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Effects of Ethanol- Acrylic Acid-Diesel Emulsions on the Performance and Emission Characteristics of DI Diesel Engine

K Ramesh, A.Gajendran

Abstract— In this study the diesel fuel was replaced with Acrylic acid, Ethanol 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%Ehanol and 1% acrylic acid ,18% Ehanol 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, CO, SOx emissions are measured and quiet decreased and co_2 increased comparison with the base fuel. The NOx emission is increased due to increased supply of oxygen.

I. INTRODUCTION

Diesel engines have higher thermal efficiency,specific power output with high fuel economy and are more efficient than gasoline engine. The major pollutants emitted from compression ignition engine are oxides of Nitrogen (NOx), Carbon monoxide (CO), Carbon dioxide(CO2) and particulate matter. The scientists are confronted with energythe following new challenges; they are related with environmental hazards, fuel scarcity, demand and stringent emission norms. The above difficulties can easily be overcome by discovering alternative fuels. A lot of research is being carried throughout the world to evaluate the performance and exhaust emission characteristics of the existing engines using several alternative fuels such as hydrogen, compressed natural gas (CNG), alcohols, liquefied petroleum gas (LPG), biogas, producer gas, bio-diesels, and others.

Ethanol 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 an co-solvent.

B.H.West et al.(1990) have studied the performance and emission characterictics of a constant speed CIengine on ethanol-diesel –cosolventemulsions.cosolvents such as alkyl nitrates, acrylic acids, and several vegetable oil derivatives. They found that a diesel engine calibrated with reference fuels, cetane numbers for fifty four blends were estimated. The apparent cetane numbers ranged from around 20 to above 50 with the majority between 30 and 45. Emissions of nitric oxide were measured for a few select fuels and were found to be 10 to 20% lower than No. 2 diesel fuel .Alcohol's poor ignition quality usually necessitates the use of often expensive cetane enhancers, full-time glow plugs, or spark assist. Reported herein are results of screening tests of clear microemulsion and micellar fuels which contain 10 to 65% C_1- C_4 alcohol. Ignition performance and NO emissions were measured for clear, stable fuel blends containing alcohols, diesel fuel and additives such as alkyl nitrates, acrylic acids, and several vegetable oil derivatives.

R. Parthasarathi et al.(2014)studied the performance, combustion and emission Characteristics of DI diesel engine ethanol-diesel -Benzalkonium chloride emulsions. They found that The D50 E40 blend gives the best performance of increase in brake thermal efficiency and decrease in brake specific fuel consumption.Hydrocarbon (HC) emission of blended fuel (D50E40) shows higher emission as compared to diesel. At full load condition, HC emission of D50E40, D60E30, D70E20, D80E10 and diesel is found to be 63, 47, 38.2, 39.1 and 39 ppm respectively. The oxides of nitrogen (NOX) emission is higher for higher concentration of ethanol (40%) in the blend.The smoke density emission of the blend D50E40 is lower than that of diesel fuel.The CO2 emission is higher for D50E40 blendcompared to diesel fuel

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

II. MATERIALS AND METHODS

Experiments were conducted on a single cylinder four stroke direct injection compression ignition engine as shown in **Fig. 1** and 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.

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%

K Ramesh, is Assistant Professor (SG), Department of Mechanical Engineering, Government College of Technology (Coimbatore), India. (Email : dr_ramesh@live.com)

A.Gajendran is PG Scholar , Department of Mechanical Engineering, Government College of Technology (Coimbatore), India. (Email : lalgaja@gmail.com)

load. Further the tests were repeated under above load conditions with different ratio of emulsified fuels at constant speed of 1500 rpm.

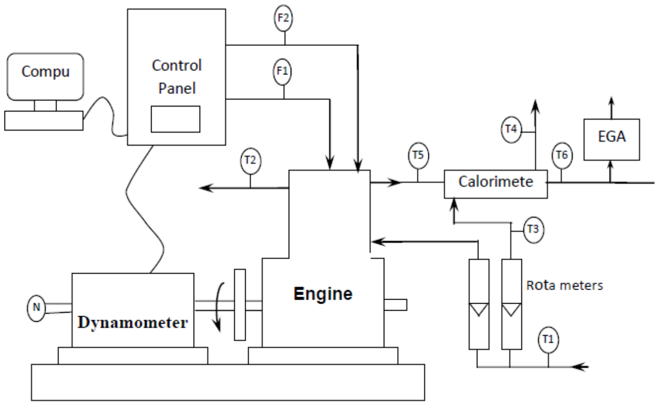

Fig.1 Experimental setup

Table 1 .Engine 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 2.physical-chemical properties

Properties	Diesel	Ethanol	Acrylic acid
Density	0.8289	0.789	1.045
Specific gravity	0.81	0.796	1.05
Kinematic viscosity	3-4	1.2	1.1
Flash Point°C	60	16	68
Calorific value kj/kg	42800	26,600	13000

III. RESULTS

Brake Specific Fuel Consumption:

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.

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.

IV. EMISSION ANALYSIS:

Hydro Carbon:

The formation of HC emission during combustion process under various loads was shown in Fig 4. 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.

Nox Emission

The effect of acid addition with diesel on NOx formation during combustion process was shown in Fig 5. 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 NOxformation at high flame temperature. So the NOx emission was increased with increase in acid content.

Co Emission:

The trend which observed for HC emission also repeated in CO formation. As shown in Fig 6, 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.

Co2 Emission:

At lower loads, Because of partial involvement of fuel in combustion process enormous CO2 emission was observed as shown in fig 7.. It will slightly incresase with increase in engine load.

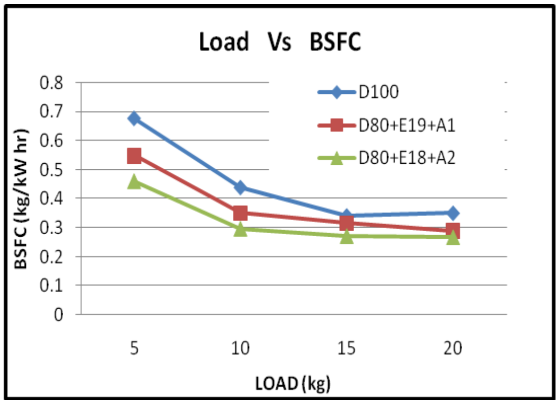

Fig.2 Load Vs BSFC

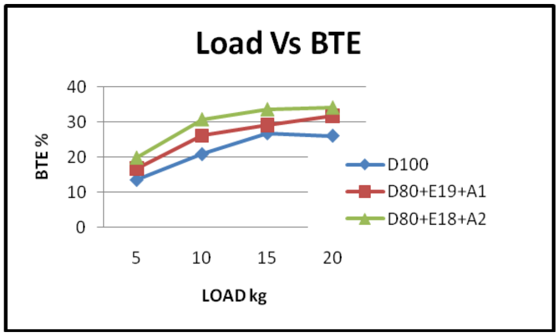

Fig.3 Load Vs BTE

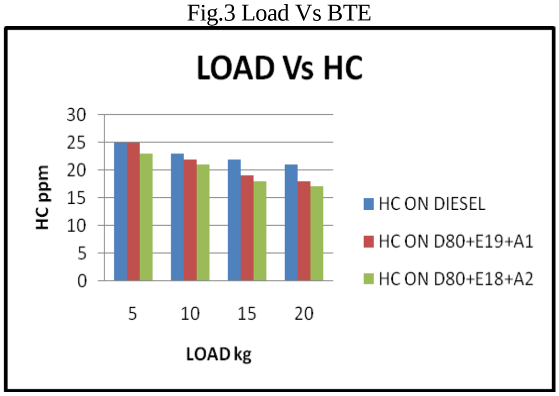

Fig.4 LOAD Vs HC

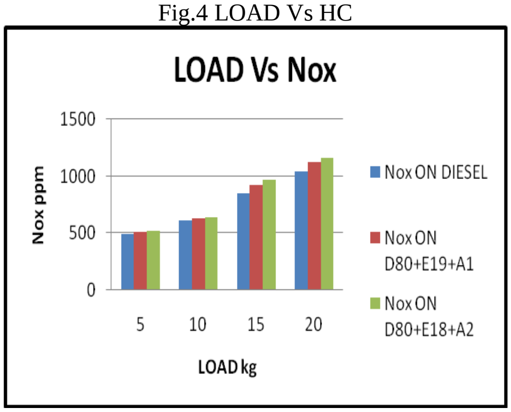

Fig.5 LOAD VsNox

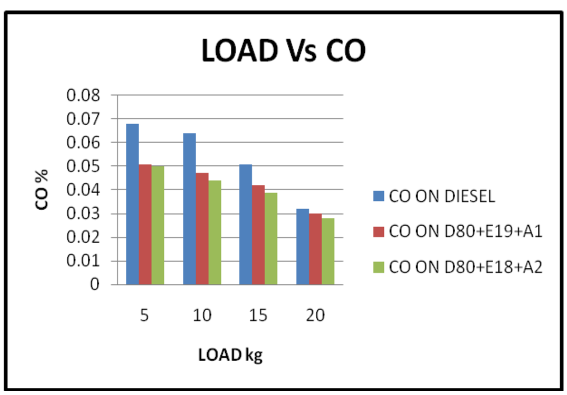

Fig.6 LOAD Vs CO

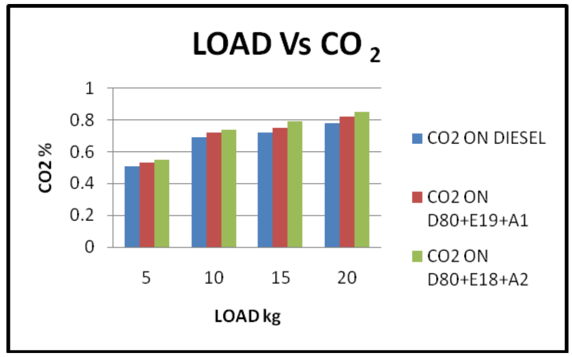

Fig.7 LOAD Vs CO_2

V. CONCLUSION

The Experimental investigation was carried out, to investigation the effect of acrylic acid addition with diesel, the performance and emission characteristics of diesel engine was done. The final result shows that, 6.5% increase in the brake thermal efficiency with the addition of Acrylic acid to diesel than the efficiency of diesel taken. In emission characteristics, NOx emission increases with addition of acid with Diesel fuel; in 12.28% due to the enormous temperature induced inside the combustion chamber. In HC emission – 23.14%, CO emission – 32%, were reduced as it compared with the blended Acrylic acid and diesel. In summary Acrylic acid shows better performance results.

REFERENCES

[1] West, B., Compere, A., and Griffith, W., "High-Alcohol Microemulsion FuelPerformance in a Diesel Engine," SAE Technical Paper 902101, 1990,doi:10.4271/902101.

[2] Ashok, M.P., 2011. Identification of best additive using the selected ratio of ethanol-diese-based emulsified fuel. Int. J. Sustain. Energy, 31: 203-212. DOI:10.1080/1478646X.2011.556736

[3] R. Parthasarathi, S. Gowri and C.G. Saravanan"Effects of Ethanol-Diesel Emulsions on The Performance, Combustion And EmissionCharacteristics of DI Diesel Engine" doi:10.3844/ajassp.2014.592.600 Published Online 11 (4) 2014 (http://www.thescipub.com/ajas.toc)