Experimental Utilization of 2-Ethoxy Ethyl Acetate as a Blend in a Single Cylinder CI Engine

Rahul Sood, Ashwani Kumar, Gurpreet Singh Batth

Abstract: In this investigating study diesel fuel was used as a reference fuel for 2-Ethoxy Ethyl Acetate –diesel blends. The blends containing 5, 10 and 15% of 2-Ethoxy Ethyl Acetate fuel by volume are tested on test rig developed for the experimentation. All the tests were conducted in steady state and were set at constant engine speed 1500 RPM. With the addition of oxygen in the fuel, it has been observed that the emission contents reduce remarkably. Moreover there is an increase in the Brake Horse Power and Brake Thermal Efficiency of the engine. So it can be concluded that the addition of 2-Ethoxy Ethyl Acetate by 10% in diesel not only helps to reduce the exhaust emission but also increases the performance of the diesel engine. 10% blend increases the BHP by 7.6% and BTE increases by 7.2 % at full load conditions. Also this blend ration decreases the CO % by 16%, HC by 11.9% and Smoke Opacity reduces by 19.11%. The experimental results prove that the use of 2-Ethoxy Ethyl Acetate fuel as a blend improves the engine operation and reduces the environmental pollution.

Keywords: 2-Ethoxy Ethyl Acetate, Oxygenated fuel, Diesel engine, Engine emission, Exhaust smoke, Carbon monoxide, Carbon dioxide, Hydrocarbon.

I. INTRODUCTION

The diesel engine dominates the field of commercial transportation and agricultural machinery on account of its superior fuel efficiency. However they emit more emissions. The use of oxygenated fuels seems to be a promising solution towards reducing emissions in existing and future diesel engines. Oxygenated fuel is a chemical compound containing oxygen. It is used to help fuel burn more efficiently and cut down on some types of atmospheric pollution.

Oxygenated fuels are characterized by the following molecular conditions of the fuels: molecular weights are low and the molecules have high hydrogen to carbon ratios and a low number of carbon to carbon bonds which lower the formation of solid carbon particulates, molecules contain oxygen which suppress the formation of soot, molecular bonds break up to radicals at reasonable activation energy which leads to high cetane numbers. The oxygenated blends usually enhance the combustion efficiency, burn rates and the ability to burn more fuel and these blends offer the reduction of exhaust emissions. Oxygenate utilization to produce "cleaner burning" diesel fuels has been known for over fifty years. Oxygenates are well known to reduce particulate emissions. Low molecular weight alcohols, such as methanol, ethanol, and t-butyl alcohol, have been reported to reduce emissions. Higher alcohols, carbonates, diethers, such as diglyme, and various glycol ethers have also been reported.

Manuscript received on April 16, 2014.
Er. Rahul Sood, PG student, Mechanical Engineering Department, Rayat & Bahra Instituteof Engg and Bio Tech, Kharar, India.
Er. Ashwani Kumar, Associate Professor, Mechanical Engg. Department, Rayat & Bahra Institute of Engg and Bio Tech, Kharar, India.
Er. Gurpreet Singh Batth, Assistant Professor, Mechanical Engineering Department, Chandigarh College of Engg Tech. Sec 26 Chandigarh,India.

Particularly attractive are P-series glycol ethers, which contain both ether and a propylene glycol end-group. This paper deals with 2-Ethoxy Ethyl Acetate criterion and emmision reductions in modern diesel engine. Diesel engine exhaust emissions (commonly known as 'diesel fumes') are a mixture of gases, vapours, liquid aerosols, and substances made up of particles.

II. EXPERIMENTAL SETUP

The test rig facility used in the experimentation is developed at GGS College of Modern Technology, Kharar. It consists of CI engine of 5 HP rated power, a single-cylinder, 4-Stroke, water-cooled engine. An electrical dynamometer was used for loading the engine; a 5 KW generator was attached to the engine. A digital tachometer was used to measure the speed of the engine. The exhaust gas temperature was measured by a K-type thermocouple. The concentrations of NOx, HC and CO were measured by an exhaust gas analyzer. The output power of the engine was calculated based on the data of the engine torque and speed, while the brake thermal efficiency was obtained by using the data of the engine output power and the data of the fuel consumption measured by using burette.

Fig. 1 Test Rig with all Equipment

Figure 1 shows the experimental setup used for experimentation. Table 1 highlights the specifications of the diesel engine used for the experimentation.

Engine manufacturer	Kirloskar Oil Engines Limited, India
Engine type	Vertical, 4-stroke, Single cylinder, DI
Cooling	Water cooled
Dynamometer	Eddy current dynamometer
Rated power	3.75 kW at 1500 rpm
Horse power	5
Bore/Stroke	80/110 (mm)
Compression Ratio	16.5:1
Injection pressure	200kg/cm^2
Engine weight (kg)	175

Table 1 Specifications of the Test Rig

Also figure 2 shows the block diagram of the experimental setup. Exhaust gas temperatures were also recorded for all loads. Airrex exhaust gas analyzer (German Make) is used to measure CO, CO_2, HC, and O2 in the exhaust gases at all loads and graphs are drawn to analyze the emissions. A centrifugal governor is mounted to maintain the constant speed. The engine is properly balanced and flywheel is statically balanced for the smooth operation of the experimental work.

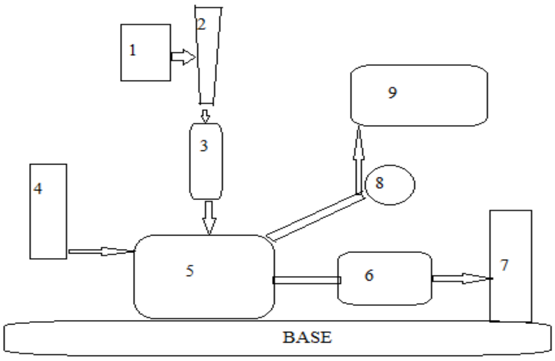

Fig. 2 Schematic arrangement of the test rig (block diagram)

<u>Parts of the Test Rig</u>

1. Fuel tank 2. Burette (fuel measurement)
3. Fuel filter 4. Air filter
5. Diesel engine 6. Generator
7. Load cell 8. Thermocouple
9. Emission gas analyzer

III.EXPERIMENTAL PROCEDURE AND RESULTS

For getting the base line data of the engine first the experimentation is performed with diesel and then with the blends of 2 Ethoxy Ethyl Acetate (5%, 10% and 15 %). Performance and emission tests were conducted under different loading condition on these various diesel-EEA blends. The optimum blend was found out from the graphs based on maximum thermal efficiency, minimum brake specific energy consumption and safe emission at all loads. The performance of an engine is evaluated on the basis of the basis of brake thermal efficiency, brake horse power, brake specific fuel consumption and. The readings from the experimentation are tabulated in the form of column charts.

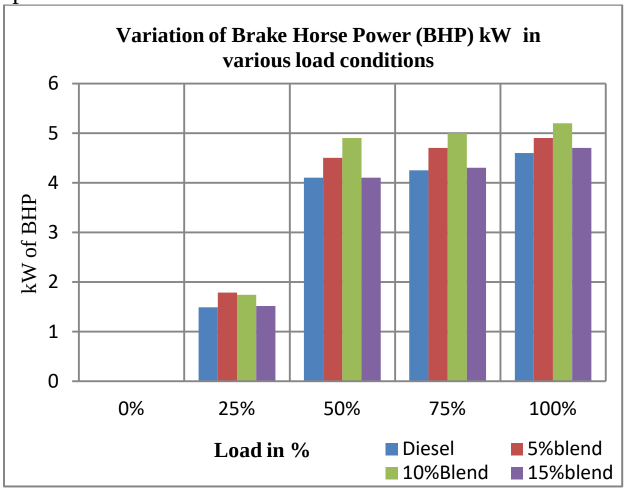

Chart 1 Variation of Brake Horse Power (kW) with Changing Load

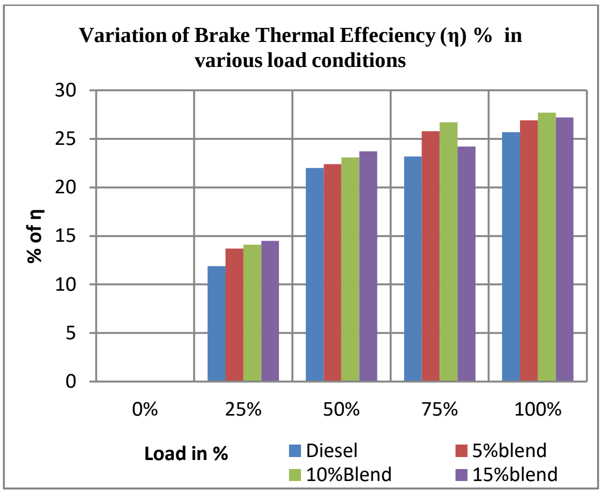

Chart 2 Variation of Brake Thermal Efficiency (η) with Changing Load

Chart 1 shows the engine power output (Brake Horse Power) under the changing load operating conditions. It is clear from the chart that the power of engine increases with the amount of oxygen in the fuel blend. Chart 2 shows the brake thermal efficiency (BTE) variation with respect to varying load for Diesel and 2-EEA blends. The brake thermal efficiency increases with increase in 2-EEA percentage.

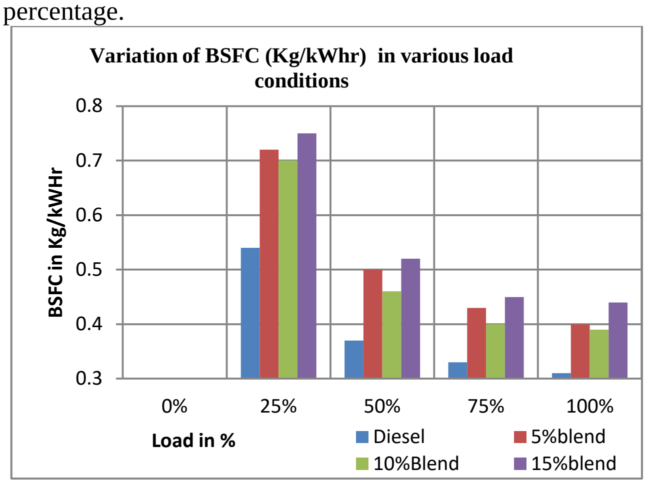

Chart 3 Variation of Brake Specific Fuel Consumption with Changing Load

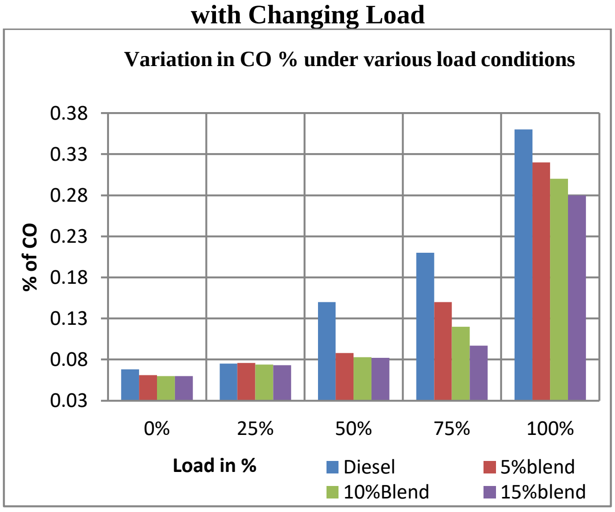

Chart 4 Variations in CO % under Various Load Conditions.

The variation of BSFC with load for different blends and loads are presented in Chart 3. It is observed that the readings for the BSFC at different load conditions with different blends, that the BSFC for all the fuel blends tested decrease with increase in load. This is due to higher percentage increase in Break power with load as compared to increase in the fuel consumption.

Chart 4 shows the CO emissions. The exception for load at 75% may be due to the observed change in the fuel blend properties. In general, CO decreases as load increases, also, the amount of CO decreases with oxygen addition.

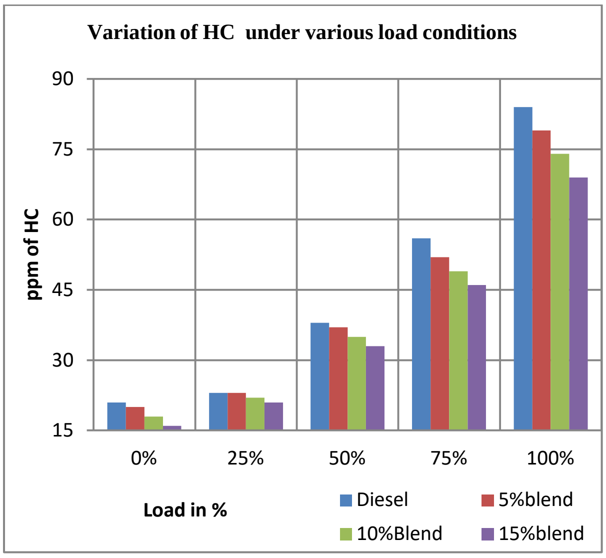

Chart 5 Variation of HC % under Various Load Conditions

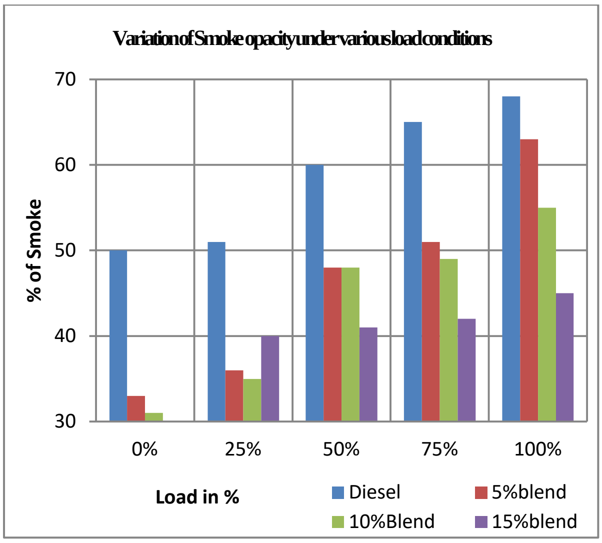

Chart 6 Variation of Smoke opacity under Various Load Conditions

The variation of HC emission for different blends at various loads is indicated in Chart 5. Fuel-borne oxygen aids the reduction of hydrocarbon emissions. Chart 6 shows typical smoke levels for various engine loads. It is possible to see that 2- Ethoxy Ethyl Acetate blends produce lower smoke levels than their diesel counterparts for corresponding speed load conditions. It is clearly confirmed from the Chart 6 that oxygenation reduces the total amount of smoke and by a more significant margin, reduces the total number of carbon particles.

IV.CONCLUSION

The results from this research lead to the following conclusions:

1. 2- Ethoxy Ethyl Acetate blends can be use as supplementary fuel in compression ignition engine. The engine operates in a similar manner with the 2-Ethoxy Ethyl Acetate the diesel fuel, as reviewed in the engine stability data.
2. In the process of using 2- Ethoxy Ethyl Acetate products to improve the efficiency of an internal combustion engine combustion aid acts more like combustion "catalyst" than a fuel. These improvements in combustion also add energy to the combustion process and allow more of the hydrocarbon fuel's energy to be released in the engine's cylinders to produce work.
3. 10% blend increases the BHP by 7.6% and BTE increases by 7.2 % at full load conditions. Also this blend ration decreases the CO % by 16%, HC by 11.9% and Smoke Opacity reduces by 19.11%.

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AUTHORS PROFILE

Er. Rahul Sood is an M Tech (Mechanical Engineering) student of Rayat and Bahra Institute of Engineering and Bio-Technology, Kharar, Punjab. He did is B.tech from the CEC, Landran. His areas of interest are Automobile Engineering and IC Engines.

Er. Ashwani Kumar is presently associated with Rayat and Bahra Institute of Engineering and Bio-Technology, Kharar, Punjab. He is pursuing PhD from PEC, Chandigarh. His area of interest is IC Engines, Thermal Engineering and Manufacturing Technologies.

Er. Gurpreet Singh Batth is presently associated with Chandigarh College of Engineering and Technology, Sector 26, Chandigarh. He did is M Tech from Rayat Institute of Engineering and Information technology, Ropar, Punjab. His areas of interest are Cad Cam, Automobile Engineering and IC Engines.