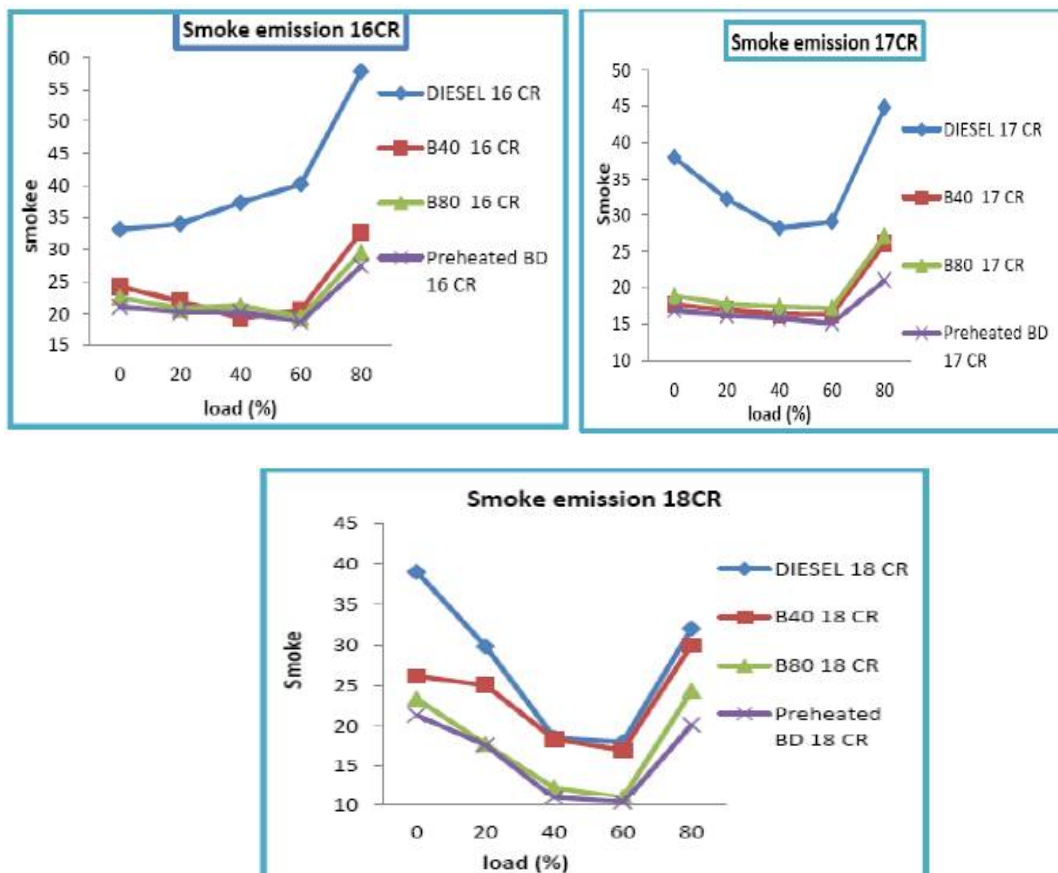
4) O₂ Emission:



As we seen in the graphs that O₂ emission for the blends of biodiesel is higher than that of the Diesel. This is due to because Biodiesel is an oxygenated fuel and it contains oxygen of about 11% by weight. High oxygen content leading to complete combustion. The presence of oxygen in biodiesel fuel results in higher heat release during the premixed phase combustion. As we seen in the graphs that O₂ emission is maximum for the preheated biodiesel is maximum and then for the biodiesel blends and lowest for the mixture the emission of the O₂ will be increase. Emission of the O₂

decrease with the increase in the load. And it is minimum at 80% load, because at this load the brake power is maximum thus mean increase in the combustion rate and consumption of the oxygen of the fuel for the combustion process.

5) Smoke Emission:

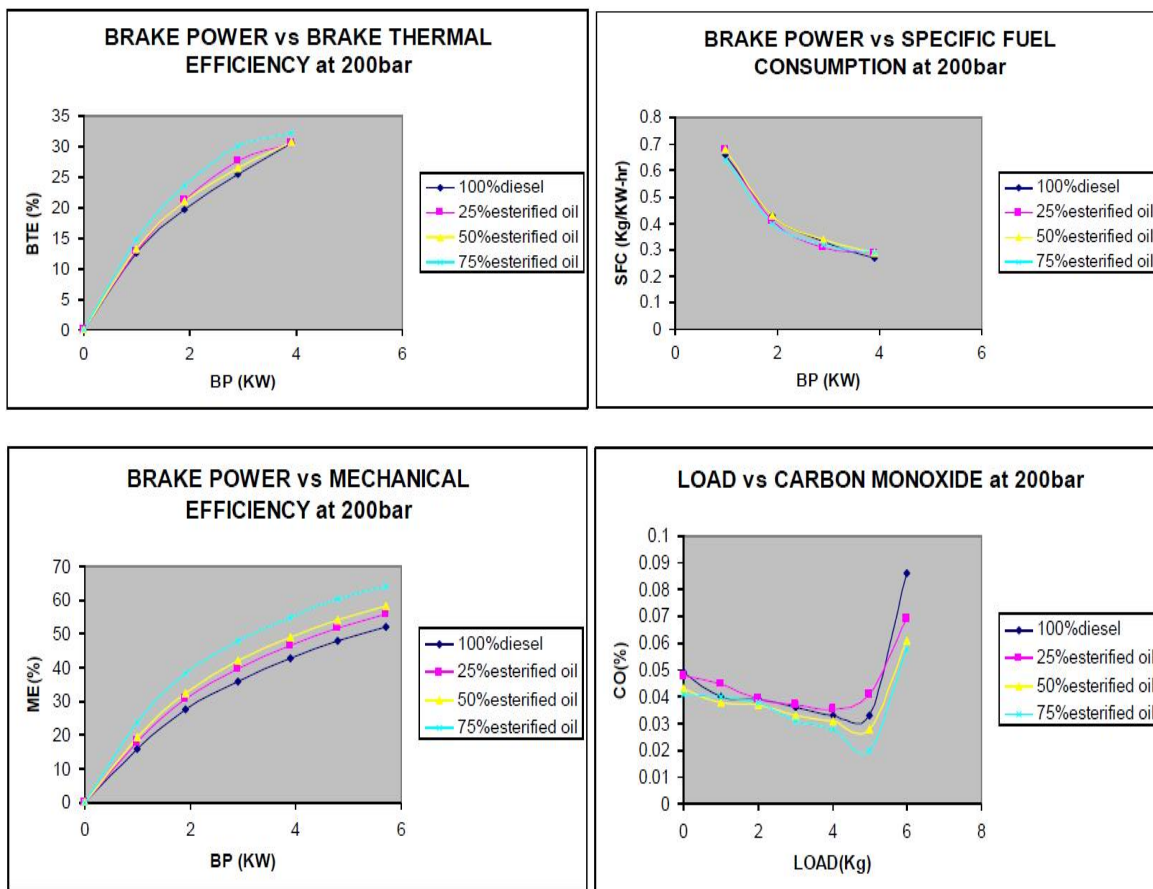


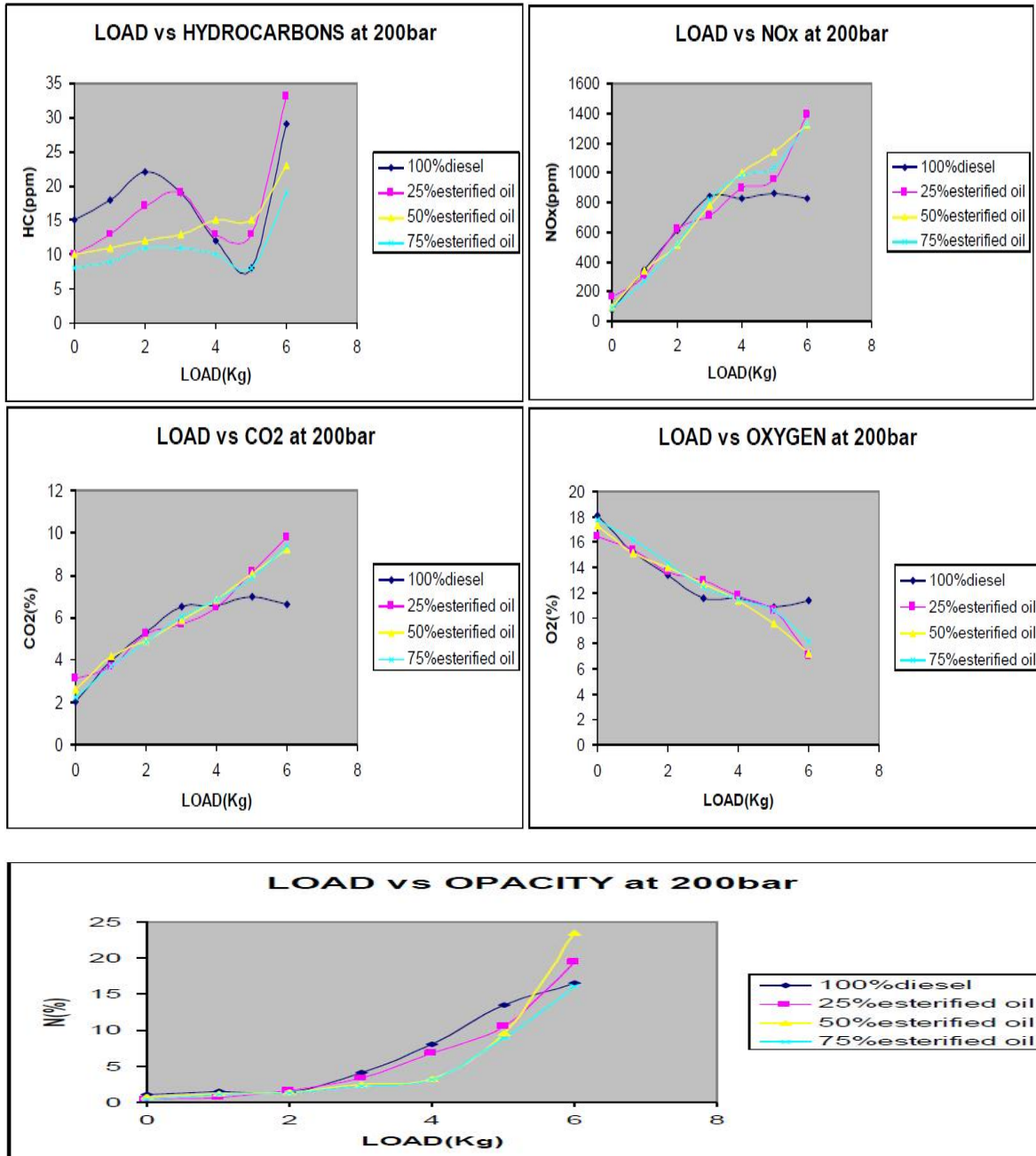
The graph was plotted between smoke emission and varying load (%). The smoke emission found to increase continuously with the increase in load. It is clear from the graph that smoke emission for the diesel is maximum and minimum for the preheated Jatropha oil, Blends of Jatropha biodiesel shows intermediate performance for the smoke emission, the lies between the Diesel and Preheated Jatropha oil in the smoke emission characteristics. At the zero load smoke emission is high but as the load increase it value decrease till 60% load, but at 80% load it value suddenly increase. Smoke emission for the diesel is minimum at the 60% load approximate 20 % 18CR, and for the B40 and B80 blends also minimum at 60% load, this also continue in the case of preheated biodiesel. Thus from the this experimental data it is clear that Diesel, all blends of Jatropha Biodiesel and preheated Jatropha oil shows good smoke emission characteristics for the 60% load and 18 compression ratio.

Findings:

It is found that the performance of the diesel engine at the 80% load is efficient.

CO, CO₂ and HC emission for the biodiesel blends and preheated biodiesel is lower than that of the diesel fuel, this is due to that biodiesel is a green fuel and contain less carbon molecules. O₂ emission for the blends of the biodiesel is higher than that of diesel, this shows that Biodiesel is an oxygenated fuel and it contains oxygen of about 11% by weight.





Findings:

800-850ml of esterified Mahua oil is extracted from 1000ml of Mahua oil during esterification. Percentage increase in esterified Mahua oil increases the viscosity of diesel. Increase in percentage of Mahua oil increases the cetane number of the blend. Smooth running of engine is observed with esterified Mahua oil compared with that of diesel. Slight increase in brake thermal efficiency and decrease in specific fuel consumption is observed in the case of esterified Mahua oil (all blends especially 75% Mahua oil) compared to that of diesel.

IV. CONCLUSION

The studies executed in the scope of both analysis and experimentation of title has revealed the followings:

- 1) Use of Bio-Diesels in Compression ignition engine is possible.
- 2) The main problem is that the output gets changed drastically depending upon the fuel we use.
- 3) Also the compression ratio plays a significant role in output and performance. Compression ratio should always be raised and should not be lower, as lower compression ratio leads to incomplete combustion of fuel.
- 4) Above mentioned statement leads to generation harmful exhaust gases and sometimes even dangerous exhaust gases can be formed.
- 5) Also it should be noted that high viscous fuel should be avoided as they leads to formation of wax within the engine.
- 6) Formation of wax in engines leads to rise in temp. of engine and lowering of and power generation drops.
- 7) To avoid above problems transesterification process is used to break down the high viscous oil into esters and alcohol respective to the oil used.
- 8) Jatropa oil is only oil in the list of selected bio-diesel which can be directly used in engine without any pre-processing.
- 9) In Blending 20:80 proportion is used i.e. 20% vegetable oil and 80% of Diesel.
- 10) Smoke reduces as compression ratio increase. When compared with diesel fuel the smoke increases for all blends for lower CR while for higher CR smoke reduces drastically. As compression ratio increases the NO_x increases for neat diesel while NO_x decreases for lower blends.CO was not changed with compression ratio for all the blend of fuel. Brake specific fuel consumption decreases with the compression ratio increases. Brake thermal efficiency increase with the compression ratio for all fuel. Exhaust gas temperature increases with compression ratio for all blends.

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