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Experimental Analysis of Emission Parameters for Various Blends of Gasohol on Multi-Cylinder and Single Cylinder Petrol Engine

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Abstract: *In India, Ethanol is generally produced as a by-product of sugar is blended with petrol and was tested for their use as a substitute fuel, based on their emissions. The main aim of this experiment is to study the effect of various blends on the exhaust of the engine. The 99.96% pure ethanol was blended with gasoline, solutions of gasohol (ethanol blended gasoline) with 5%, 10%, 15%, 20% and 25% ethanol blended in gasoline, volume per volume were prepared and tested on a 1000cc four stroke four cylinder inline engine by a digital analyzer and on a 100cc four stroke single cylinder engine by standard PUC norms followed in India. It was observed that E20 had the optimum readings of emission.*

Keywords: *Engine, Ethanol, Exhaust Emission, Gasohol, Substitute Fuel.*

I. Introduction

Petrol engines are widely used for various applications in automobiles. Spark Ignition Engine has the advantages of low specific weight, compactness and simplicity in the design, low production cost and low maintenance cost. However this type of engine has serious drawback of High pollutant emission.

With increasing concerns on environmental pollution and the steadily inflation in demand for liquid fuels and downtrend in supply of petroleum crude oil, researchers have been forced to look to substitute fuels in order to fulfill the future demands for liquid fuels. Recent events throughout the world, including the inadequacy of petroleum crude oil, the sharp rising in the cost of oil and gasoline motor fuels, and the political instability of some crude oil producing countries, have demonstrated the vulnerability of the current sources for liquid fuel. Nevertheless, even if these supply and economic risks were acceptable, it is clear that worldwide product of petroleum products at projected levels can neither keep pace with the increasing demand nor continue indefinitely. It is becoming increasingly evident that the time will soon come when there will have to be a transition to resources which are more plentiful and preferably renewable.

Alternative fuels, as defined by the Energy Policy Act of 1992 (EPACT, US), include ethanol, natural gas, hydrogen, biodiesel, electricity, methanol and so on. These fuels are being used worldwide in a variety of vehicle applications. They are a major force in the effort to reduce petroleum consumption, harmful pollutants and exhaust emissions in the transportation sectors.

Among alternative fuels, ethanol is one of fuels employed most widely. The reasons are in the followings. First, it is technically feasible to make ethanol from a wide variety of available feed-stocks. Fuel ethanol could be made from crops which contain starch such as feed grains, food grains, and tubers, such as potatoes and sweet potatoes. Crops containing sugar, such as sugar beets, sugarcane, and sweet sorghum also could be used for the production of ethanol. In addition, food processing byproducts, such as molasses, cheese whey, and cellulosic materials including grass and wood, as well as agricultural and forestry residues could be processed to ethanol. Thus it is renewable source of energy. Secondly, ethanol (CH_3CH_2OH) is made up of a group of chemical compounds whose molecules contain a hydroxyl group,-OH, bonded to a carbon atom; so, the oxygen content of this fuel favors the further combustion of gasoline. Besides, ethanol is most commonly used to increase gasoline's octane number [1-3]. It can be concluded that using ethanol–gasoline blended fuels can ease off the air pollution and the depletion of petroleum fuels simultaneously. As a result, study of the effect of ethanol fuel on the pollutant emissions of an engine gain more attention.

1.1 Literature Related Review

C. Ananda Srinivasan et al. [4] tested the properties of ethanol-gasoline blended fuels with various blends. Results show that using ethanol–gasoline blend with additives causes improvement in engine performance and exhaust emissions. Ethanol addition results in the increase in brake thermal efficiency. Using ethanol blended gasoline leads to a significant reduction in exhaust emissions. For all engine speeds, the values

of CO, CO_2, HC, and NO_X have been reduced. On the other hand, O_2 emissions have been increased significantly. The E60 gives the best result for the engine performance and exhaust emissions: The brake thermal efficiency is 23.24% at 2,800 rpm. The CO emission is reduced to 0.08% by volume at 2,600 rpm and 3,000 rpm. The CO2 emission is reduced to 7.9% by volume at 2,800 rpm. The HC emission is reduced to 15 ppm at 2,800 rpm and 3,000 rpm. The NO_X emission is reduced to 224 ppm at 3,000 rpm. The O2 emission is increased to 9.5% by volume at 2,800 rpm. The study of He et al. [5] pointed out that the fuel containing 30% ethanol by volume can drastically reduce engine-out HC, CO and NO_X emissions at idle speed, but unburned ethanol and acetaldehyde emissions increase. Hasan [6] investigated that using an ethanol–unleaded gasoline blend leads to a significant reduction in exhaust emissions by about 46.5 and 24.3% of the mean average values of CO and HC emissions, respectively, for all engine speeds. On the other hand, CO_2 emission increases by about 7.5%. The research of Ajava et al. [7] showed that the exhaust gas temperature, lubricating oil temperature and exhaust emissions (CO and NO_X) are lower with operations on ethanol–diesel blends as compared to operation on diesel.

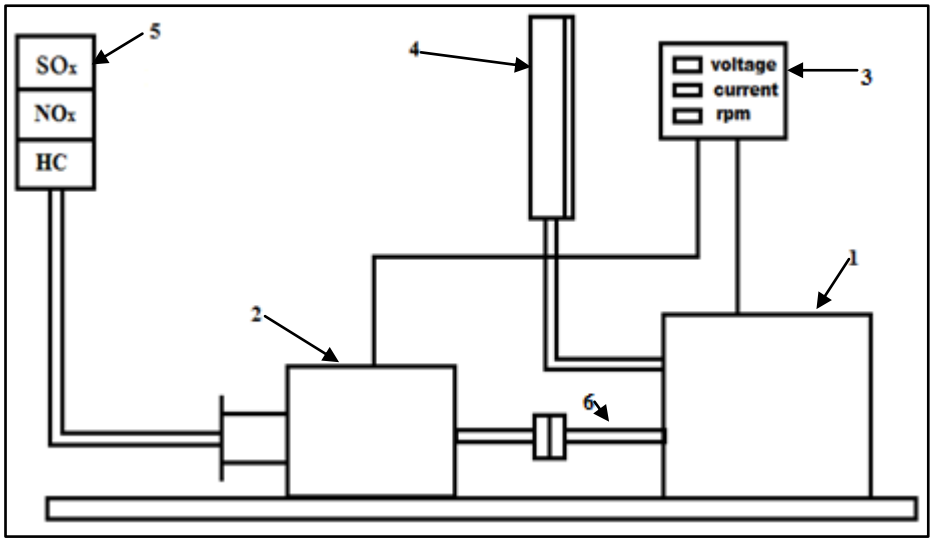
II. Objectives of the Study

Hygroscopic nature of ethanol may produce corrosion effect on metallurgies of engine. Since corrosion effect is negligible for proportion of ethanol up to 25, hence ethanol up to 25% can be readily used in existing engine without any modification. So the objective of present study is to gain insight into the effect of ethanol-gasoline blended fuel with various blended rates (0, 5, 10, 15, 20, 25 %) by volume on exhaust emission of Spark Ignition Engine.

III. Experimental Apparatus and Method

3.1 Engine Setup

The experiments were carried out on four stroke four cylinder engine having cylinder of 65mm bore and stroke of 72 mm and swept volume of engine is 1000 cm^3 with compression ratio 8.8:1.The engine having rated power is 44 BHP at 3000 rpm. This engine is attached with electrical dynamometer in order to measure torque produce by engine at output shaft. Fuel consumption was measured by burette and stopwatch. The emission of $NO_X$and SO_X were measured by digital gas analyzer. The single cylinder four stroke engine having 100 cc displacement was used and maximum power developed by engine was 7.2 BHP at 8000 rpm. Using this engine PUC report for HC was generated.



1. The Engine
2. Dynamometer
3. Digital Display
4. Fuel Burette
5. Gas Analyzer
6. Drive Shaft

Figure 1: The schematic diagram of the engine and its instrumentation

Figure 2: Experimental Setup

3.2 Fuel Used

In this experiment two types of fuel were used, ethanol and unleaded gasoline. Using these two fuel different blends were made in which ethanol contain vary from 0% to25% with increment of 5%.The fuel are represented by E5,E10,E15,E20 and E25.Here E5 stands for 5% ethanol in one liter blend with 95% gasoline. Properties comparison of both the fuels is given in table.

Table 1: Properties Comparison of Ethanol and Gasoline

Properties	**Gasoline**	**Ethanol**
Formula (Liquid)	C_8H_{18}	C_2H_6O
Molecular weight (kg $kmol^{-1}$)	114.15	46.07
Density (kg m^{-3})	765	785
Heat of vaporization (kJ kg^{-1})	305	840
Specific heat (kJ kg^{-1} K^{-1}) (Liquid)	2.4	1.7
(Vapor)	2.5	1.93
LHV (kJ kg^{-1})	44000	26900
Stoichiometric air-fuel ratio	15.13	9.00

From above tables it can be seen that there is minor difference in density of ethanol and gasoline so they can be easily blended. Calorific value of blended fuel decreases from E0 to E25 as low heat value (LHV) of ethanol is lower than gasoline.

3.3Procedure

The engine was made to run at constant 3000 rpm and 99.96% pure Ethanol blended with regular gasoline in various compositions was used as fuel. A four cylinder four stroke, inline S.I. engine of 1000cc and a single cylinder four stroke S.I. engine of 100cc was used in this analysis. The 1000cc engine is directly attached to an electric dynamometer which was used for analysis and its SO_X, NO_X and HC emission was checked by gas analyzer. PUC reports of various blends on 100cc bike engine were generated.

IV. Results and Discussions

4.1 SO_X Emission

Table 2: SO_X Emission for Various Blends

BLENDS	E0	E5	E10	E15	E20	E25
SO_X	0.96	0.78	0.60	0.57	0.54	0.50

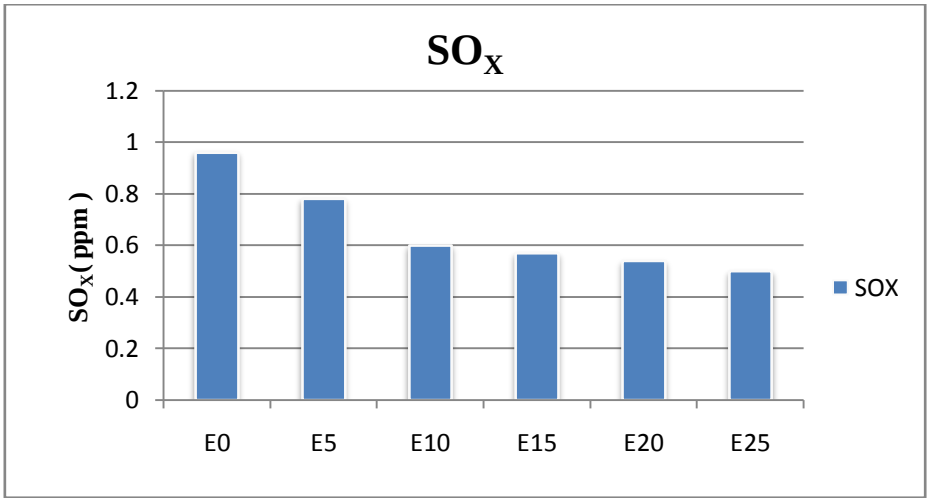


Figure 3: Emission of SO_X for Various Blends

The results of SO_X from the gas analyzer suggest that the amount of SO_X emission decreases with increase in percentage of ethanol in the fuel, which makes it a better and a greener fuel in compare of only gasoline (E0). Analysis shows that E25 has the least SO_X emission and is optimum fuel, based on SO_X emission.SO_X emission depends upon amount of sulphur contain in gasoline,since the amount of sulphur will reduce in ethanol blended gasoline as quantity of gasoline reduces in gasohol compare to pure gasoline, emission of SO_X reduces in case of gasohol.

4.2 NO_X Emission

Table 3: NO_X Emission for Various Blends

BLENDS	E0	E5	E10	E15	E20	E25
NO_X	1.98	1.94	1.64	1.62	1.60	1.58

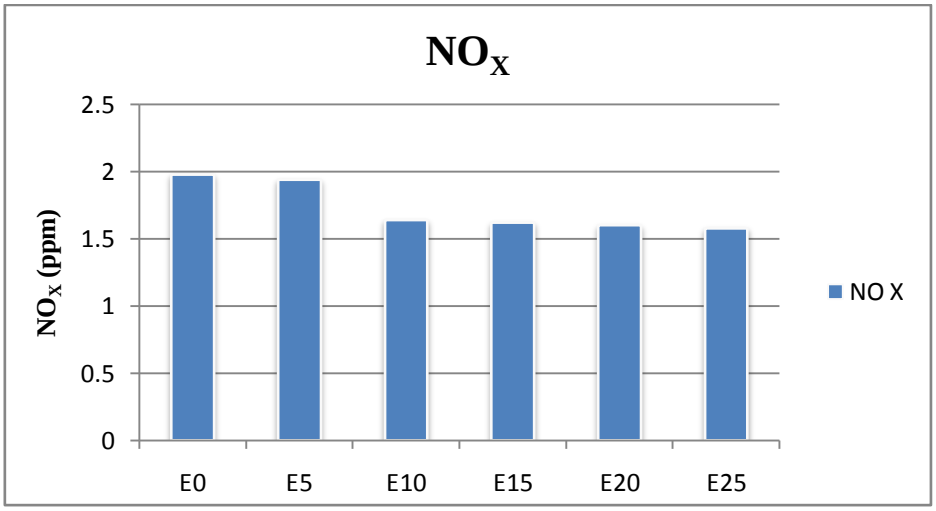


Figure 3: Emission of SO_X for Various Blends

Above NO_X emission graph represents that emission of NO_X reduces with increase in proportion of ethanol in gasoline and in our experiment NO_X emission is optimum in case of E25.The reason behind reduction in NO_X emission is that the reaction rate between nitrogen and oxygen will be high at higher temperature, since calorific value of ethanol is lower than gasoline so temperature of combustion product will be less than that of gasoline which reduces the emission of NO_X.

4.3 HC Emission

Table 2: HC Emission for Various Blends

BLENDS	E0	E5	E10	E15	E20	E25
HC (ppm)	3140	1868	1123	1049	605	967

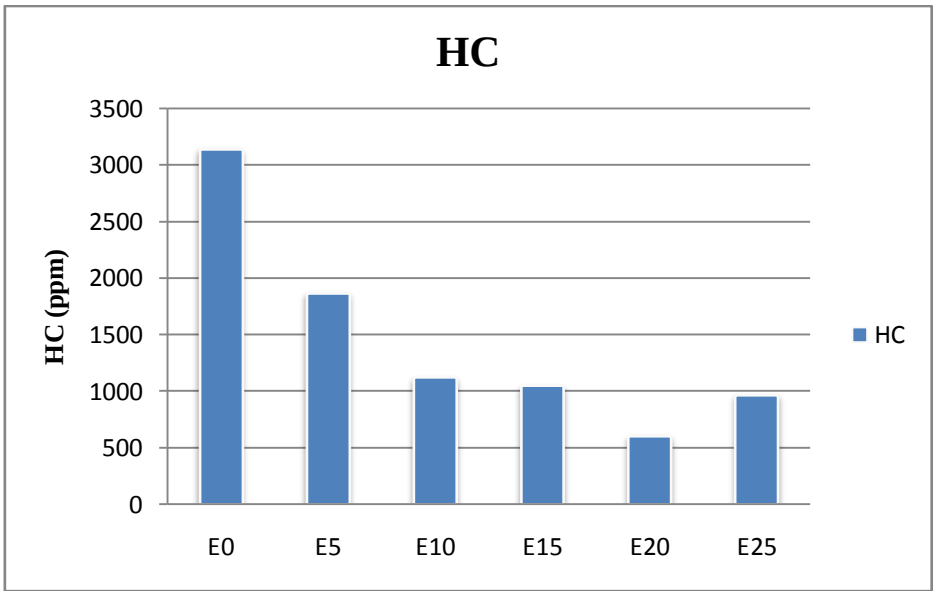


Figure 3: Emission of HC for Various Blends

The emission of Hydro-Carbon (HC), decreases from E0 to E20 and then again increases from E25, suggesting that the combustion efficiency of the fuel increases with increase in amount of ethanol, till E20 and then decreases at E25. Thus, suggesting that E20 is the optimum fuel.The cause behind reduction of HC in emission is that extra O_2 present in the ethanol helps in combustion and it will take combustion process towards complete combustion hence reduction in HC emission take place.

V. Conclusions

In the present study, the effect of ethanol blended gasoline on pollutant emission of commercial engine has been investigated. The results of research indicated that the amount of $SO_X$and NO_Xemission decreases with increase in percentage of ethanol blended with gasoline and E25 has highest i.e. 48% and 20 % reduction in $SO_X$and NO_Xemissionrespectively when compared with pure gasoline (E0). It is also found that increasing the ethanol content, amount of HC emission decreases drastically and reduction is highest for E20 i.e. 81% when compared with pure gasoline(E0).Thus the use of ethanol reduces adverse effect on health of living creature caused by $SO_X$and $NO_X$and further lead to cleaner environment by reducing HC emission. It can be concluded that using ethanol–gasoline blended fuels can ease off the air pollution and the depletion of petroleum fuels simultaneously.

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