EMISSION ANALYSIS ON VARIOUS BIODIESELS BY VARYING THE INJECTION PRESSURES ON SINGLE CYLINDER CI ENGINE

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Abstract:

The use of biodiesel, the methyl esters of vegetable oils are becoming popular due to their low environmental impact and potential as a green alternative fuel for diesel engine. The aim of this presentation is to study the potential use of Corn oil, Rice Bran oil and Castor oil methyl ester as a substitute for diesel fuel in diesel engine. B25 blend of Corn oil, Rice Bran oil and Castor oil and Diesel is prepared by transesterification process on volume basis and used as fuels in a four stroke single cylinder diesel engine to study the performance and emission characteristics of these fuels and compared with neat diesel fuel. The engine tests have been carried out with the aim of obtaining Emission levels and the behavior of the diesel engine running on Corn oil, Castor Oil and Rice Bran oil blend. Also, the property testing of these biofuels were carried out. This oil blend substantially reduces the emission of NO, CO and increases the emission of O_2 gases in exhaust gases. The emissions of these gases for the 3 biofuels and diesel are compared and analysed at 3 injection pressures of 180 bar, 200 bar and 230 bar.

Keywords: *Biodiesel, Castor oil, Corn oil, Injection pressure, Rice bran oil*

I. INTRODUCTION

During the last decade the use of alternative fuel for diesel engines has received renewed attention. In order to reduce harmful pollutants like NOx (Nitric Oxide & Nitrogen – dioxide), particulate matter, smoke, etc, we have to go for an alternative fuel that would reduce these pollutants and also it will not emit other pollutants like Aldehydes, Ketones, etc., The alternative fuel aspiring to take this petroleum based fuels such as alcohols, LPG, CNG, LNG, Hydrogen, Vegetable Oils, Bio gas, Producer gas. Out of these gases vegetable oils are long-term fuels and also these are renewable, recyclable fuel. It is stated that biodiesel improves lubrication ability over petrodiesel[1]. There are four primary ways to make biodiesel, direct use and blending, microemulsions, thermal cracking (pyrolysis) and transesterification[2]. Out of these, we have used Transesterification method to prepare biodiesels for testing. Nowadays, Nanocatalysts play an important role in improving product quality in biodiesel production and achieving optimal operating conditions[3]. Although biodiesel cannot entirely replace petroleum-based diesel fuel, it provides a market for excess production of vegetable oils and animal fats and it decreases, although will not eliminate, the country's dependence on imported petroleum. Also, biodiesel is renewable and does not contribute to global warming due to its closed carbon cycle. Moreover, the exhaust emissions of carbon monoxide, unburned hydrocarbons, and particulate emissions from biodiesel are lower than with regular diesel fuel. Unfortunately, most emissions tests have shown a slight increase in oxides of nitrogen (NOx). Finally, biodiesel provides more Oxygen for combustion of the fuel which will deliver more energy during burning. This paper is mainly focused on the emission characteristics of Corn oil, Castor oil and Rice Bran oil for NO, CO and O_2 at 3 different injection pressures of 180, 200 and 230 bar along with diesel

II. EXPERIMENTAL WORK

Initially, B25 blend of the 3 biofuels and diesel are made through transesterification process. First, take 200ml of Methanol and add 4g of NaOH to it and shake it well to dissolve NaOH completely. Then take 1L of Corn/Castor/Rice Bran Oil and add it to the Methanol + NaOH solution. Heat the mixture at 65 ° C on a burner(Transesterification). Heat the mixture for 45 minutes and shake it at 15 minutes interval during heating. Allow the mixture to cool down. Transfer the mixture to a separating funnel and keep it undisturbed for 24 hrs for the glycerol to settle down. Separate the mixture using separating funnel and the biofuel is obtained. Mix biofuel and pure diesel in the ratio 1:3 to obtain biodiesel of B25 blend.

Fig 1 : Castor and Corn biofuel

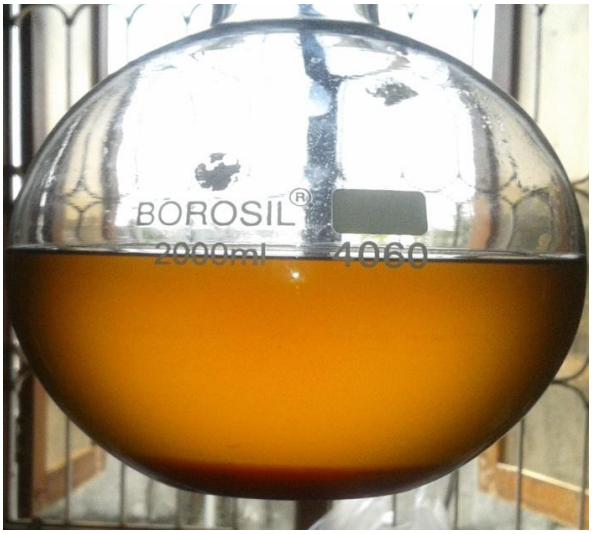

Fig 2 : Rice Bran biofuel

The prepared biodiesels are tested on a diesel engine to determine the emission levels of CO, NO and O_2 gases at 3 different injection pressures. The obtained results are compared and analysed.

Engine specifications

TYPE: Four stroke, single cylinder vertical air cooled diesel engine.

- Rated power – 4.4kW
- Rated speed – 1500rpm
- Bore dia(D) – 87.5mm
- Stroke(L) – 110mm
- Compression ratio – 17.5:1
- Orifice diameter -13.6mm
- Coefficient of Discharge(Cd) – 0.6
- Density of Diesel – 860 kg/m^3

III. RESULTS AND DISCUSSIONS

A comparison of the CO, NO and O_2 emissions are to be discussed in this section. The percentage of each gases produced for Corn, Castor, Rice Bran biofuels and Diesel while burning is shown in graphs is here. It is expected to have greater emissions of CO and NO for diesel compared to other biofuels, while O_2 emissions should be less for diesel with respect to other biofuels.

A. CO Emissions

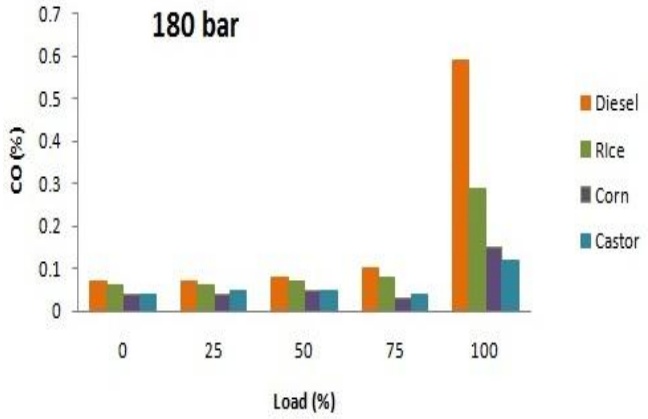

Fig 3 : Emission Result of CO at 180 bar

In the above graph, for all the loads, diesel is giving the greatest emission of CO comparing to other biofuels. Corn biofuel is giving the lowest emission of CO at 75% load out of all the loads in 180 bar pressure. Castor biofuel is giving nearly similar emission as that of corn biofuel in most of the loads except at 100% load. The emission of Rice Bran biofuel is increasing as the load increases and the diesel is also showing the same pattern.

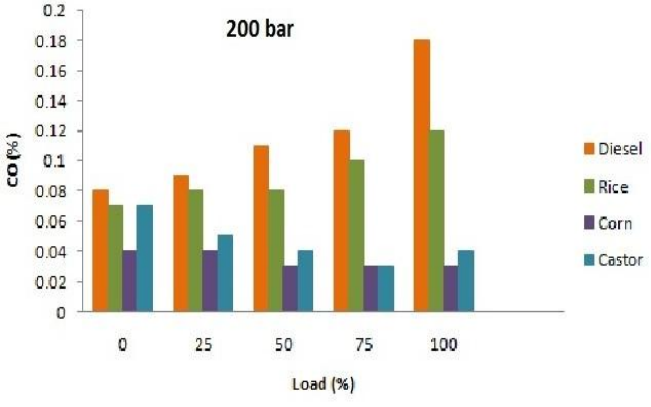

Fig 4 : Emission Result of CO at 200 bar

In the above graph, according to our expectations, diesel is giving the largest amount of emission in all the loads. Rice Bran biofuel is standing next after diesel in CO emission at all loads in this pressure. The Corn biofuel is giving the lowest emissions at all loads and the lowest emission occurs at 75% load. Both Diesel and Rice Bran biofuels are showing increasing trend in emission as the load increases, while corn biofuel shows a decreasing trend. The Castor biofuel is giving uneven emissions with the increasing load.

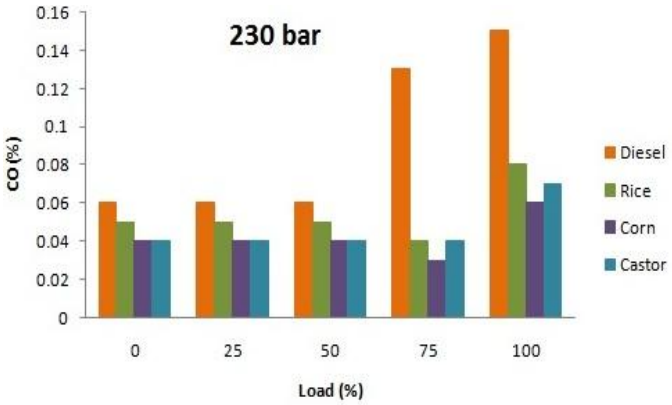

Fig 5 : Emission Result of CO at 230 bar

Diesel is giving again the highest emissions compared to other biofuels as expected and the emission rate is very high at 75% and 100% loads compared to other biofuels. Rice Bran biofuel is giving the second largest emission rates after Diesel. The emissions of Castor, Corn and Corn biofuels remain same till 50% loads, but it shows a slight decrease at 75% load and then again increases at 100% load. All the biofuels and diesel are showing the largest emissions at 100% load. From the above graphs, Fig.3, Fig.4, Fig.5, as the load increases, CO emission increases gradually for all biodiesels. The rice bran biodiesel shows more emission for all the three pressures than other biodiesels. It is clearly seen that corn and castor biodiesel shows similar emission CO in all three pressures. The lower CO emission is occuring at 180 bar pressure and all the oils are showing very less emission at lower loads on this pressure. We can inferred from the graphs that Corn oil is giving the lowest CO emission at 75% load for 180 bar injection pressure

B. NO_X Emissions

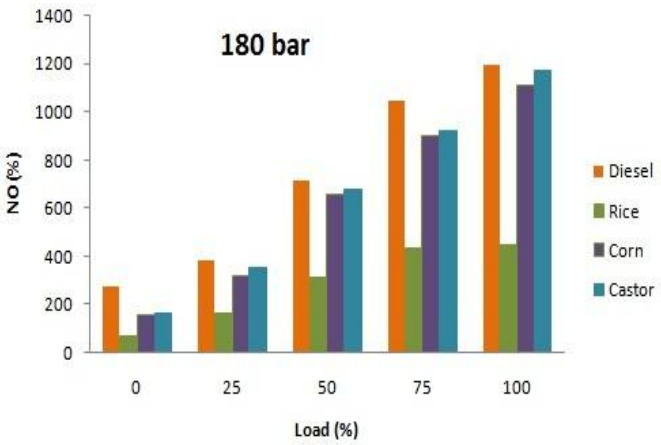

Fig 6 : Emission Result of NO at 180 bar

All the biofuels and diesel are showing an increasing trend in emission as the load is increasing. The diesel is giving the largest amount of NO in all loads and it is highest at 100% load as already mentioned. The lowest emission is for Rice Bran biofuel and it is very low compared to diesel at all loads. Corn and Castor biofuels are showing almost similar amount of emissions with Castor's emission little higher. However, the NO emission of Rice Bran biofuel is very low compared to other biofuels and diesel. Moreover, emissions of Corn and Castor biofuels are almost near to the emission of diesel at 100% load.

At 200 bar pressure, again the fuels are sowing an increasing trend in emission with increase in load. As required, diesel is giving the largest emissions at all loads. The lowest emissions are for Rice Bran biofuel. Castor and Corn biofuels are giving nearly same emissions and it is very close to diesel's emission rate in all the loads. Rice Bran is considered to be the appropriate fuel regarding NO emission at this pressure.

For NO emission at 230 bar, again Diesel is giving the largest emissions at all loads and the greatest emission occurred at 100% load. Eventhough all the fuels are showing an increasing trend in emission with increase in load, the relative rate of emissions among each fuel is changing. Corn is showing the lowest emissions at 25% and 50% loads, but it is giving the largest emission out of all biofuels at 100% load. All the other fuels are showing a gradual increase in emission with increase in load.

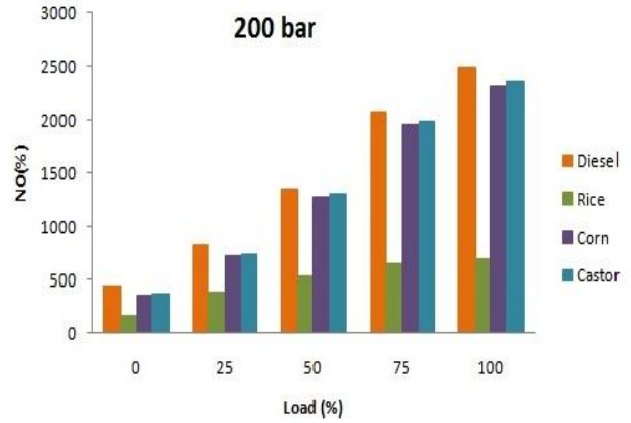

Fig 7 : Emission Result NO of at 200 bar

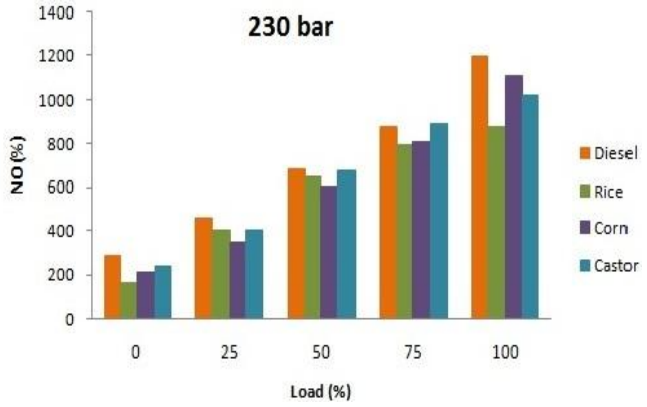

Fig 8 : Emission Result of NO at 230 bar

From the above graphs, Fig.6, Fig.7, Fig.8, the NO increases with increase in load and least are at minimum load condition. This is because of the fact that at higher load conditions engine runs at high RPM resulting in higher NO emission. The castor oil biofuel shows the maximum NO emission in all pressures also at every loads. The rice bran biofuel is giving comparatively lesser emission of NO at 180 bar for 0 load. The rice bran biofuel is showing the lowest emission at 230 bar also. All other biofuels are having higher emission of HC than Rice bran biofuel

C. For O_2

As expected, Diesel is giving the lowest emission of O_2 and the biofuels are giving larger emissions of O_2 compared with diesel. In contrast to the emission of other 2 gases, the O_2 emissions are decreasing with increasing load. The Corn and Castor biofuels are showing the largest emissions of O_2 with almost same amount of emissions.

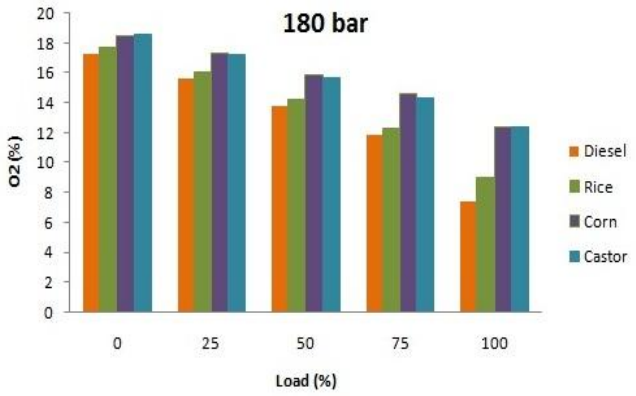

Fig 9 : Emission Result of O_2 at 180 bar

The emission by Rice Bran biofuel is low compared to other 2 biofuels and its difference with the emissions of other biofuels are increasing as the load increases.

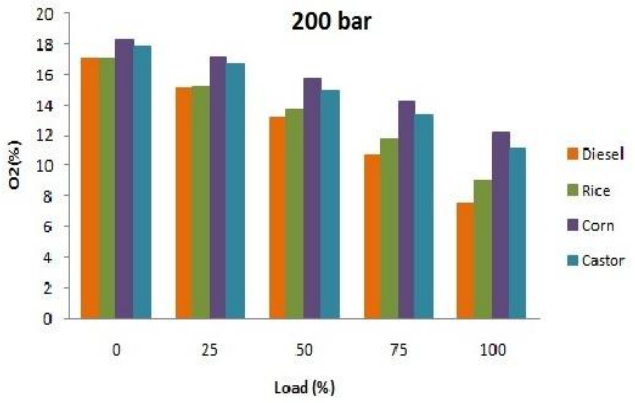

Fig 10 : Emission Result of O_2 at 200 bar

The lowest emission is given by Diesel at 100% load and the largest emission is given by Corn biofuel at 0% load. The Corn biofuel is giving the lowest emissions compared to other 2 biofuels at all loads. The emission of O_2 by Rice Bran is almost similar to diesel at 100% load and the trend continues till 50% load and then shows a visible difference. All the fuels are showing a decreasing trend in emission with increase in load. Moreover, Corn biofuel is giving largest emissions at all the loads with Castor biofuel at the second place.

Both Corn and Castor biofuels are giving the largest emissions at 0% load while, Diesel is giving the lowest emission at 75% load. All the 3 biofuels are showing a decreasing trend in emission with increase in load, but diesel is showing that trend only till 75% load. Diesel is showing an increase in emission when it goes from 75% load to 100% load. Corn and Castor biofuels are showing almost similar emission rates at all loads. Rice Bran

biofuel and Diesel are also showing almost same emission rates except at 75% load

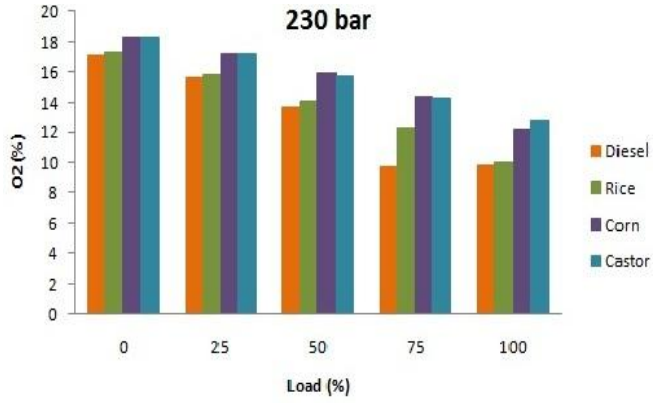

Fig 11 : Emission Result of O_2 at 230 bar

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From the above graphs, Fig.9, Fig.10, Fig.11, as the load increases, O_2 emission decreases gradually for all biodiesels also for diesel. Maximum O_2 emission is shown in 0% load for all the three pressures. It is clearly seen that the rice bran biodiesel has least oxygen emission for all pressures. Castor biofuel is giving the peak emission of Oxygen at 180 bar pressure for 0 load. Corn biodiesel is also giving nearly same amount of Oxygen emission.

IV. CONCLUSIONS

While considering CO emissions, the lower CO emission is occurring at 180 bar pressure and all the oils are showing very less emission at lower loads on this pressure. We can inferred from the graphs that Corn oil is giving the lowest CO emission at 75% load for 180 bar injection pressure. Next, regarding rice bran biofuel, it is giving comparatively lesser emission of NO at 180 bar for 0 load. The rice bran biofuel is showing the lowest emission at 230 bar also. All other biofuels are having higher emission of HC than Rice bran biofuel. Finally, Castor biofuel is giving the peak emission of Oxygen at 180 bar pressure for 0 load. Corn biodiesel is also giving nearly same amount of Oxygen emission.

In conclusion, we can infer that the results are according to our expectations with regard to emission of gases in diesel. Moreover, the more emission of Oxygen in biodiesel can helps in greater combustion of biodiesel compared to diesel. Hence, by comparing emission results of the 3 three biodiesels with diesel, it can be concluded that biodiesels are more efficient and eco friendlier than diesel.

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