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Analysis of Combustion and Emission Characteristics of SI Engine Powered with Diethyl Ether Blended Petrol as Fuel

G. Satheeshkumar
Pannai College of Engineering Andtechnology, Sivagangi

Abstract

Incomplete burning of the fuel and high emission in the engine were the major problems in using the petrol as a fuel. In this Experimental study, the effects of Diethyl Ether, petrol fuel blend investigated on four stroke four cylinder SI engine for analyzing the performance and combustion characteristics. The tests were performed while running the engine at speeds of 1500&1000 rpm and at four different engine load conditions (0, 3, 6, 9 kW). The results obtained from the use of Diethyl Ether, petrol fuel blends are compared to those of sole petrol in SI engine. The results indicated that when Diethyl Ether, petrol fuel blends were used, the Brake Specific Fuel Consumption and exhaust emission are decreased. Exhaust gases namely, carbon dioxide, carbon monoxide and total unburned hydrocarbons are measured using AVL exhaust gas analyzer. Performance and exhausts emissions are compared with sole petrol, using Diethyl Ether, petrol fuel blends. This oxygenates shows significant improvement for exhaust emission and also fuel consumptions at different load conditions.

Keyword- Diethyl ether, blend with petrol, Pollution reduction, improved performance

I. INTRODUCTION

S.I engines are a major and widely used power source for on-land transportation vehicles due to their simple mechanism, excellent performance, easy maintenance, low fuel oil cost, low fuel consumption rate, low breakdown rate, high power/weight ratio, high fuel oil density, high thermal efficiency and durability. S.I engines are the most performance-efficient engines in human history.

However, S.I engines are also considered a major source of air pollution because of their black smoke, HC, NO_x, particulate matter (PM), CO, CO_2, So_x emissions. The disgusting odor and noise from these engines may impair human health and the natural environment, such as ozone layer destruction, greenhouse effect enhancement and acid rain production. While S.I engines are still the most common energy production equipment for on-land vehicles, the air pollution threat caused by them cannot be neglected.

The amount of particulate matter emission depends on the quality of the fuel oil and the completeness of burning in the combustion chambers.

Particulate matter is generated from incomplete hydrocarbon burning when the fuel oil is injected into a cylinder and mixes with its surrounding air imperfectly. Particulate matter is generally composed of three compounds: (1) solid carbon particles produced from the burning process, particulate matter emitted from the diesel engines in the early burning stage consisting of 40–80% solid carbon particles; (2) soluble organic fractions (briefly termed as SOF), produced from the adsorption or condensation of hydrocarbons with heavy molecular weight onto the surface of the carbon particles.

Most SOF come from unburned lubricant (about 40% of the total) and fuel oil (about 25% of the total); (3) sulfides, additives for fuel oil, etc. Hence, adequately controlling the burning process can effectively reduce the solid carbon particles and SOF, leading to a decrease in the exhausted particulate matter. In the case of sulfur oxides, the reaction between sulfur in the fuel oil and oxygen generates gaseous SO2 and a few sulfide particles. Controlling the quantity of sulfur in the fuel oil is a valid approach to suppress the formation of sulfur oxides PM10 represents particles that have a mean diameter less than 10 μm. Small particulate like PM10 is difficult for the respiratory organs to filter and thus becomes easily inhaled into the lungs of human beings.

According to the report from the American Environmental Protection Agency, there are about ten thousands chemical Compositions adhering to the surface of PM10, which were confirmed to cause Mutation in a short-term medical test (Carel, 1998). Experiments conducted on animals showed that inhalation and deposition of particulate matter onto the lungs would lead to cancer. Particulate matter not only threatens to impair human health, but also causes destruction of the ecological environment. The use of an oxygenating agent with fuel oil to adjust the fuel constitution has been considered as one of possible approaches for improving the emission characteristics of S.I engines. After systematically evaluating some potential oxygenating agents for their physical properties, chemical characteristics, stability, availability, reliability, toxicity, cost and possibility of air-pollution improvement, Diethyl Ether is considered as a promising blend.

The addition of DEE into a fuel oil may enhance the fuel oxidation reaction. This occurs primarily because of the high oxygen content up to 46.1 wt%. This might result in a significant reduction in particulate matter, toxic gas and black smoke emissions.

The remainder of this paper is organized as follows .Section II gives problem identification; Section III presents fuels and methods. Section IV presents emission analysis. Finally, Section V presents table of results. Section VI discusses conclusions and gives an outlook onto future work

II. PROBLEM IDENTIFICATION

Knocking is an unnecessary sound created in the engine while driving a vehicle. The reason for that sound is improper combustion in the engine. Due to that, the temperature of the engine is increased to very high level. As a result pre ignition will takes place that creates an unwanted sound. To avoid that problem proper combustion is required. For proper combustion of fuel in the engine, the fuel should have the high octane number and high calorific value. So we try to find additive to rectify that problem. We found that Diethyl Ether is a suitable additive to rectify that problem. It improves the octane number when mix with petrol at particular percentage.

In an internal-combustion engine, sharp sounds caused by premature combustion of part of the compressed air-fuel mixture in the cylinder. In a properly functioning engine, the charge burns with the flame front progressing smoothly from the point of ignition across the combustion chamber. However, at high compression ratios, depending on the composition of the fuel, some of the charge may spontaneously ignite ahead of the flame front and burn in an uncontrolled manner, producing intense high-frequency pressure waves. These pressure waves force parts of the engine vibrate, which produces an audible knock

When an engine pings, it releases pollution into the environment in the form of nitrogen oxide and raw, unburned hydrocarbons. These two chemicals are poisonous gases that show up as yellowish-brownish in a polluted sky. They can also cause respiratory problems like asthma and emphysema.

III. FUELS AND METHODS

Petrol was blended with Diethyl Ether to prepare a different blend on a volume basis. The samples are (5%DEE + 95% petrol) and (10%DEE +90% petrol). The tests were conducted on engine, which has a four-cylinder, four stroke, and carburetor system with AVL gas analyzer.

.All tests were compared with sole petrol in SI engine.

A. Table of Observation

1) Sole Petrol Test (1500 Rpm)

Sl. No.	*Applied load*	*Time for 'x' cc of fuel consumption (sec)*		
			Trial	*Trial*
			T_2	T_{ave}
1	0	42	41.64	41.82
2	3	37.50	37.40	37.50
3	6	31.00	31.41	31.20
4	9	16.40	17.00	16.7

2) Sample 1 Test (1500 rpm)

Sl. No.	*Applied load*	*Time for 'x' cc of fuel consumption (sec)*		
			Trial	*Trial*
			T_2	T_{ave}
1	0	38.48	38.60	38.54
2	3	34.10	35.02	34.62
3	6	27.56	28.48	28.02
4	9	23.74	24.50	24.12

3) Sample 1 Emission at 1500 Rpm

load(kg)	no_x*(ppm)*	co_2*(%vol)*	o_2*(%vol)*	*co(%vol)*
0	109	12.00	2.97	1.45
3	237	12.20	1.46	2.41
6	203	11.10	0.75	5.92

IV. EMISSION ANALYSIS

A. CO Emission

The effect of the petrol with Diethyl Ether blend on CO emissions is shown in Fig. It can be seen that Petrol with DEE concentration increases and reduces the CO emission. In stage 1500 rpm, it was found that in sample, the concentration of CO emissions decreased. In stage 1000 rpm, it was observed that in sample , the concentration of CO emission decreased This is due to the increase in the percentage of DEE and additive concentrations that has resulted in leaner combustion and also due to the presence of oxygen in DEE.

Due to leaning, CO emissions decrease tremendously. In general, for all concentration blends, CO emissions are found to be reduced when concentration is increased. The pressure of the OH group in alcohol makes alcohol combustion an interesting variation of the analogous paraffin hydrocarbons. A similar leaning effect can be expected for other oxygenates additives.

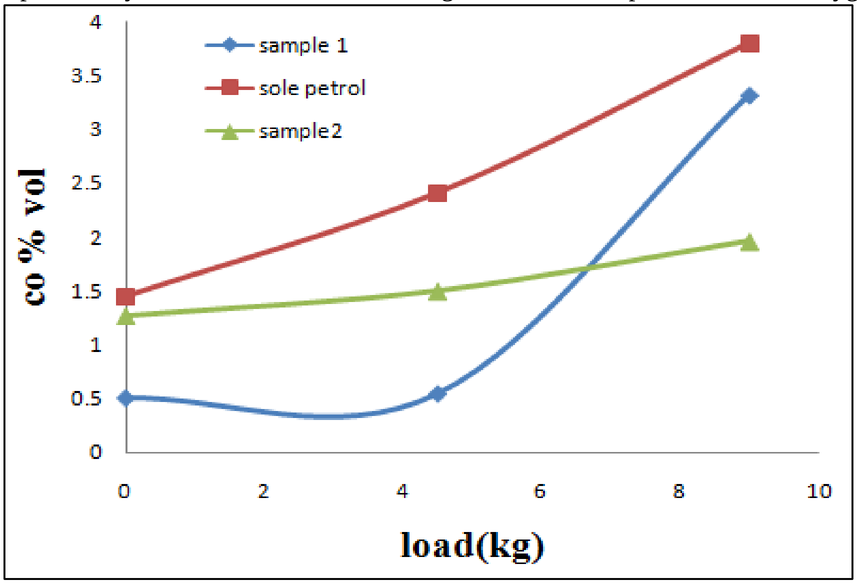

Fig. 4.1: CO Emission (1500 rpm)

B. CO_2 Emissions

The effect of the DEE- Petrol with oxygenated additives blends on CO_2 is shown in Fig. As the speed increases, the CO_2 emissions gradually increase. It indicates the complete combustion of the fuel in the combustion chamber. In stage 1500 rpm, it was found that in sample, the CO_2 value was 12.5% of volume.

This was minimal when compared with sole petrol. It is obvious that there is significant reduction in CO_2 emission when using DEE blend samples. There was an appreciable reduction in sample when compared to other samples.

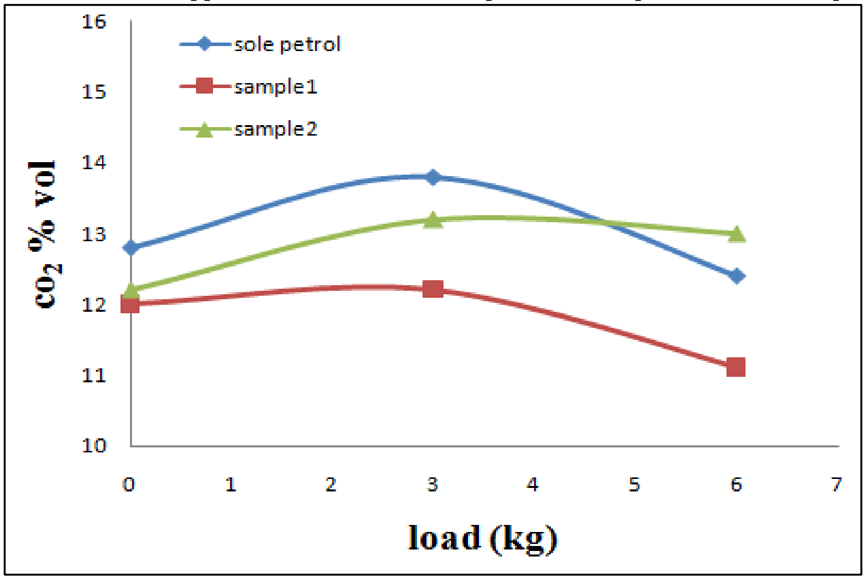

Fig. 4.2: CO_2 Emission (1500 rpm)

C. HC Emissions

Fig. shows the effect of the DEE percentage in the blend on the HC emissions. In sample, HC emissions were found to have increased at all speeds. At this point, it has to be noted that DEE has a lower flame speed as compared to sole fuel operation. As a result, less mass fraction of the fuel is burnt in the case of DEE-blended petrol.

Hence, higher amounts of unburnt fuel are left in each cycle. On account of the cooling effect and increasing quench volume of DEE in the combustion chamber, the HC emissions were enhanced. In addition to the cooling effect that increases engine volumetric efficiency, it may also have been the effect of using DEE as arising fuel.

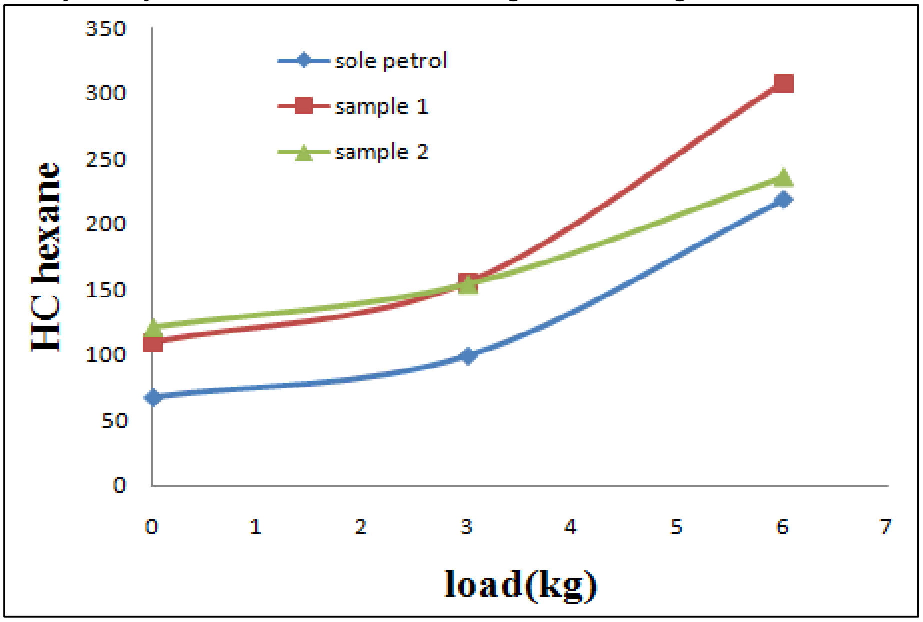

Fig. 4.3: HC Emissions (1500 Rpm)

D. NO_X Emissions

The effect of the DEE with petrol blends on NO_x emissions is shown in Fig. It can be seen that the blend decreases NO_x emissions. For sample, it was found that the NO_x emission level was significantly reduced for all speeds. The percentage of reduction in NO_x emission level ranges from 100 to 250 ppm for sample. This indicates that they had a lower heating value for DEE than for petrol resulting in decrease in the combustion heat energy and reducing the combustion temperature in the cylinder.

The major factors contributing to NO_x emissions include high flame temperature and presence of excessive oxygen during combustion. Due to the much lower flame temperatures for sample combustion, its NO_x emissions are usually lower than those of petrol. It is apparent that in any HC oxidation process that takes place during the combustion of DEE fuels provides leaning of mixtures that reduces the NO_x emissions. It is evident that the heat release rate decreases for blended fuels

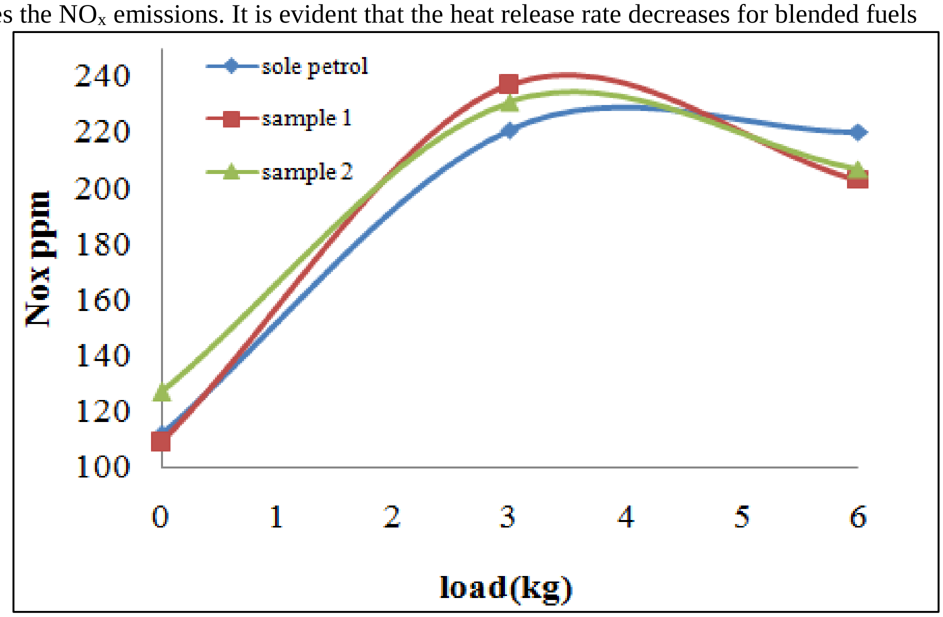

Fig. 4.4: NO_X Emission (1500 rpm)

E. O_2 Emissions

The effect of the petrol-DEE blends on O_2 is shown in Fig. 7. Sample was found to increase the O_2 emissions at all speeds. In sample, the oxygen content in the exhaust gas was decreased. The increase in the oxygen content of the exhaust gas was due to the increase in the DEE and the oxygenated additive percentages.

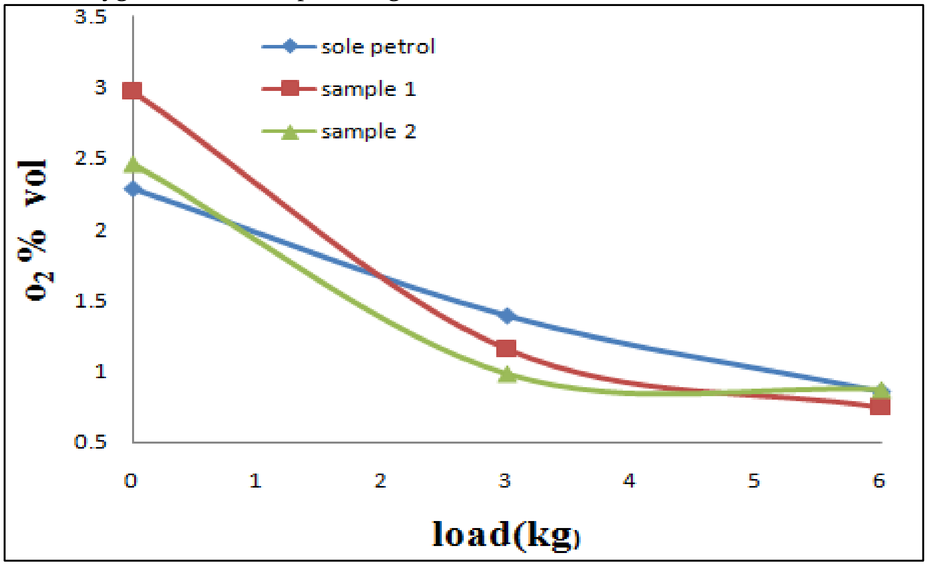

Fig. 4.4: O_2 Emission (1500 rpm)

V. TABLE OF RESULTS

Applied load (kg)	BP (kW)	TFC (kg/hr)	SFC (kg/kw.hr)	FP (kW)	IP (kW)	Mech. Efficiency (%)	Brake thermal efficiency (%)
0	0	1.2692	∞	2.2	2.2	0	0
3	0.739	1.417	1.917	2.2	2.939	33.59	3.19
6	1.478	1.701	1.150	2.2	3.679	40.2	6.52
9	2.217	3.178	1.433	2.2	4.418	50.2	5.23

A. Sample 1 Test (1500 rpm)

PARAMETER	SOLE PETROL	95%PETROL+5%DEE
CO(% BY VOL)	2.94	2.82
HC(PPM)	1452	1671
CO_2	3.6	2.4
O_2	18.51	19.44
LAMBDA	3.181	3.736

VI. CONCLUSION

Adding DEE to petrol will lead to a leaner better combustion. It was experimentally investigated that adding DEE to the blends led to an increase in the engine brake thermal efficiency and decreases BSFC.

The lean combustion improves the completeness of combustion and therefore the CO emission is expected to be decreased. The oxygen enrichment generated from DEE increased the oxygen ratio in the charge and lead to lean combustion. The CO2emission increased slightly. Unburned HC is a product of incomplete combustion which is related to A/F ratio.

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