Influence of Nanocatalyst on Emission Characteristics in Direct injection Engine using blends of castor oil

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Abstract

The significance of this study is the complete alternate of diesel fuel with bio-fuels. For this purpose. Bio-fuels, namely, methyl ester of castor oil used as fuel in the form of blends. For a diesel engine, fuel injection pressure (FIP) is the very important parameter, which influence the engine performance, emissions, and combustion.. A single cylinder with 4.4 KW kirloskar research engine used to experimentally determine the effects of fuel injection pressure with Mgo nanocatalyst on engine emission characteristics. The results show a 10.5% reduction in HC emissions and a 17% reduction in CO emissions for the B20 blend with a 2.7% decrease in NOx emission at full load.

Key Words*: castor oil, Emission, Mgo*

I. INTRODUCTION

As the fuels are depleting day by day, alternative fuels like LPG, CNG, hydrogen etc has emerged as a solution. As a gaseous fuel, gains from LPG have already been established in terms of low emissions of carbon monoxide and hydrocarbon. Air-fuel ratio, operating cylinder pressure, ignition timing and compression ratio are some of the parameters to be analyzed and optimally exploited for better engine performance and reduced emissions. The operating parameters and conditions of LPG gas which result in better performance of the engine are being analyzed.

O. Armas et al. performed a comparative experimental study for determining the effect of fuel properties on the constructive characteristics of some pieces of a current common rail injection system used in light duty diesel vehicles. Results showed that the use of the ethanol–biodiesel–diesel blend produced a similar effect on the durability on the injection pump components studied and on the injector nozzle as that produced by diesel fuel. [1]

Biodiesels are used in diesel engines without making any alterations to the engine. The ethanol mixed bio-diesel is widely researched and experimented with various compositions and their performance is noted down. Iso-propanol is also being added to mixture. Experimental results show that the ethanol addition reduced CO, soot and SO2 emissions, but it has increased the NOx emission and power reductions. It was also found that increasing the injection pressure decreases the CO and the smoke emissions. [2]

Ethanol being widely used as a blend in biofuels., It is being researched extensively. During analysis, special emphasis is placed on the factors such as stability, viscosity and lubricity, safety and materials compatibility critical to the potential commercial use of these blends. The effect of the fuel on engine performance, durability and emissions is also considered. But maintaining vehicle safety with these blends may entail fuel tank modifications and work is required in specifying acceptable fuel characteristics, confirming the long-term effects on engine durability, and ensuring safety in handling and storing ethanol–diesel blends. [3]

In 1996 an oil-soluble organo-metallic iron combustion catalyst was developed for turbine engines. It included oil-soluble magnesium to reduce vanadium deposits and corrosion which resulted in significant reduction of smoke in the exhaust of engines operating in steady state and non-equilibrium start-up conditions. The same bio-fuel when used for steam boilers and compression-ignited reciprocating engines, it was noted that it promotes complete and more efficient combustion in the engine, resulting in increased power, improved fuel economy and radically reduced smoke emission. The iron-magnesium combination acts synergistically to give greater activity than expected. [4]

In the research works it was noted that the influence of a ferrous pirate based homogeneous combustion catalyst on fuel consumption and smoke emission of a laboratory diesel engine, it was noticed that the brake specific fuel consumption and smoke emission decreased as the dosing ratio of the catalyst doped in the diesel fuel increases. At a certain point, the brake specific fuel consumption was reduced from 2.1% to 2.7% and the smoke emission was reduced from 6.7% to 26.2% at the full engine load. The results indicated that the potential of the fuel is saved at light load. [5]

In a recent study, where ethanol with Palm Steering Methyl-Ester oil as additive has been carried out in a CI diesel engine to study engine power, torque, brake specific fuel consumption, brake thermal efficiency and exhaust gas temperature with the diesel – ethanol blend with addition of small amount of biodiesel(PSME). The study was tested using diesel blended with ethanol at certain mixing ratios. From the experiment it was shown that the brake thermal efficiency of the engine increased at B40 blend for medium load capacity and showed that the exhaust gas temperature for B10 ratio is near the diesel fuel. The exhaust temperature for diesel fuel was higher compared to other bio-fuel. Brake specific fuel consumption of all ethanol Methyl-ester, diesel blends were lower compared with diesel at full load. [6]

Apart from the various blends which are being tested day by day with different additives, different methods of producing them are also been found. Some of the biodiesel production techniques are super critical methanolysis, ultrasonication method and microwave technique by which maximum biodiesel can be produced. The new approach of using nano particle in biodiesel shows very good results in reducing the level of pollutant gases in the engine exhaust and increased performance without any engine modification. [7]

Now a days, there is technological development seen all over the world. The research work is progressing, but the resources involved in them are depleting rapidly. The demand of resources and fuels for the technological development is increasing day by day. In order to keep the pace of development high, we need to think about some alternate fuel with better efficiency which would help to overcome the demand to conserve the resources for the future generation. However, the net effect was nevertheless a reduction in the emission of CO_2. The emissions of HC, CO, NOx, some aldehydes and hydrocarbons were slightly affected by the new fuel composition. [8].

II. EXPERIMENTAL SETUP

The experiments were conducted on a single cylinder Kirloskar build direct injection four stroke cycle diesel engine. Water cooled eddy current dynamometer was used for the experiments. The engine is equipped with crank angle sensor, cylinder pressure sensor, thermocouples to measure the temperature of water, air and gas. Rota meter is used to measure the water flow rate and manometer to measure the air flow and fuel flow. The various parameters that govern the performance characteristics are Brake Power, total fuel consumption, exhaust gas temperature and Brake thermal efficiency.

The various samples of biodiesel are as follows:

Sample 1- 80% diesel + 20% Castor oil + 100 ppm Magnesium Oxide nanoparticles (200 Bar)

Sample 2- 80%diesel + 20% castor oil + 100 ppm Magnesium Oxide nanoparticles (220 Bar)

Sample 3- 80%diesel + 20% castor oil + 100 ppm Magnesium Oxide nanoparticles (240 Bar)

III. RESULT AND DISCUSSION

After the detailed experimental analysis for the emission characteristics of the biodiesel at different composition ratios, the following graphs are plotted as the emission curves.

A. BRAKE POWER VS CARBON MONOXIDE.

All the Compositions of the Bio diesel under different pressure level were compared on the basis of the amount of carbon monoxide released .It was seen that at 220 bar, the carbon monoxide is lower when compared to 200 bar and 240 bar.

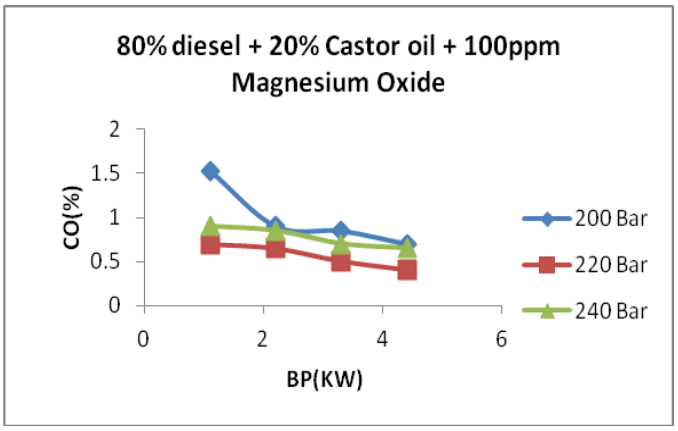

Fig 1 Brake Power Vs. Carbon Monoxide

B. BRAKE POWER VS CARBON DIOXIDE

It was observed that the amount of carbon dioxide released based on the experimental analysis was noted that at 240 bar, the amount of CO_2 released is minimum when compared with 200 and 220 bars. This Experimental analysis indicates a remarkable significance over the emission characteristics of the biofuel.

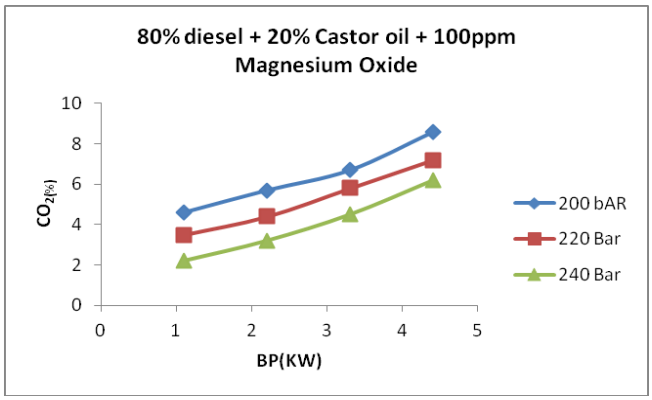

Fig 2 Brake Power Vs. Carbon dioxide

C. BRAKE POWER Vs. HYDROCARBON

Fig. 3 shows, for the biodiesel, the Hydro Carbon percentage varies in the exhaust at different pressure levels (200,220,240 bars). It was observed that for 220 bar, the amount of hydrocarbon released is lower. The amount of hydrocarbon released increases drastically, when the injection pressure 200 bar and 240 bar. Hence the amount of hydrocarbon released for 220 bar comparatively is less than other pressure levels and suitable for the environmental emission conditions.

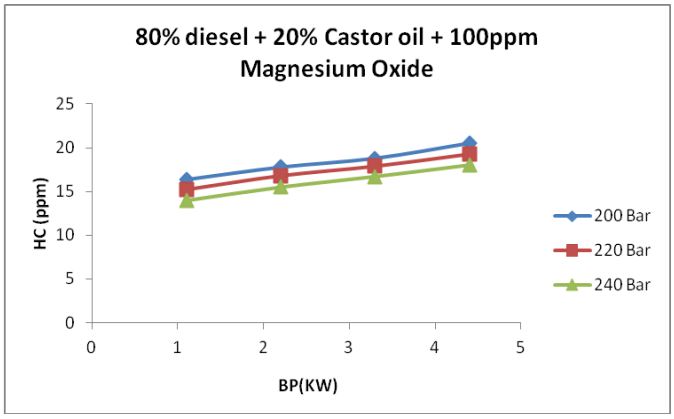

Fig3 Brake Power Vs. Hydrocarbon

D. BRAKE POWER VS NO_x

The NO_x emissions of castor oil with 100ppm composition of Magnesium Oxide and its blend with 20% is shown in Fig.4.It is observed that NO_x decreases more at 240 bar compared with 200 and 220 bar.

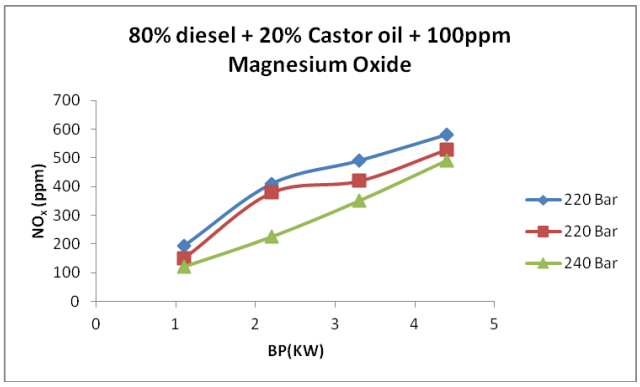

Fig 4 Brake Power Vs. Nitrous Oxide

IV. CONCLUSION

After the successful experimental analysis of the biofuel of various compositions, Hydrocarbon and Carbon Dioxide gave the most positive outcomes at 240 Bar. (80% diesel + 20% Castor oil + 0.032gm Magnesium Oxide). On comparing with Different pressure levels, it is observed that at pressure 240 bar the value of NO_X is lower than pure diesel. The lower value of Hydrocarbon content in the emission shows the efficient burning of fuel. The value of CO emission has also been reduced during effective burning of the fuel.

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