Investigation on the Effects of Methanol-Diesel Emulsions in a Di Diesel Engine Using Various Blends

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Abstract— The Environmental concerns and regulations to reduce greenhouse gas emission and fluctuation of fossil fuel price have stimulated research on alternative fuels. A lot of research is being carried throughout the world to evaluate the performance, exhaust emission and combustion characteristics of the existing engines using several alternative fuels .In this study the diesel fuel was replaced with Methanol emulsions blended with diesel as an alternative fuel. This investigation also aims to determine the performance and emission characteristics of the blended fuel in a diesel powered engine in comparison with the base fuel.In this work 19% Methanol and 1% acrylic acid (Emulsifier) ,18% Methanol and 2% acrylic acid blended fuel were taken, the performance and emission characteristics of the engine was determined. The exhaust gas components such as hydrocarbons, CO2, CO, SOx emissions are measured and quiet decreased with the base fuel. The NOx emission is increased due to increased supply of oxygen.

Key words: Methanol emulsions blended diesel, thermal efficiency and emission characteristics

I. INTRODUCTION

Initially in a design and development stage an engineer would design an engine with certain aims in his mind. The aim may include variables like indicated power, brake power, brake specific fuel consumption, exhaust emissions, cooling of engine, maintenance free operation etc. The other task of the development engineer is to reduce the cost and improve power output and reliability of an engine. In trying to achieve these goals he has to try various design concepts. After the design the parts of the engine are manufactured for the dimensions and the surface finish may be with certain tolerances. In order verify the design and the engine developed one has to go for testing and performance evaluation of the engines.

Thus, in general, a development engineer will have to conduct a wide variety of engine tests starting from simple fuel and air-flow measurements to complicated injector needle lift diagrams, swirl patterns and photographs of the burning process in the combustion chamber. The nature and the type of the tests to be conducted depend upon various factors, some of which are: the degree of development of the particular design, the accuracy required, the funds available, the nature of the manufacturing company, and its design strategy.In this investigation methanol used as diesel additive.Methanol cannot be easily mixed with diesel fuel because of the prevailing wax content, hydrocarbon composition, water content and wide range of temperature of the diesel fuel. The problem of this occurrence can be solved by using emulsifierand co-solvent. In this experiment acrylic acid used as a co-solvent.

Jikar P.C. et al (2010) experimentally investigated and evaluated the effects of using methanol as additive to diesel blends on the engine performance, emission and combustion characteristics of a direct injection diesel engine under variable operating conditions.

IsmetCelikten et al (2010) studied the sources of air pollution in the environment and global warming issues, by formulating the performance and emission studies on port injection of hydrogen with varied flow rates with diesel as an ignition source and finally improved the performance and reduces the exhaust emission.

OrkunOzener et al (2014) in this study, the combustion performance and emission characteristics of conventional diesel fuel and biodiesel produced from soybean oil and its blends were compared. Those results indicated that biodiesel could be used without any engine modifications as an alternative and environmentally friendly fuel.

Zheng Chen et al (2013) in this work, the commercially available diesel fuel (Bu00), (Bu20), (Bu30), (Bu40) fuels were tested. It is interesting that smoke decreased significantly at all conditions with the use of butanol-diesel blends, and the more butanol blending ratio the less smoke. Overall butanol is a potentially promising biofuel, which could be used conveniently up to high blending ratio with diesel fuel in diesel.

The main objective of this study was to study the performance, emission and combustion characteristics of different ratio of methanol-diesel emulsions and tocompare these results with diesel fuel in single cylinder 4 stroke diesel engines at varying load conditions withconstant engine Speed (1500 pm).

II. MATERIALS AND METHODS

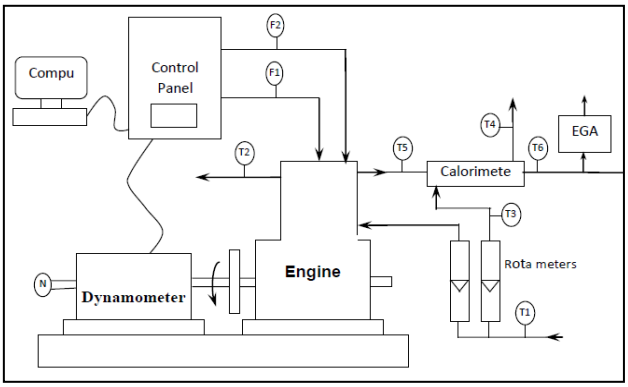

Fig. 1: Experimental setup

Parameters	Specifications
Manufacturer	Kirloskar Oil Engines Ltd., India
Type of Engine	Direct Injection Diesel Engine

Number of Strokes	Four Stroke
Number of Cylinders	Single Cylinder
Cooling	Water Cooled
Engine Speed	1500 Rpm, Constant
Rated Power	3.5 Kw @ 1500 Rpm
Bore Diameter	80 Mm
Stroke Length	110 Mm
Type of Loading	Eddy Current Dynamometer
Method of Starting	Manual Cranking
Compression Ratio	16.5:1
Dynamometer Arm Length	0.185 M
Orifice Diameter	0.02 M

Table 1: Engine specifications

Experiments were conducted on a single cylinder four stroke direct injection compression ignition engine as shown in Fig.1 the specification of the engine is given in Table 1. An eddy current dynamometer was used for loading the engine. The smoke meter used for analyzing the exhaust gas is i3sys.It has the capability to measure five exhaust gas emissions namely CO_2, CO, HC, SO_x and $NO_x$and CO_2 is measured in % of sample and HC, SO_x, $NO_x$are measured in ppm.

Properties	Diesel	Methanol	Acrylic acid
Density Kg/L	0.8289	0.792	1.045
Specific gravity	0.81	0.791	1.05
Kinematic viscosity cP	3-4	0.56	1.1
Flash Point°C	60	16	68
Calorific value kj/kg	42800	23000	13000

Table 2: Physical-chemical properties

The engine was started and allowed to warm up for about 30 min with diesel fuel to attain a normal working temperature. Experiments were started initially with diesel fuel and the results were obtained at 20, 40, 60, 80 and 100% load. Further the tests were repeated under above load conditions with different ratio of emulsified fuels at constant speed of 1500 rpm.

III. Results

A. *Brake Specific Fuel Consumption*

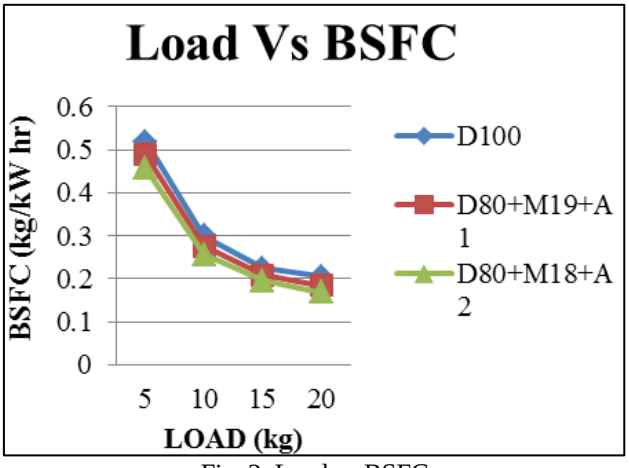

Fig. 2: Load vs BSFC

The variation of BSFC with varying proportion of blends was shown in Fig.2. The BSFC for diesel was found to be lower, whereas addition of acid content will leads to improvement in BSFC. It is due to the fact two different fuels involved in combustion process. The maximum BSFC was observed for 2% acid addition with diesel.

B. *Brake Thermal Efficiency*

The effect of acrylic acid addition on engine efficiency was shown in Fig.3.From that it was observed that, with increase in Brake Thermal Efficiency was observed. It was due to that, the acid will decrease the fuel viscosity, made the finer atomization process. This will lead to better mixing with oxidizer and hence combustion process in enhanced.

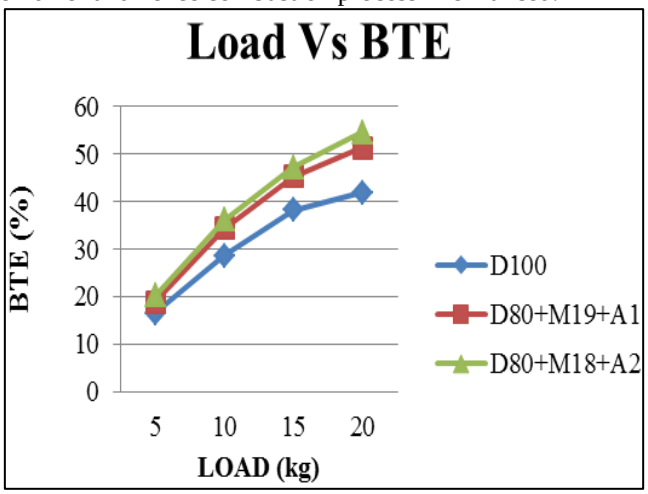

Fig. 3: Load vs BTE

IV. Emission Analysis

A. *CO Emission*

The trend which observed for HC emission also repeated in CO formation. As shown in Fig.4, acid addition will reduce the CO formation. At lower loads, Because of partial involvement of fuel in combustion process enormous CO emission was observed. It will slightly reduce with increase in engine load. Like HC emission formation, acid addition will helps to burn the Hydrogen & carbon contents completely, so it reduce the carbon emission.

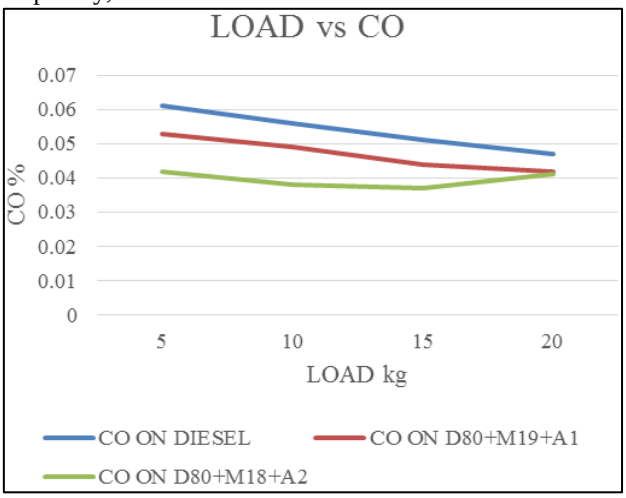

Fig. 4: LOAD vs CO

B. *CO_2Emission*

At lower loads, Because of partial involvement of fuel in combustion process enormous CO2 emission was observed as shown in fig.5. It will slightly increases with increase in engine load.

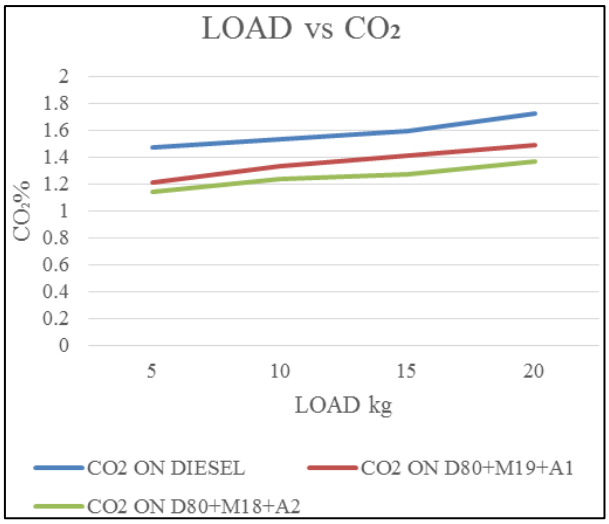

Fig. 5: LOAD vs CO_2

C. *Hydro Carbon*

The formation of HC emission during combustion process under various loads was shown in Fig.6. From that it was observed that, HC emission was slightly reduced with acid addition.As discussed earlier, acid addition will leads to improve the combustion process , so it burn almost all Hydro carbon in the input fuel we supplied. So this leads to reduction in HC emission.

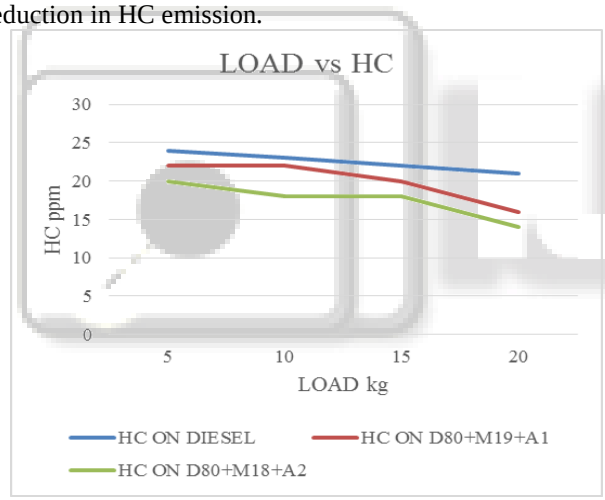

Fig. 6: LOAD vs HC

D. *NO_x Emission*

The effect of acid addition with diesel on NO_x formation during combustion process was shown in Fig.7. The NOx emission was increased linearly with increased in load on the engine.Because of finer atomization with acid addition, the combustion will very rapid. This will leads to temperature rise inside the combustion chamber. Since it induce NO_xformation at high flame temperature. So the NO_x emission was increased with increase in acid content.

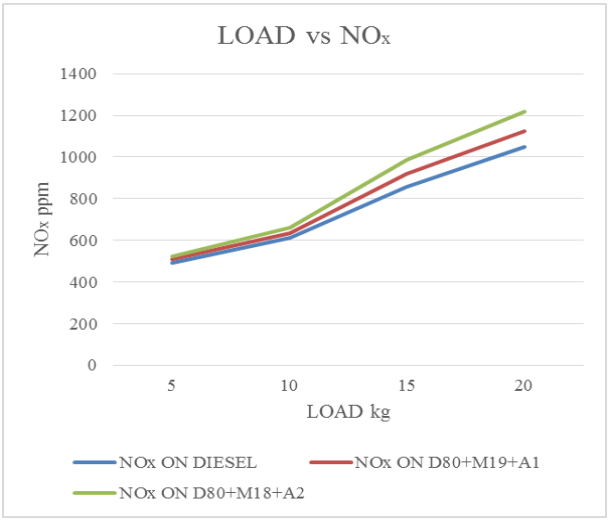

Fig. 7: LOAD vs NO_x

V. Conclusion

The Experimental investigation on the effect of Methanol emulsion with diesel was carried out and the performance and emission characteristics of diesel engine were measured.The final result shows that, 3.6% increase in the brake thermal efficiency when methanol emulsion blended with diesel.In emission characteristics, CO_2 decreased up to 22% and NO_x emission increases up to 6% due to the enormous temperature induced inside the combustion chamber.HC emission reduced up to 16% and CO emission 31 % reduced when the test was carried out on methanol emulsion blend.

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