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PERFORMANCE AND EMISSION CHARACTERISTICS OF DI-CI ENGINE FUELED WITH METHANOL BLENDED DIESEL FUEL

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ABSTRACT

Fossil fuels are one of the major sources of energy in the world today. Their popularity can be accounted to easy usability, availability and cost effectiveness. But the limited reserves of fossil fuels are a great concern owing to fast depletion of the reserves due to increase in worldwide demand. So efforts are on to find alternative sources for this depleting energy source. Even though new technologies have come up which have made solar, wind or tidal energy sources easily usable but still they are not so popular due to problems in integration with existing technology and processes. So, efforts are being directed towards finding energy sources which are similar to the present day fuels so that they can be used as direct substitutes. Diesel fuel serves as a major source of energy, mainly in the transport sector. The present work is carried on the DI- CI with different blends of diesel blended methanol. In this work performance characteristics like brake specific fuel consumption , brake thermal efficiency and emission characteristics like hydrocarbons, carbon monoxide, oxides of nitrogen at various loads (4kg, 8kg,12kg,16kg) were studied. The results observed that all the characteristics of engine with methanol blended diesel are very close to characteristics of engine with baseline petroleum diesel.

Keywords: *Diesel, Methanol, Engine and Emissions.*

I. INTRODUCTION

Alcohols such as ethanol and methanol also received a wide attention from the researchers due to it's oxygenate nature. Alcohols derived from bio resources widely used in compression ignition engine as a supplementary fuel to that of petroleum diesel. However, methanol has an advantage because of its low price and higher oxygen fraction. But as reported by several researchers there is some difficulty to form a homogeneous diesel methanol mixture, hence the research on this area is very limited. Methanol is produced from synthesis gas (carbon monoxide and hydrogen), itself derived from oil, coal or, increasingly, biomass. It may become central to the development of bio refineries as an intermediate in the conversion of biomass to useful products. Diesel comprising 10 percent of methanol can be utilized in the majority of modern autos bereft of modification.[1] Khalil Ibraheem Abaas, et al conducted the tests on steady state conditions in a four-cylinder DI diesel engine at full load at 1500-rpm engine speed. The experimental results showed that diesel methanol blends provided 12.7% increase in brake-specific fuel consumption due to its lower heating value. The results indicated that methanol may be blended with diesel fuel to be used without any modification on the engine. [2] T.Yusaf,I.Hamawand, et al conducted test on a four-stroke four-cylinder diesel engine. The results showed that mixing methanol at different fractions with diesel fuel has a significant effect on the engine performance. The methanol to diesel ratio of 10:90 exhibited the lowest exhaust temperature and achieved an improvement in the output power of approximately 70% compared to the other ratios. Also, the brake thermal efficiency improved at all the mixing ratios used. Furthermore, the BSFC of pure diesel fuel registered a lower value than any other mixing ratio. [3] Joshua Marcus Paul, Balamurali.S, et al conducted tests on 4stroke, single cylinder DI-CI water cooled engine. In their study, they found that, increased oxygen percentage as a result of methanol addition there is an improvement in the combustion efficiency and hence the brake thermal efficiency increases by 1.4% and 5.5% at 80% load for the M10 and M30 blends. [4] P.B Ingle ,et al conducted tests on 4stroke 4cylinder diesel engine using methol-diesel blend. In their study, they concluded that methanol/diesel blend can be used in diesel engines. The output power and torque for diesel fuel is lower compared to methanol-diesel blended fuel at any ratio, the exhaust temperature for diesel fuel was higher compared to any mixing of the blended fuel, the brake specific fuel consumption for the three mixing ratios was not varying

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significantly but the lowest was for 30% Methanol and 70% Diesel but specific fuel consumption for diesel fuel was much lower compared to any mixing ratio. [5] Cenk Sayin, et al conducted test on four stroke single cylinder DI-CI engine In their study, the effects of injection pressure and timing on the performance and emission characteristics of a DI diesel engine using methanol (5%, 10% and 15%) blended-diesel fuel were investigated. The tests were conducted on three different injection pressures (180, 200 and 220 bar) and timings (15, 20, and 25 CA BTDC) at 20 Nm engine load and 2200 rpm.

II. EXPERIMENTAL SETUP

The experimentation was carried out on Kirloskar 4-Stroke 1-Cylinder water cooled Variable Compression Ratio Diesel engine which is altered from a normal 4-Stroke 1-Cylinder water cooled Diesel engine. An Eddy Current Dynamometer is attached to it to vary the loads. A manometer and rotameter are provided to measure the air flow and water flow. The specifications of the V.C.R Engine are given in table 1 and it is shown in figure 1. The engine experimental setup photograph consisting of engine, display panel, eddy current dynomo meter. Figure 2 shows the photograph of exhaust gas analyser of Indus 5 gas analyser (model: PEA 205) manufactured by INDUS scientific pvt.ltd Bangalore, is used to analyse the emissions and its features in the table 2. The experiments are carried out on the engine setup by M0(0%Methanol + 100% Diesel) ,M5(5%Methanol + 95% Diesel),M10(10%Methanol + 90% Diesel),M15(15%Methanol + 85% Diesel),M20(20%Methanol + 80% Diesel), and M25(25%Methanol + 75% Diesel),.Tests are conducted on the engine at 4Kg, 8Kg, 12Kg and 16Kg load.

Table 1. Engine Specifications

ManuFacture	Kirloskar Oil Engine
Engine	Single Cylinder Direct Injection Compression Ignition
RPM	1500
Fuel	Diesel
Rated power	3.7 Kw (5Hp)
Cooling	Water Cooled
Bore X Stroke	80 mm X 110 mm
Starting	Cranking
Method of Ignition	Compression Ignition
Compression Ratio	14 – 24 : 1
Length of the Arm	150 mm

Table 2. Exhaust Gas analyser

Exhaust Gas analyser make : Indus		
Emission Type	Range	Resolution
NOx	0 – 5000 ppm	1 ppm
HC	0-15000 ppm	1 ppm
CO	0-15.0%	0.01%

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Figure 1. Engine Set up

Figure 2. Exhaust Gas Analyser

III. RESULTS AND DISCUSSIONS

Tests are conducted at different loads 4Kg, 8Kg, 12Kg and 16Kgwith different blends of M0 , M5, M10, M15, M20 and M25. These tests are conducted at constant speed of 1500r.p.m. Though the engine is variable compression engine the compression ratio is set at 16.5 :1.The performance and emission characteristics are considered for the study purpose and the results are investigated and compared with petroleum diesel.
Brake Specific Fuel Consumption:

The test results of the break specific fuel consumption when the engine fuelled by different fuel blends is as shown in figure 3. Specific fuel consumption is the fuel consumption rate to produce unit power. It also indicates the ability of the combustion system. From the results presented in the figure indicates the variation of bsfc at different load conditions ranging from 4kg to 16kg.from the results, it is observed that the specific fuel combustion is higher at lower loads. But the value of bsfc is decreased gradually with the increase in the load on the engine. From the figure, it is observed that all types of blends follow similar trends as in the case of pure diesel.

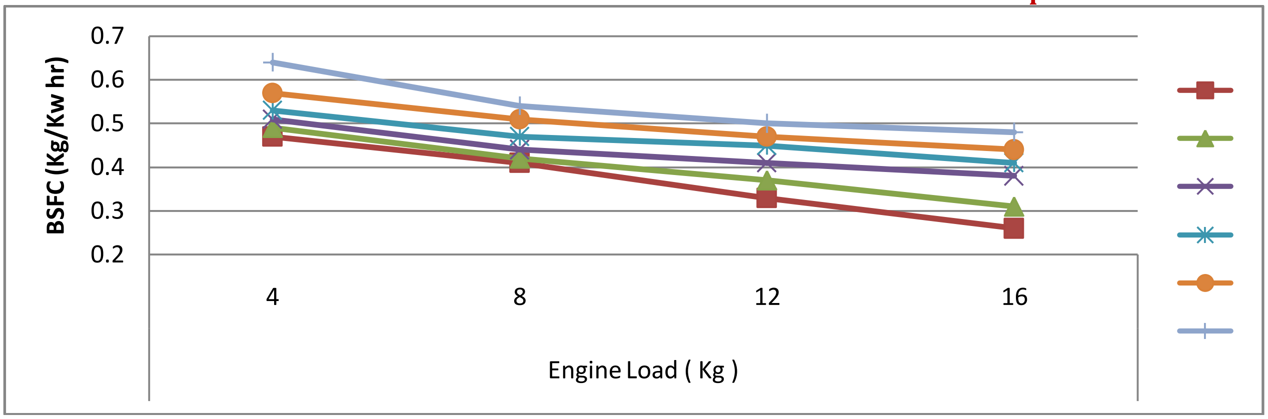

Figure 3. Variation of BSFC with engine load

Brake Thermal Efficiency:

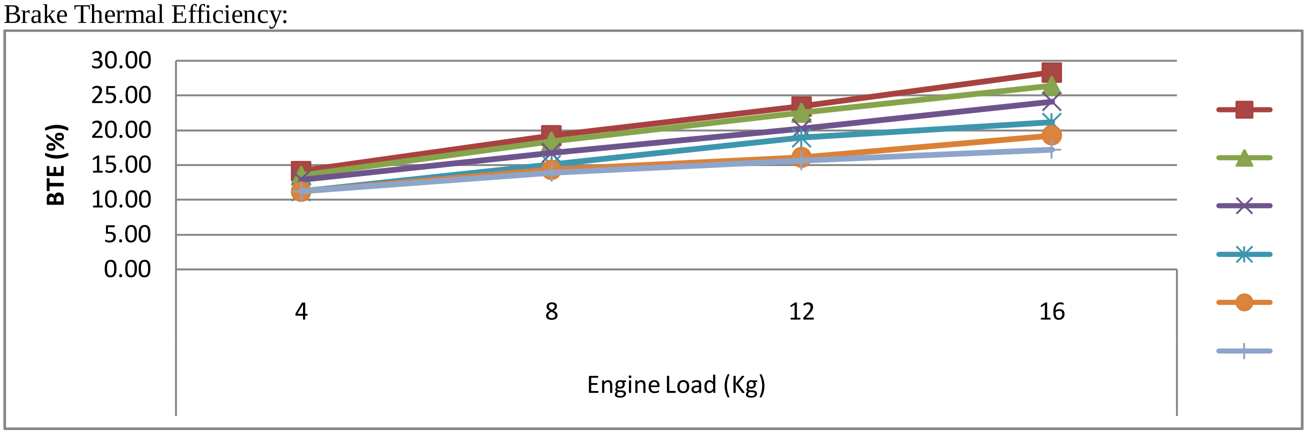

Figure 4. Variation of BTE with Engine load

Brake thermal efficiency is defined as the ratio of power output and the energy released due to complete combustion of fuel. The variation of BTE with engine load is shown in the figure 4 and it is observed that BTE increase's with engine load but the BTE of M25 is less than M0

CO Emission :

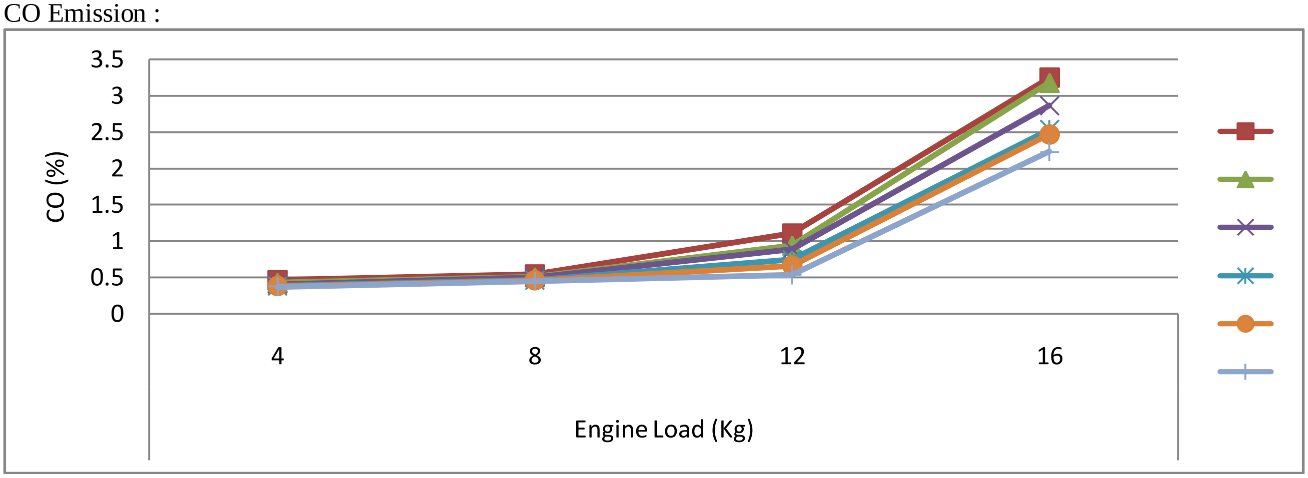

Figure 5. Variation of CO with Engine Load

The CO emissions with engine load are shown in the figure 5. The CO emissions increases as the engine load is increased for all different diesel blended methanol. The CO emissions of M25 is less than the CO emissions of M0

HC Emission :

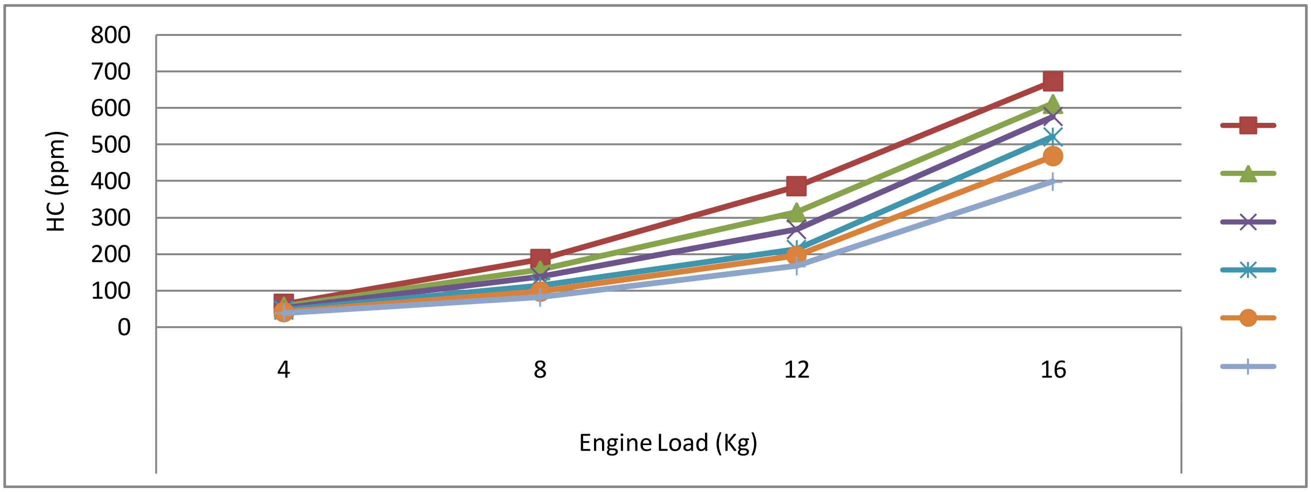

Figure 6. Variation of HC with Engine Load

The test results of HC emissions of engine with different loads when engine fuelled by different fuel blends and diesel is as shown in above figure 6. The results showed that the HC emissions from the engine for the blends were increased as engine load increased for different fuel blends. When compared to pure diesel the fuel blends have less HC emissions.

NO_x Emission :

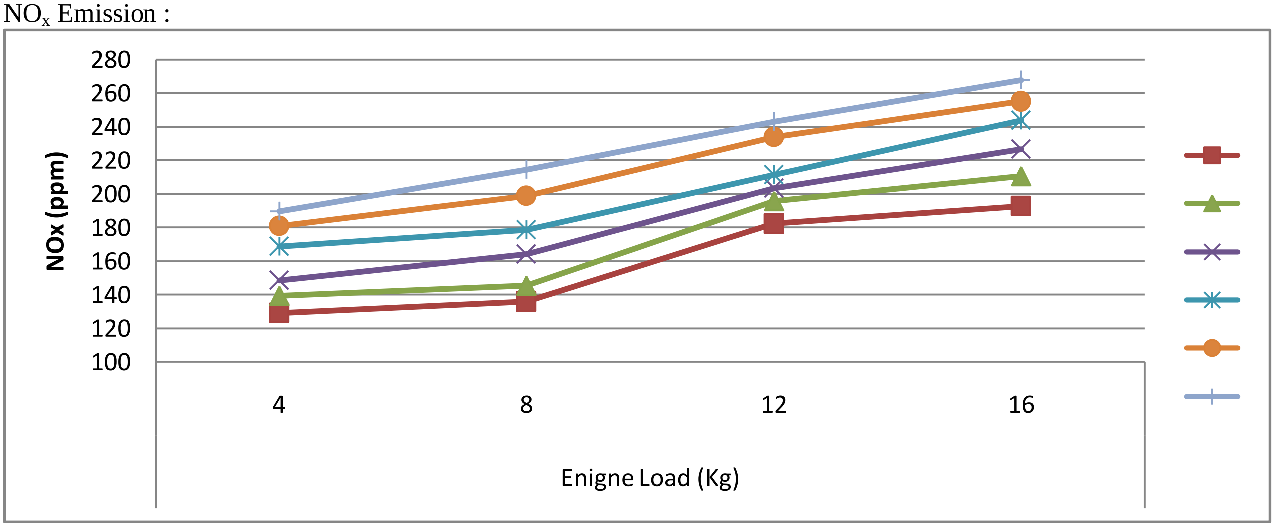

Figure 7. Vatriation of NOx with engine load

The results of NO_x emissions of engine with different loads when engine fuelled by different fuel blends and diesel is as shown in above figure 7. The results showed that the No_x emissions from the engine for the blends were increased at higher loads for different fuel blends and for pure diesel. The NO_x emissions of pure diesel are less than the NO_x emissions of different fuel blends at various loads.

IV. CONCLUSIONS

The performance and emission characteristics are analysed and compared with petroleum diesel of single cylinder four stroke DI – CI engine fuelled with methanol blended diesel and the conclusions are summarized below.

1. BSFC increases with increase of percentage of methanol but the BSFC decreases as the engine load is increased for pure diesel and also for different blends.
2. BTE is more for petroleum diesel compared with different blends. BTE increased for petroleum diesel and also for different blends as the load increases.
3. CO emissions are less for methanol blended diesel than pure diesel at different loads.
4. HC emissions increases for diesel and also for blends as the load is increased.
5. NO_x emissions are more for methanol blended diesel than petroleum diesel.

From the conclusions it is evident that methanol can be blended with diesel and used as an efficient alternative fuel in compression ignition engines.

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