The Effect of using an Methanol and Ethanol blends with gasoline on Emissions in an SI Engine

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Abstract

In this study, the performance parameters are investigated for a single cylinder, four-stroke, spark-ignition engine with varying speed (1000 to2500 rpm) with compression ratios (CR=8). For this analysis, (base fuel) and blends of ethanol with base fuel (E10, E20) and methanol with base fuel (M10 & M20) are used. The results show that the exhaust temperature increases with the increase in engine speed for all the tested fuels. lost of heat energy with exhaust were decreased and exhaust emissions were reduced with the increase of ethanol and methanol -gasoline blends content.

Keywords: Methanol ,Ethanol, Gasoline, Exhaust emissions

1. INTRODUCTION

Fuel additives are very important, since many of these additives can be added to fuel in order to improve its efficiency and its performance. Internal combustion engines have been in use for more than a century and have undergone tremendous changes in design, materials used and operating characteristics. Never ones during their long history of development have they lost their importance as the planet most widely used prime movers. In the past few decades, research efforts have been focused largely on better spark ignition engine, from the perspective of reducing the pollutant emissions without sacrificing performance and fuel economy. Another driving force behind the need to design engines amenable to operate on non-conventional fuels is the rapid depletion rate of currently used fossil fuels [1]. Suat Saridemir et al., studies the effects of unleaded gasoline (M0) and unleaded gasoline-methanol blends (M10, M20, M30, M40) on engine performance and pollutant emissions were investigated in a single cylinder, four stroke, spark-ignition engine at the wide open throttle. The results show that the exhaust temperature and lost of heat energy with exhaust were decreased and exhaust emissions were reduced with the increase of methanol - gasoline blends content [2]. S. Babazadeh Shayan1 et al, studies the effects of Methanol (M5, M7.5, M10, M12.5, M15) on the performance and combustion characteristics of a spark ignition engine (SI) were investigated. The experimental results showed that the performance of engine was improved with the use of methanol. It was also shown that CO and HC emissions were reduced with the increase of methanol content while CO2 and NOx were increased[3]. Mallikarjun M.V. In the present day scenario emissions associated with the exhaust of automobiles resulting in global warming is a major menace to the entire world and also detrimental to health. Here an experimental attempt has been made to know the level of variation of exhaust emissions (Carbon monoxide, Hydrocarbons, Nitrusoxides) in S.I. four cylinder engine by adding methanol in various percentages in gasoline and also by doing slight modifications with the various subsystems of the engine under different load conditions. For various percentages of methanol blends (0-15%) pertaining to performance of engine it is observed that there is an increase of octane rating of gasoline along with increase in brake thermal efficiency, indicated thermal efficiency and reduction in knocking. On the other hand exhaust emissions CO and HC are considerably decreased but CO2 and Nox simultaneously slightly increasing. It is notable that for these methanol blends combustion temperature is found to be high and exhaust gas temperature decreasing gradually[4]. Sahib Shihab Ahmed, discuss the performance and exhaust emissions of a vehicle fueled with low content alcohol (methanol) blends and pure gasoline. It is found that increasing the blending percentage reduces the emitted concentration of carbon oxides and HC[5] .

Palmer [6], he indicated that 10% of ethanol addition to gasoline could reduce the concentration of CO emission up to 30%. [7]Abdel-Rahman and Osman (1997) carried out performance tests using different percentages of ethanol in gasoline fuel, up to 40%,under variable compression ratio conditions. The results show that the engine showed power improvement with the percentage addition of the ethanol in the fuel blend. The maximum improvement occurred at 10% ethanol/90% gasoline fuel blend.

[8]In the experimental study of Al-Hasan (2003), the effects of usage of unleaded gasoline–ethanol blends on spark ignition engine performance and exhaust emission were investigated. The best result at the engine performance and exhaust emissions was obtained by usage of 20% ethanol fuel blend.

2. Experimental apparatus and procedure

2. 1. Engine and Equipment

The internal combustion engine used in the experiments is a single cylinder, variable compression ratio varicomp type (GR 306/000/037A) made by the Prodit company, (Italy). It is 4 strokes, overhead poppet valve and is connected to a hydraulic dynamometer. The engine is adaptable to run either as a (SI) or as a (CI) engine. Spark Ignition engine is used in this work. The compression ratio was varied from (4 to 17.5). The engine is mounted on a stainless steel sturdy main frame which was purposely designed to contain and support all the apparatuses and for carrying out all experimental tests.

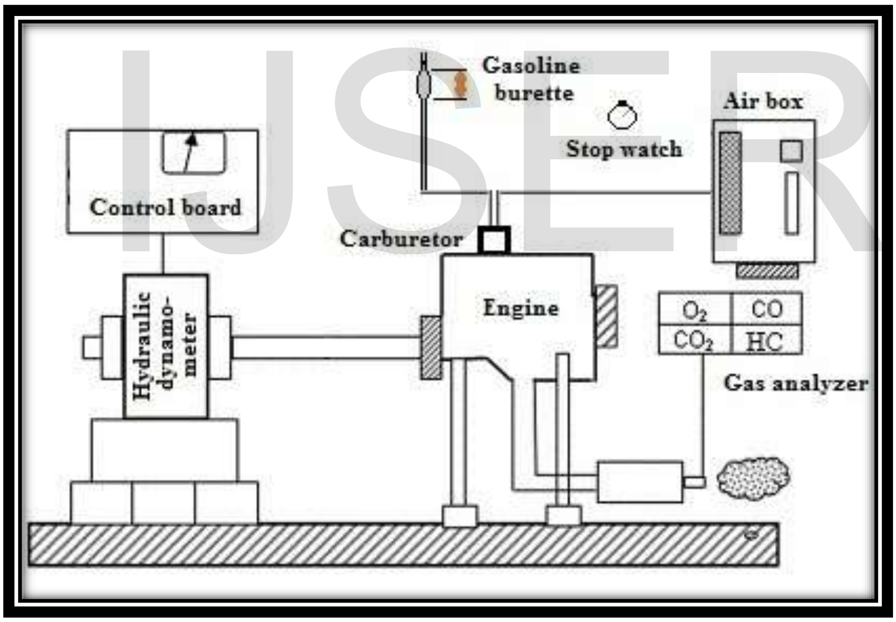


Figure (1): Schematic of experimental apparatus

<u>2.2-Exhaust Gas Analyzer</u>

The exhaust gas analyzer type (Flux) was used to analyze the emissions of exhaust as shown in figure (2).The analyzer detects the CO-CO2-HC-O2 contents. The gases are picked up from the engine exhaust pipe by means of the probe. They are separated from water moisture through the condensate filter and then they are conveyed into the measuring cell. A ray of infrared light, generated by a transmitter, is send through the optical filters on to the measuring elements. The gases in the measuring cell absorb the ray of light at different wavelengths, according to their concentration. The H2 – N2 –O2gases due to their molecular composition, do not absorb the emitted ray. This prevents measuring the concentration through the infrared system. The CO-CO2-HC gases, thanks to their molecular composition, absorb the infrared rays at specific wavelengths (absorption spectrum).However the analyzer is equipped with a chemical kind sensor through which the oxygen percentage (O2) is measured.

Fig (2). The exhaust gas analyzer type (Flux)

2. 3. Fuels

Four different fuel samples were experimentally investigated during this study. Base gasoline was obtained from the ALDORA Oil Refinery Company. Methanol and Ethanol with the purity of 99.9% was obtained from Laboratory for chemical. The base gasoline (G) was mixed with methanol (M) and ethanol (E).The fuel blends were prepared just before starting the experiment to ensure that the fuel mixture is homogeneous.

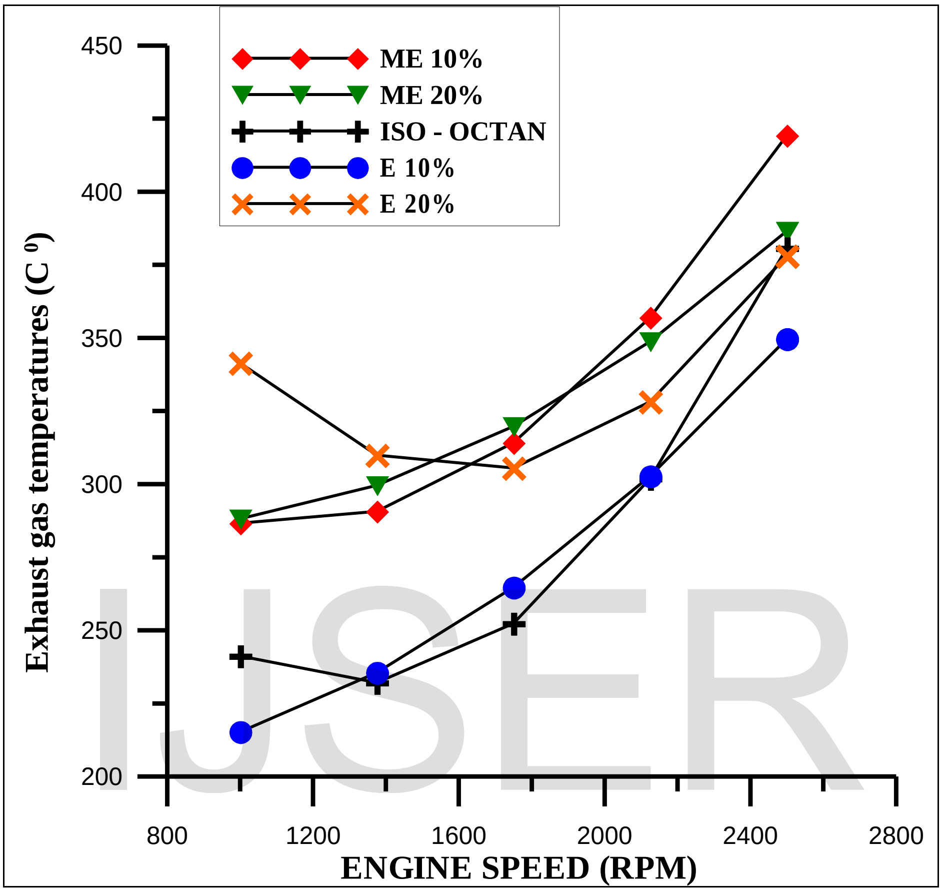
2.4 Procedure

The engine was started and allowed to warm up. Engine tested were performed at 1000,1500, 1750, 2000, and 2500 rpm engine speed at wide open throttle. Before running the engine to a new fuel blend, it was allowed to run for a sufficient time to consume the remaining fuel from the previous experiment.

3- RESULTS and DISCUSSIONS

1-Exhaust Temperature

Fig.3 shows the variations in exhaust gas temperature with respect to engine speed for various fuels tested at a constant load. It is shown in the figure that exhaust temperature increases with the increase in engine speed for all the tested fuels. This is explained with several reasons. With the increase in engine speed, combustion gases gets less time to remain in contact with cylinder wall and therefore more quantity of energy is released with exhaust gases which increases the temperature of exhaust gases. At 2500 rpm, the value of exhaust temperature is maximum for M10 fuel and minimum for E10 fuel. At 1750 rpm. These variations in exhaust temperature can be attributed to increase in thermal efficiency or A/F ratio which affects the combustion temperature.



Fig(3). The effect of methanol and ethanol blends addition on the exhaust gas temperature

2- Effects of Alcohol Blending on Exhaust Emissions.

The CO emissions in the exhaust gases represent the lost chemical energy that is not fully used in the engine. Generally, CO emission is affected by air–fuel ratio, fuel type, combustion chamber design and atomization rate, start of injection timing, injection pressure, engine load, and speed. The most important among these parameters is the air–fuel ratio. The variation in the CO emissions of the engine is shown in Fig4. when methanol–gasoline fuel blends are compared to pure gasoline fuel. The results show that the concentration of carbon monoxide decreases with increases (methanol and ethanol) blends ratio. This is due to the reduction in carbon atoms concentration in the blended fuel and the high molecular diffusivity and high flammability limits which improve mixing process and hence combustion efficiency. It is observed that CO increases with increasing load for all the percentage of methanol. If percentage of additive increases CO reduces. This is due to the batter combustion of gasoline when methanol used as an additive. The concentration of CO decreases with the increase in percentage of (methanol and ethanol) in the fuel. This may be attributed to the presence of O2 in methanol, which provides sufficient oxygen for the conversion of carbon monoxide (CO) to carbon dioxide (CO2).

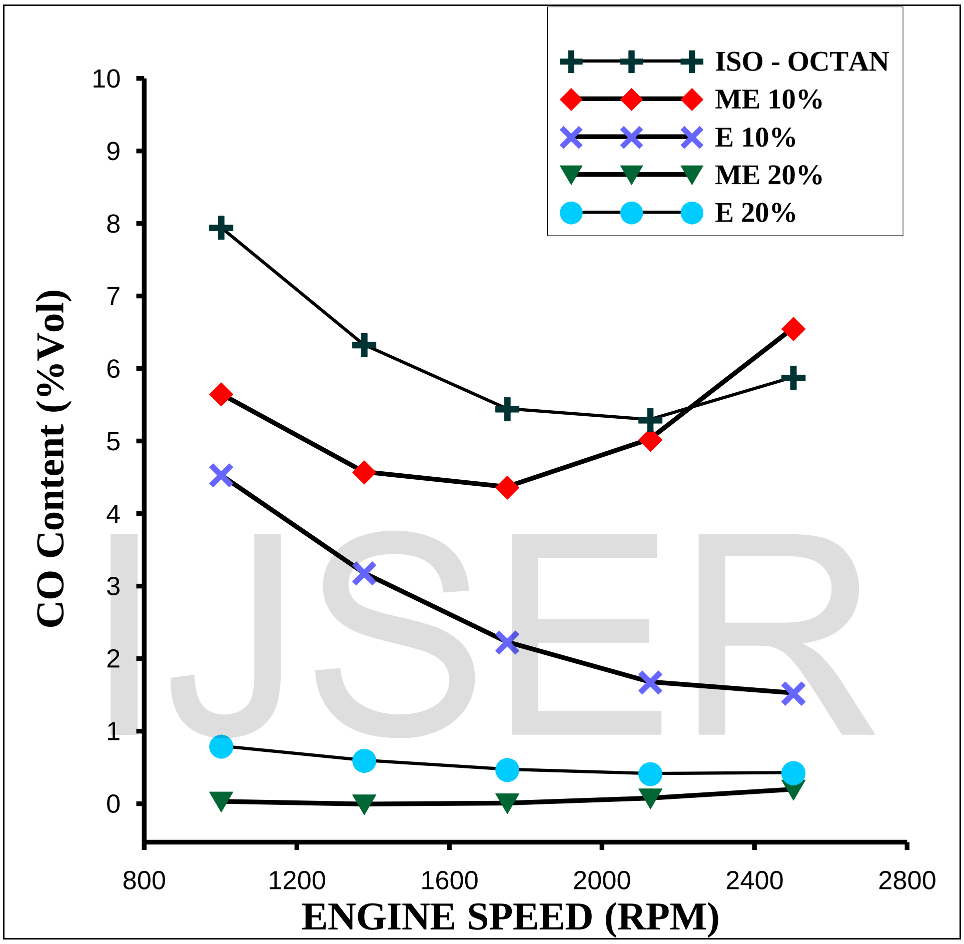


Fig. 4. The effect of methanol and ethanol blends addition on the Co emission

Unburned hydrocarbon emissions (UBHC) consist of fuel that is a combination of completely unburned and partially burned. UBHC emission is mostly due to the retention of unburned fuel in crevices in the cylinder. Figs. 5 show the changes in the UBHC emission of the engine using (methanol and ethanol) blends. As seen in the figures, the UBHC emission was gradually reduced when the (methanol and ethanol) blends ratio increased in the fuel blend, due to the effect of different methanol contents on UBHC emission. The petrol fuel operation showed the slightly higher concentrations of UBHC in the exhaust at all loads. Since methanol is an oxygenated fuel, it improves the combustion efficiency and hence reduces the concentration UBHC in the engine exhaust.

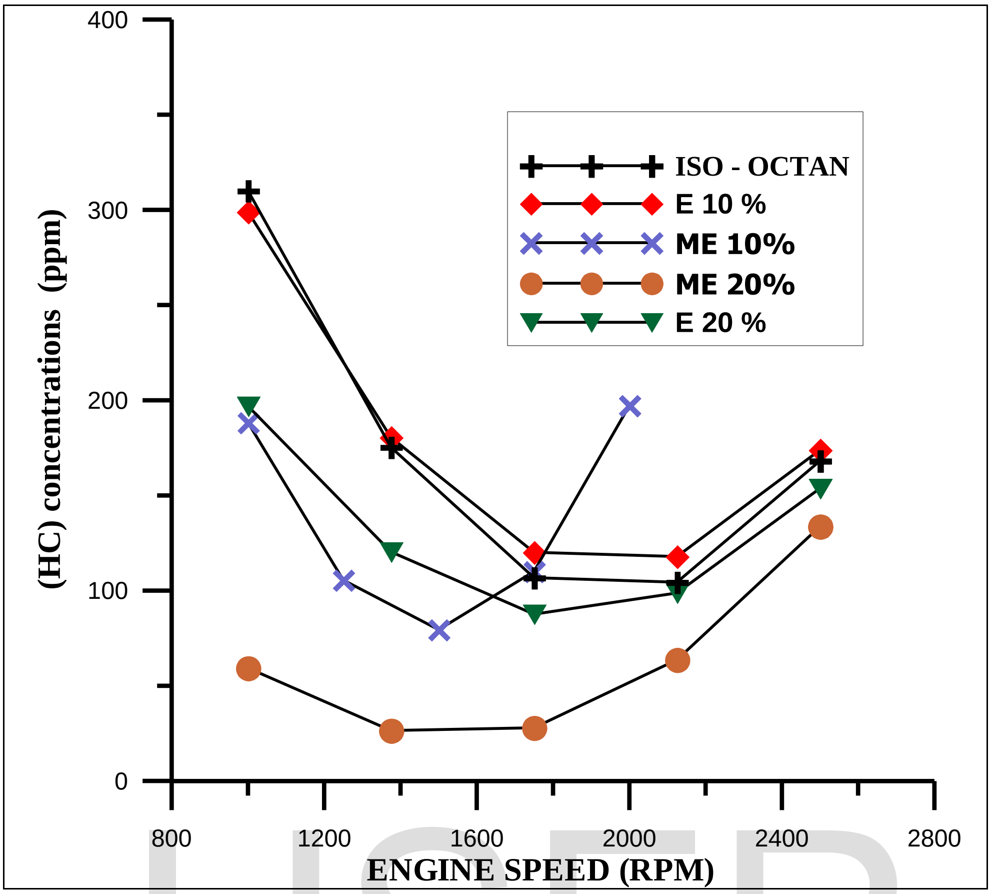


Fig. 5 . The effect of methanol and ethanol blends addition on the HC emission

Conclusions

Environmental protection is an important issue for the future of the world. Because of the reducing amount of petroleum reserves and its rising price, alternative fuels are intensively investigated for the full or partial replacement with gasoline fuel. Therefore, in this study, the effect of load and engine speed on the exhaust emissions of a SI engine has been experimentally investigated during the usage of methanol and ethanol blended gasoline fuel. The following conclusions can be drawn from the present paper:

1- Exhaust gas temperatures are reduced with increasing the methanol and ethanol percentage.
2- Compared to gasoline fuel, all fuel blends yielded a decrease in the un burnt hydrocarbons (UBHC), and CO emissions.
3- The combustion process is improved by added methanol and ethanol .
4- Adding methanol reduced engine noise by lessening combustion noise, making smoother burning.

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