Study of Emission Control Techniques in Compression Ignition Engines

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Abstract- *There has been a great concern, in recent years, that IC Engines are prominent cause for too much atmospheric pollution, which adversely effects to human health and environment. The main pollutants emitted by I.C. engines are Carbon monoxide (CO), Nitrogen Oxides (NOX), partially burnt Hydrocarbons (HC) and other particulate emission. Due to which biodiesel have received great attention both as a renewable alternative fuel and as an additive to the existing petroleum-based fuels. Biodiesel exhibits many advantage when compared to that of the existing petroleum fuels. In making of this biodiesel, methanol or ethanol is the commonly used alcohols. Techniques to control emission from automobile engines are Platinum catalysts for exhaust purification, Use of rice bran methyl ester, Catalytic convertors, etc. This paper presents use of rice bran methyl ester, leads to control the emission of single cylinder four stroke diesel engines by decrease in Carbon Dioxide (CO2) emissions, increase in Hydrocarbon (HC), and increase in Nitrogen Oxides (NOX).*

Keywords- Rice Bran Oil, Biodiesel, Methanol, Catalytic convertors.

I. INTRODUCTION

As we know with increase in population and living standard, the vehicle population throughout the world is increasing rapidly and the fossil fuels are degrading at a very faster rate which results in increasing exhaust pollution and particularly in metro cities as density of these vehicles are very high. The time has come to take necessary steps in order to make our planet safe for us and for the generations to come. Major sources of pollutants are categorized as:

1. Point sources, like factories and electric power plants.
2. Mobile sources, like cars and trucks but also lawn mowers, airplanes, and anything else that moves and releases pollutants into the air.
3. Biogenic sources, like trees and vegetation, gas seeps, and microbial activity.
4. Area sources, like smaller stationary sources such as dry cleaners and degreasing operations.

Apart from this pollutant the major cause for air pollution is improper combustion of gasoline and diesel fuel which results in emission of harmful gases from the vehicles. So there is need for complete combustion of fuel. The perfect condition for correct combustion is stated below:

FUEL (HYDROCARBONS) + AIR (OXYGEN AND NITROGEN) = CO2 + WATER + UNAFFECTED NITROGEN.

But often in vehicles this condition is very difficult to achieve; in fact in actual condition the combustion takes place in the following manner.

FUEL+ AIR= UNBURNED HYDROCARBONS + NITROGENOXI+CARBONMONOXIDE+CARBON DIOXIDE +WATER

To overcome the problem caused by degradation of crude oil and increase emission of automobile various alternates are found out, which are under experimental consideration. Following list shows a few investigations:

1) Investigation made on Diesel-ethanol mixture that are more viable alternative and require little or no change in diesel engines. The use of diesel-methanol blends can significantly reduce the emission of toxic gases and particulate matters when compared to pure diesel.

2) Investigation made on the performance and emission significance of rice bran oil as a potential source for biodiesel.

3) Investigation made on direct injection diesel engine and calculated the Performance, Emission and Combustion Characteristics Rice Bran Oil.

4) Experimentally investigated the effect of Rice Bran oil Emission characteristics with methyl Easter as an additive for compression ignition engine.

5) Investigation on the effect of compression ratio and injection pressure in a direct inject diesel engine running on Jatropha methyl ester.

6) The blends of biodiesel and methanol with diesel significantly reduce the emissions of the exhaust gasses coming from engine.

7) Investigation on neem based methyl esters on VCR engine and concluded that neem oil can be directly used in diesel engines without any engine modifications.

Due to this investigation various alternative fuels are being explored worldwide to reduce environmental pollution. In past few years, very useful efforts were under taken by many researchers to determine the perfect use of vegetable oil and its derivatives as fuel. Various methods used to implement vegetable oil as fuel in diesel engine are blending, emulsification, thermal cracking and transesterification.It is well known fact that fuel is critical to any strategic plan for economic researchers have shown that particulate matter, unburned hydrocarbons, carbon monoxide, and sulfur levels are significantly less in the exhaust gas while using biodiesel as fuel. So thereby there is need of alternate fuel to implement reduction in exhaust emission. Biodiesel is one of the best alternative fuels for diesel engines and is becoming more attractive in recent decade. It is defined as a fuel consisting of mono alkyl esters of long chain fatty acids derived from vegetable oil or animal fat. It can be blended at any level with petroleum diesel to produce a biodiesel blend (mixture). It can be used in compression ignition engine with fewer modifications. It is simple to use, bio degradable, non-toxic and essentially free of sulphur and aromatics.

According to BHARAT STAGE IV norms emissions from diesel engines are as follow:

Table No I: Diesel Emission Norms

Emission Norm	CO	HC	NO_X	$HC+NO_X$	PM
BS-IV	0.50	--	0.25	0.30	0.025

II. SIGNIFICANCE OF RICE BRAN OIL

With various vegetable oil available in the market, rice bran oil can be used as CI engine fuel because rice is one of the major crops that is grown easily in India.Crude rice bran oil (CRBO) containing higher (more than 3%) free fatty acid content is not suitable for eating purposes. As the second largest producer of rice in the world, India has a great capability to produce rice bran oil and it does not require any special cultivation since it is a by-product of the rice milling process. It is obtained through the polishing of the rice grain contains 15-23% lipids and thus, if the by-products are derived from the crude rice bran oil and the resultant oils can be used as a feedstock for producing biodiesel, the resultant biodiesel obtained could be very economical and affordable. Also, the methyl esters of rice bran oils does not require any change in modification of existing engine design. So therefore one of the best blending agent is RICE BRAN OIL. It is a potential resource for production of biodiesel, because of its mineral diesel like properties, it is used in the sectors like irrigation, water-ways transportation, and small diesel fuelled community power-plants etc. A major physical advantage of rice bran oil is locally availability, and less processing infrastructure, while its limitation is its high density, viscosity and suspended particulates.

Table No II: Properties of diesel, rice bran oil biodiesel and bio methanol.

Property parameters	Diesel Fuel	Rice Bran Oil Biodiesel	Methanol
Density at 200 ^oC (g/cm3)	0.82	0.96	0.78
Viscosity at 400^0C(mm2/s)	3.4	4.56	1.35
Flash Point ^oC	57	160	21
Fire Point ^oC	60	175	25
CetaneNumber	45	54	10
Calorific value (KJ/kg)	43500	39800	28700

III. CASE STUDY

A. Use of Rice Bran Methyl Esterbend

The experiment mainly focuses on the usage of the alternative fuel(Rice Bran Methyl Ester) in internal combustion engines and the effect of compression ratio of the engine. Experimental study on this variable compression ratio (VCR) computerized diesel engine, fuelled with diesel and different percentage of blend were studied with respect to the performance and emission characteristics.

Various tests were conducted with the blend of:

- (B10%): blend of 90% diesel and 5% biodiesel and 5% methanol.
- (B20%): blend of 80% diesel, 15%biodiesel and 5% methanol.

- (B30%):blend of 70% diesel, 25% biodiesel and 5% methanol.

B. Experimental set-up

In the present experiment Apex innovation PVT. LTD, single cylinder, four stroke, water cooled diesel engine is used for computing performance and emission characteristics of diesel, and biodiesel mixture.

Experiment is conducted on a rated speed of 1500 rpm at 200 bar of injection pressure.

Table No III: Specifications of the VCR diesel engine

ENGINE	Parameters
No. of cylinders	1
No. of strokes	4
Fuel	H.S diesel
Rated power	3.5 KW @1500 RPM
Cylinder diameter	87.5mm
Stroke length	110mm
Connecting rod length	234mm
Compression ratio	12-18:1
Orifice diameter	20mm
Dynamometer arm length	185mm

Fig.1.Vcr Engine Test Setup

III. OBSERVATIONS

1) A plot of load% vs. emission of CO (%volume) at pressure of 200 bar and VCR of 18:1 shows the following result:

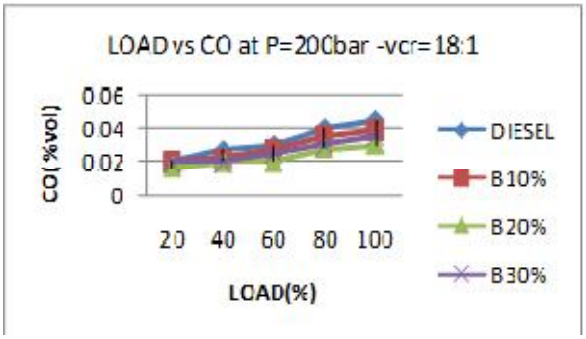

Fig.2.Vary of CO with load at injection pressure 200 bar and VCR. -18:1.

As the increase in load % the emission of CO from diesel fuel is greater as compared to B10, B20 and B30. But the results show that the CO emissions are low with the increase of rice bran oil percentage in the diesel-biodiesel-methanol blend up to B20.

2) A plot of load% vs. emission of CO (%volume) at pressure of 200 bar and VCR of 16:1 shows the following result:

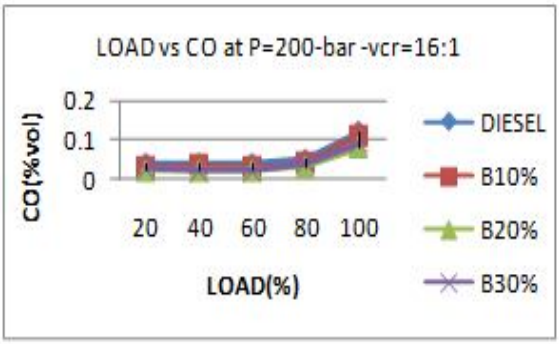

Fig.3. Vary of CO with load at injection pressure 200bar and VCR-16:1.

There is not much variation in CO emissions of all diesel and blends up to 80% load on the engine, after that the CO increased rapidly at high loads. The CO emissions of the diesel-biodiesel-methanol blends are not much variation from that of conventional diesel at all loads as shown in the figure.

3) A plot of load% vs. emission of NOX (%volume) at pressure of 200 bar and VCR of 18:1 shows the following result:

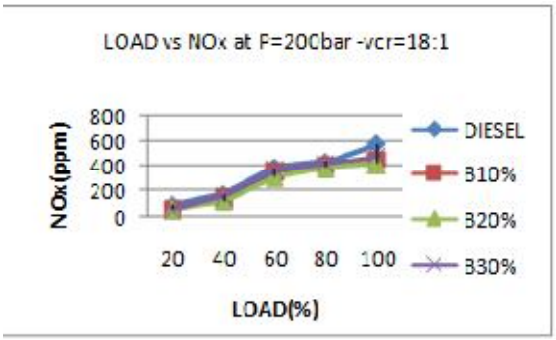

Fig.4.Vary of NOX with load at injection pressure 200 bar and VCR- 18:1

At full load conditions of the engine, the NOX emissions of diesel fuel are high as compared with various blends at injection pressure 200 bar and compression ratio of the engine is 18:1.

4) A plot of load% vs. emission of NOX (%volume) at pressure of 200 bar and VCR of 16:1 shows the following result:

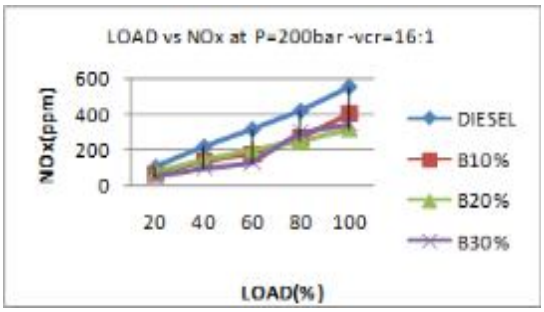

Fig.5.Vary of NOX with load at injection pressure 200 bar and VCR- 16:1

The result from figure 5 shows that the NOx emissions of diesel are high at all load conditions. The NOx emissions of blends are increased with the increasing the load on the engine under all load conditions. The NO emissions of diesel- biodiesel –methanol blends B20% and 30% are lower than that of the conventional diesel fuel under all loads on the engine.

5) A plot of load% vs. emission of NOX (%volume) at pressure of 200 bar and VCR of 18:1 shows the following result:

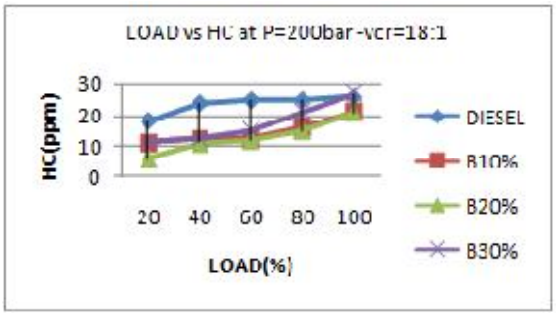

Fig.6.Vary of HC with load at injection pressure 200 bar and VCR- 18:1

The HC emissions of diesel at 200 bar IP are high at all loads and all speeds of the engine as compared to that of the HC emissions of biodiesel blend B10%, B20% and B30%. The HC emissions of diesel-biodiesel-methanol blends are similar at almost all the loads

6) A plot of load% vs. emission of HC (%volume) at pressure of 200 bar and VCR of 16:1 shows the following result:

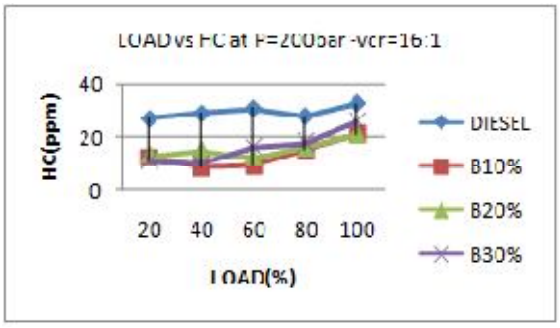

Fig.7.Vary of HC with load at injection pressure 200 bar and VCR- 16:1

The result from figure, HC emissions of conventional diesel at 200 bar IP are maximum at all loads and all speeds of fuel modes as compared to that of the HC emissions of biodiesel blend B10, B20 and biodiesel blend B30 . The HC emissions of biodiesel blend B20 are low at low loads of the engine. The HC emissions of biodiesel blend B10% are low at medium load of the engine.

IV.CONCLUSION

The emission characteristics of diesel, rice bran oil biodiesel-methanol blends were carried out on a single cylinder computerized variable compression ratio diesel engine and following conclusion were made:

1) The CO emissions of the rice bran oil biodiesel were lower than that of the conventional diesel fuel at different compression ratios (VCR-18 andVCR-

16).The minimum CO emissions were observed with the blend B20%.

2) The HC emissions were increased with increased of rice bran oil percentage in diesel-biodiesel-methanol blends and lower than those of the conventional diesel at different compression ratios. The minimum CO emissions were observed with the blend B20%.

3) The NOx emissions were increased with increased of the rice bran biodieselengine. But NOX emissions were low at all compression ratios. The minimum NOX emissions were observed with the blend B20%.

Producing and using alternate fuels for transportation is one the best approach for a sustainable energy in future worldwide. Renewable fuels also substantially reduce contributions to global climate change. Higher oxygen content in biodiesel fuel than that of diesel fuel caused lower smoke emissions. Addition of a bio fuel in a limited proportion reduces air pollution to large extent. From the overall study of performance as well as emission parameter of diesel, biodiesel and its blends, we can conclude that methyl esters of rice bran oil can be used as alternative to the conventional diesel.

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