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EXPERIMENTAL INVESTIGATION ON EMISSIONS PERFORMANCE OF A FOUR CYLINDER SI ENGINE USING ETHANOL- A ECO-FRIENDLY FUEL

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Abstract:
Conventional fuels, which are in use today, predicted to last for not more than thirty years. High prices coupled with limited availability of petroleum based fuel provides us compelling incentive to search for new and renewable energy source and also to undertake conservation efforts. With world reserves of petroleum fast depleting, in recent years ethanol has emerged as most important alternative resource for liquid fuel. Research on improving ethanol production has been accelerating for both ecological and economical reasons, primarily for its use as an alternative to petroleum based fuels. This paper presents experimental results based analysis of emission characteristics by using ethanol/gasoline blends and used as a spark ignition engine fuel. The investigation has been made by conducting different trials on "MARUTI" MAKE (MPFI MULTI CYUNDER), four Cylinders, 4 Stroke, Petrol engine. Blends of 50:50; 60:40; 65:35 and 70:30 (ethanol: Petrol) were prepared on volumetric basis and used for different experimental runs. In this study, effect of different blends on exhaust gas emissions is analyzed and discussed in detail. The experimental results indicate that the higher percentage of reduction in CO level is obtained at 50:50 ethanol/petrol proportions. The percentage of reduction in HC is higher in 60:40 ethanol/petrol proportions. It is also found that CO_2 percentage Level reduces at average 57% in each proportion of ethanol. Hence it is concluded that use of ethanol effectively helps to reduce the exhaust emission which will act as eco-friendly fuel.
Keywords: Four Cylinder SI Engine, Ethanol, Emissions Performance, Eco-Friendly Fuel.

Introduction

To diversify the mix of domestic energy resources and to reduce dependence on imported oil, ethanol is emerging as alternate fuel for applying in combination with gasoline fuel. It has been found that the conventional fuels, which are in use today and predicted to last for not more than thirty years. A problem of air pollution is also becoming critical day by day because of the combustion of conventional fuels. Secondly due to ever increasing expenditure of foreign exchange on petroleum nod its products lot of burden is imposed on Indian budget and the oil pool deficit. Rise in crude prices by O.P.E.C. countries in 1979 caused tremendous inflation impact particularly on oil importing countries. High prices coupled with limited availability of petroleum based fuel provides us compelling incentive to search for new and renewable energy source and also to undertake conservation efforts. Due to the fuel crises it is essential to evaluate the alternative fuels for IC engines. Discrete dynamic MVE model has been developed suitable for the design of speed controllers of ethanol fuelled IC engine (ICE) [1]. Efforts has been made to emphasize on the development of various physicochemical properties using multiple alcohols (C2 to C6) at different ratios compared to that of the conventional ethanol-gasoline blend.[2,3]. The combustion and emission characteristics of a HCCI engine fuelled with ethanol were investigated on a modified two-cylinder, four-stroke engine by using port injection technique [4]. The limit of a highly boosted down-sized ethanol engine was investigated. It was observed 28% of fuel consumption reduction was achieved by means of an extreme down-sizing and 53% of down-sizing was reached by means of cutting-edge technologies implementation [5]. Comparative study has been carried out the performance and emissions from a production 1.0-l, eight-valve, and four-stroke engine fuelled by hydrous ethanol (6.8% water content in ethanol) or 78% gasoline-22% ethanol blend [6].The research has also carried out for finding out possible use of higher percentages of biodiesel in an unmodified diesel engine using ethanol as additive [7].It has been found that from literature survey still more research is required in application of ethanol as alternate fuel for SI engine. This paper presents experimental results based analysis of emission characteristics by using ethanol/gasoline blends and used as a spark ignition engine fuel.

ETHANOL AS AN ALTERNATE FUEL FOR IC ENGINE

The use of alcohol as a fuel for internal combustion engines, either alone or in combination with other fuels, has been given much attention mostly because of its possible environmental and long-term economical

advantages over fossil fuel. Table 1 shows comparative properties of ethanol and petrol.

METHODOLOGY

ENGINE TEST RIG

The test rig setup showing the various parts of it is shown below Figure1 [8].

ENGINE SPECIFICATION:

1. ENGINE MODEL (Figure 2)

1. Engine model – Maruti MPFI Multi cylinder, 4 cylinders, 4 stroke petrol engine.
2. Maximum output – 85bhp@6000 rpm
3. Maximum torque – 110 Nm@45000 rpm
4. Engine capacity – 1298 CC

EDDY CURRENT DYNAMOMETER

Water Cooler Eddy Current Dynamometer (Figure 3)

ANEMOMETER TRANSMITTER

Vane Type

Output 0-5 Vdc

LOAD CELL TRANSMITTER

S type, Range 0-50 kg.

Output 0-5 Vdc

WATER FLOW RATE TRANSMITTER:

Wheel type Range 0-1000 2.LPH,Output 1-5 Vdc

FUEL SENSOR TRANMITTER:

Output 4-20 mA,2.Range 30-300 mm

PRESSURE SENSOR AND SIGNAL CONDITIONER:-

Dynamic pressure sensor with charge amplifier

The engine used is four cylinder four stroke MARUTI engine. The engine specification is as in Table 2.

TESTING AND OBSERVATION

TESTING METHOD PROCEDURE [9]

1. Switch ON the 'MAINS 'power supply to the control panel. Warning up period is 15 min.
2. Ensure that sufficient water flow rate for engine, dynamometer and calorimeter cooling.
3. Ensure that the dynamometer controller supply is ON.
4. On the dynamometer controller and ensure that no fault LED IS GLOWING. If it is, rectify the fault and then press Reset.
5. While increasing the load on the engine, its speed may reduce. Use throttle to adjust the speed.
6. Unload the engine fully before stopping the engine. While unloading the engine, its speed may be increased. Adjust the speed using throttle. Avoid excessive increase in the engine speed.

TESTING METHOD PROCEDURE [10]

Following procedure was adopted to perform the test on the engine.

1. Blends of 50:50. 60:40. 65:35, 70:30 (ethanol: Petrol) was prepared on volumetric basis with the help of measuring jar.
2. Repeated steps I to 6 with using 50:50, 60:40, 65:35, 70:30 (ethanol: Petrol) blends as fuels respectively.

OBSERVATIONS ON EXHAUST GAS EMISSION:

Table 3 shows different observation of exhaust gas emission obtained during various Ethanol: Petrol (E: P) blends used. Where abbreviations used are **CO:**-Carbon Monoxide, **HC**:-Hydro carbon, **CO2**:-Carbon Dioxide.

Table 4 shows analysis of reduction in various parameters of exhaust gas emission obtained during various Ethanol: Petrol (E: P) blends used.

RESULT AND DISCUSSION FOR EXHAUST GAS EMISSION [11]

a. The higher percentage of reduction in Co level is obtained at 50% and 70% ethanol proportion (Figure 3).
b. The percentage of reduction in HC is higher in 60:40 ethanol petrol proportions, than that of petrol (Figure 4).
c. The percentage of reduction in Co, level is maximum for 70% ethanol.
d. CO_2 percentage Level reduces average 57% in each proportion of ethanol (Figure 5).
e. From this use of ethanol helps to reduce the exhaust emission in large proportion.

Table 1:- COMPARATIVE PROPERTIES OF ETHANOL AND PETROL

Sr.No.	Properties	Ethanol	Petrol
1	Molecular formula	C_2H_5OH	C_8H_{18}
2	Molar mass	46.067 g/mol	110 g/mol
3	Appearance	Colorless clear liquid	Yellow
4	Specific gravity	0.789 g/cm3	0.750 g/cm3
5	Melting point	11463.^{0}C (158.8 K)	1143.^{0}C (158.8 K)
6	Boiling Point	78.4 ^{0}C (351.6 K)	99.4 ^{0}C
7	Octane No.	94	80
8	Calorific value	30000 kJ/kg	43000 kJ/kg
9	Cetane No.	8	8.14
10	Latent heat vaporization	855 (kJ/Kg)	293-418 kJ/kg

Table 2: The Engine Specification

Sr. No.	Parameter	Values
1	Type of Engine	4 stroke
2	No. of Cylinder	4
3	Cylinder Diameter (D)	74 mm
4	Cylinder Stroke (L)	75.5 mm
5	Specific Heat of Water (Cp)	4.187 kJ/kg ^{0}C
6	Specific Gravity of fuel	0.85 Kg/liter
7	Calorific value of Fuel Used (Cv)	42000 kJ/Kg ^{0}C
8	Density of air (p)	1.17 kg/m cube

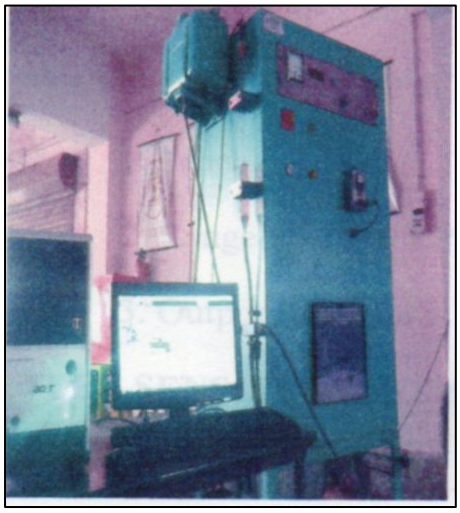

Figure 1: Engine set-up used for experimentation.

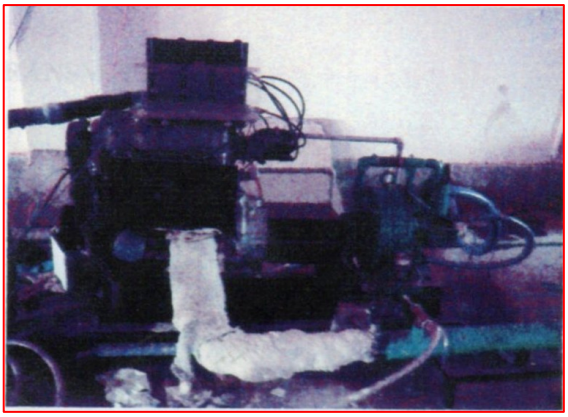

Figure 2: Engine model used for trials

Table 3: Readings of %Co, HC and CO_2 at different E: P blends.

E:P	CO%	HC (ppm)	Co_2
0:100	15.39	12361	24.60
50:50	5.91	4211	14.4
60:40	5.04	19211	14.11
65:35	6.06	1720	14.20
70:30	5.83	6731	14.36

Table 4: Reduction analysis of % Co,HC and CO_2

E:P	% Reduction In CO Level	% Reduction in HC Level	% Reduction In Co2 Level
50:50	38.40	34.06	58.33
60:40	32.74	155.41	57.35
65:35	32.87	13.91	57.72
70:30	37.88	54.45	58.37

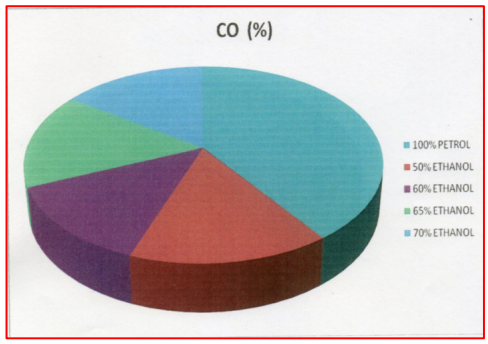

Figure 3: Pie chart of % Co at various ethanol proportions.

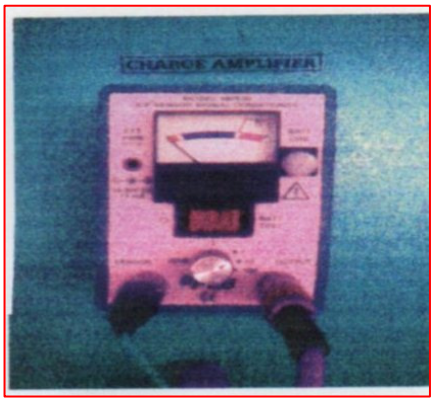

Figure 4: Water Flow Rate Transmitter

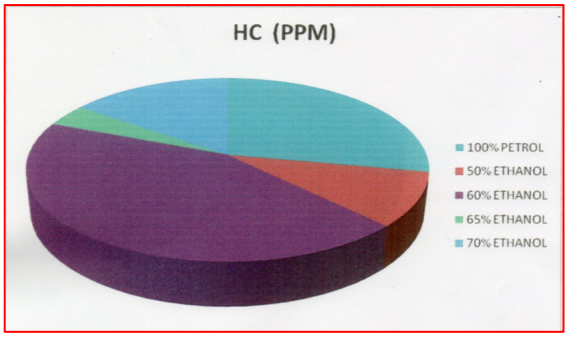

Figure 4: Pie chart of % HC at various ethanol proportions.

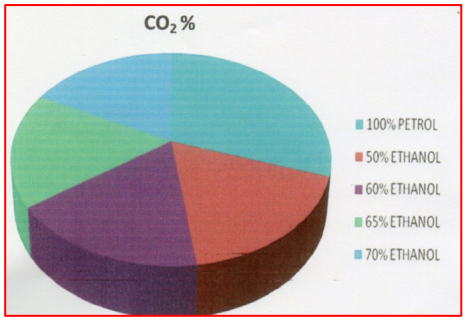

Figure 5: Pie chart of % Co_2 at various ethanol proportions.

Conclusion

As a result of present work it is concluded that Ethanol may behave like a petroleum based fuel in short term performance test. This shows its potential to act as an alternate to petrol and form renewable source of energy. In India there is large production of sugarcane by which we can produce ethanol as per fuel requirements in mass production then there is a chance for reducing its cost. Ethanol is best suited as the exhaust pollution is very much reduced and also the efficiency is near about what is obtained in the blend that is its efficiency its near to the efficiency of petrol fuel. There is considerable reduction in traffic pollution while using the ethanol as a blend. By using the ethanol as a fuel for the engine the percentage reduction of CO_2 in the exhaust gas emissions is up to 55 %, while the percentage of the CO gets reduced up to 33 %.The exhaust gas temperature is low than that of petrol. It has been also conclude from the performance test that, the engine cannot run on or above 80% ethanol. The engine cannot run above 80% ethanol and is repeatedly get off. So there is need of modification in the engine so that it can run easily on or above 80 % ethanol blends and also on 100%. Also conclusion can be drawn from the test that has been conducted on various blends of the ethanol in the petrol that, the 60 % ethanol blend is quite suitable to the engine on which we have done the resting.

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