Investigation of Ethanol blends in S.I Engine

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Abstract: -The engine performance improvement and exhaust emissions reduction are the two important factors which are considered to develop a more efficient engine with less impact on surroundings and nature. This work is based on the experimental study of Ethanol blends with gasoline as an alternative fuel in S.I engine. The experimental analysis will show better understanding by changing the different blends of ethanol with gasoline and various factors like BHP, total fuel consumption, brake thermal efficiency, air-fuel ratio, volumetric efficiency, heat balance calculations etc. Also, emission ratings of these blends will be evaluated. The blends used in this experiment are E10, E20 and Gasoline as well. The performance parameters will be evaluated at various loads 2kg, 5kg, and 10kg.

Keywords: Ethanol, Emission control, performance parameters

1. INTRODUCTION

In our surroundings, there is a bundle of harmful gases that exit from the exhaust of automobiles day by day and these harmful gases has affected the environment and society very badly. Despite the fact that the smoke that industries emit from their manufacturing places the exhaust proportion of automobiles is much more and is increasing day by day. The harmful gases that an automobile exhaust system contains are carbon monoxide (CO), nitrogen oxide (NO) and hydrocarbons (HC).Now in existence of such harmful gases, there is a possibility that these emissions can be reduced to some extent when another type of fuel is Tested and considered which might be able to improve the engines performance parameters also. Now to reduce the harmful exhaust emissions the fuels that contain more oxygen or the fuels added with more oxygen can have a very good scope to reduce the emissions from petrol as well as diesel engines. Now the main fuel containing the more amount of oxygen is ethanol. It also suits best for the required octane number rating for a petrol engine which will be discussed later on. These alcohols have become a most attractive solution, and have been considered as an advanced fuel in petrol engines. They burn cleaner than unleaded gasoline and produce less emission.
No doubt these alcohol blends can reduce the exhaust gas emissions but also many researchers are studying the effectof these blended fuels on the performance parameters also.

2. LITERATURE REVIEW

2.1 FOR ETHANOL

A.F Khierala [1,2] performed experiments of ethanol having 98.3 % concentration which was produced with the help of kenana sugar co. As an alternative source of fuel in place of petrol. Ethanol was tested normally in spark ignition engine without any modification in the engine. The fuel properties of selected ethanol/gasoline blends were studied. Those blends were namely E5, E10, E15, E20, and E25.Fuel test results showed that blends densities were found 1.003 %, 1.006 %, 1.013% and 1.015%, higher than of gasoline fuel (0.7313 kg/L).The power output and torque producing for blends decreased when the ratio of ethanol was increased.The fuel consumption rate increased for E15, E20 and decreased for E10, E25 while the specific fuel consumption decreased for E20, E25 and increased for E10, E15.The performance with tested blends showed diverse results due to the difference in fuel properties.
AlvdyasPikunyas [3]stated in his research that when ethanol was added as a fuel in the petrol engine it showed a decrease in the heat value of fuel which was blended, while there was an increase in the octane rating of the fuel mixture that was used. The power of engine along with specific fuel consumption increased slightly. The co emissions were decreased due to leaning effect caused by the addition of ethanol. The HC emissions decreased to some working conditions but CO2 emission was increased due to increased combustion.
Shane Curtis[17]represented therise in production of ethanol over the past years and the production rates increased due to increase in demand of ethanol as a fuel the survey was carried out from the years 1980 to 2007.This paper also showed how oxygenates are now

used to boost up the octane number of petrol. Also, it showed the bright scope of ethanol and other biofuels to be researched in flex-fuel vehicles. The results of this paper confirmed that E10 in 4 stroke spark ignition engine has no negative effect on the internal combustion engine. Also, E20 was tested on this engine which showed decreased fuel deficiency and brake power of the engine.
James W.Weaver [18] took two different samples of ethanol taken one from the wet mill having moisture and another from mill plant which was dry and these samples were obtained before getting denatured. Both samples were having fewer amounts of water, methanol and high molecular weight alcohols. As these denaturants are immiscible in water so their ability to absorb water was limited. The experiments with E85 and E95 showed phase separation when 15% water was added to them. Also, it showed thatthe byproducts of ethanol fuel are less soluble and are less volatile than ethanol.

B.V Lande, A.B Tupkar[14]performed some experimental tests on a two-stroke petrol engine by taking various ethanol and petrol blends and the observations were recorded. In this paper, the facts supporting the ethanol as a fuel were discussed. The blends taken for test purpose were E10, E20, and E25 with HP racer as lubricating oil. The engine used was Bajaj Chetak engine and the testing rigs used were rope brake dynamometer and NETL-NPTL emission tester, exhaust gas analyzer. Also, this paper showed that the blending of two different fuels used was easy without adding any external agent for mixing. The ethanol fuel mixture increased octane rating and the emissions were low. The torque in case of ethanol was higher than petrol. Also, the emissions of HC and CO were lowered with increased concentration of ethanol.

AshishS.Lanje [15]showed the performance and emission characteristics using blends of ethanol and LPG which is also used as a fuel in petrol engines. Reviews are shown on compression ratio, ignition timing, cylinder pressure, the air-fuel ratio that were analyzed and studied for better performance of the engine and reduced rate of exhaust gas. Apart from fuel management system and delivery system LPG-ethanol engines deliver the similar performance like normal petrol engines do. Volumetric and mechanical efficiencies are also increased also the experiment performed was helpful to reduce greenhouse gas emissions.

3. EXPERIMENTAL SETUP:-

The experiment was performed on four strokes three-cylinder petrol engine test rig with the hydraulic dynamometer.

(A)ENGINE
(1)MAKE-MARUTI ALTO 800
(2)SPEED-800-2500RPM
(3)BORE-68.5 mm
(4)STROKE-72mm

(B)A HYDRAULIC DYNAMOMETER-attached to the engine along with load indicator.

(C)AIR INTAKE MEASUREMENT
Provided with intake tank having orifice and water type manometer.

(D)FUEL INTAKE MEASUREMENT
A calibrated beaker with a fuel pump is provided to calculate the fuel intake measurement.

(E)EXHAUST GAS CALORIMETER
A calorimeter used for exhaust gas, which is water cooled.it is of shell and coil type for the study of heat lost to the exhaust gas. Water flows from inside of copper tubes and exhaust gases are transferred in the shell.

(F)MULTI-CHANNEL TEMPERATURE INDICATOR
For measuring the inlet and outlet temperature of exhaust gases and water from engine cooling jacket and calorimeter with thermocouples is used.
1. The inlet temperature of water to engine and calorimeter.
2. The temperature of the water going out from the engine.
3. The temperature of the water going out from calorimeter.
4. The temperature of exhaust gas going out from calorimeter.
5. Ambient temperature.

(G)EMISSION TESTER USED:-
NAMTECH (GA934)

Figure-1 Gas Analyzer

Figure-2 Experimental Setup

- **The research was carried out at "dav university, Jalandhar" using the apparatus "multi-cylinder petrol engine test rig" in ic engine lab under the special supervision of concerned personnel.**
- **Density of Gasoline used-760 kg/m^3**
- **Density of Ethanol used-789 kg/ m^3**
- **Diameter of orifice-25 mm**
- **Coefficient of discharge of orifice meter-0.62**
- **Density of air-1.207 kg/ m^3**
- **Specific heat of water-4.2 kJ/kgk**
- **Specific heat of exhaust gas-1.05 KJ/kgk**

Table-1 Gasoline and its blend with Ethanol showing various parameters

S.NO	FUEL TYPE	LOAD (KG)	RPM	BHP (KW)	TFC (KG/Hr)	BSFC (KG/KW hr)	BRAKE THERMAL Efficiency	MASS OF AIR CONSUMED (KG/SEC)	AIR Fuel Ratio	VOLUMETRIC Efficiency
1	GASOLINE	2	1975	1.561	0.915	0.5865	4.011	0.00386	15.91	83.4
2	GASOLINE	5	1875	3.71	1.125	0.3038	7.75	0.003127	11.45	81.5
3	GASOLINE	10	1715	6.41	1.1175	0.174	13.49	0.000326	10.51	71.7
4	E10	2	1980	1.565	0.956	0.6057	6	0.00384	13.52	77
5	E10	5	1875	3.7	1.101	0.2750	12	0.0032	12	80
6	E10	10	1750	6.91	1.2174	0.1599	14	0.00305	10.12	75
7	E20	2	1980	1.57	0.979	0.6258	5.38	0.00386	14.91	83.24
8	E20	5	1879	3.71	1.113	0.299	11.23	0.00358	11.59	81.3
9	E20	10	1792	7.08	1.224	0.172	19.47	0.00326	9.61	77.8

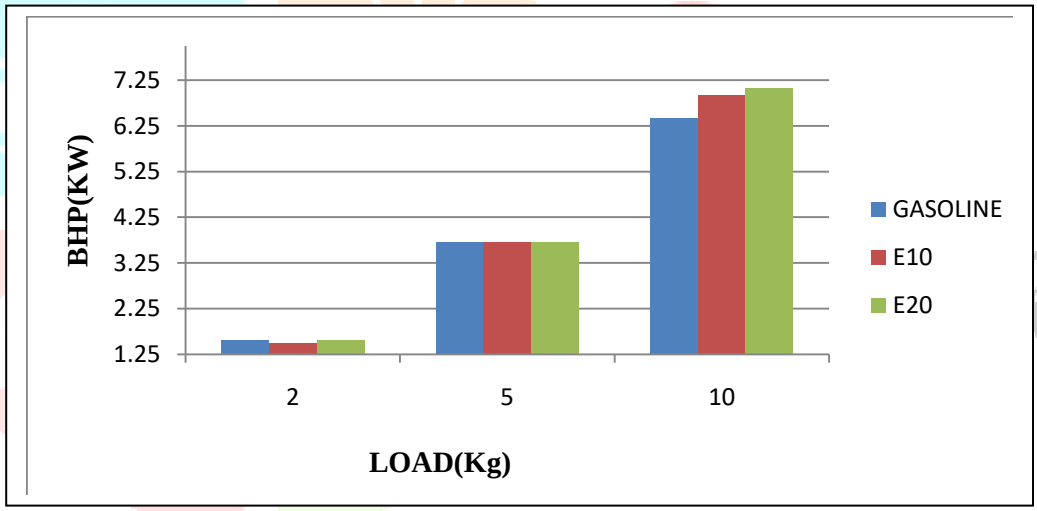

Figure 3:-LOAD VS BHP (KW)

Figure 3 represents BRAKE HORSEPOWER at different loads 2kg, 5kg, 10kg for the various fuel mixtures used along with gasoline as well.in this graph at 2kg load.at 5kg load E20(20% ethanol and 80% gasoline by volume) and showed slightly more BHP as compared with gasoline because of more RPM observed in their case.E10 showed lower BHP at 5kg load.at 10 kg load the lowest BHP observed was of gasoline that is 6.41 KW due to low RPM observed at this load.E20 showed maximum BHP at 10 kg load.

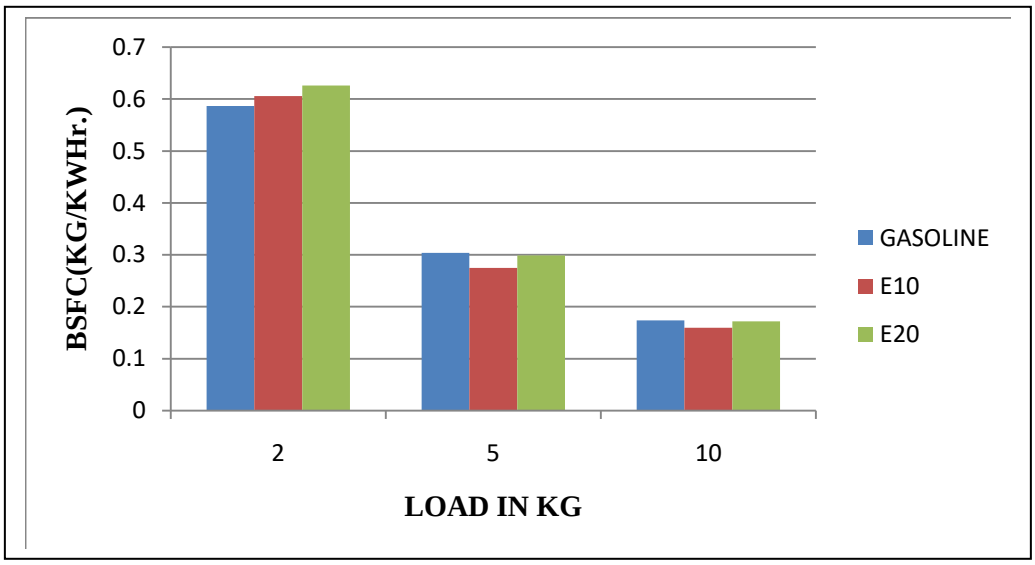

Figure 4: LOAD VS BSFC (KG/KWHR)

Figure 4represents BSFC (BRAKE SPECIFIC FUEL CONSUMPTION) at different loads 2kg, 5kg and 10 kg for various fuel mixtures used along with gasoline. At 2kg load gasoline showed the lowest BSFC and maximum was observed for B10.the value of BSFC depends upon mass of fuel consumed of total fuel consumed that is Mf=$\frac{(FINAL\ READING - INITIAL\ READING) \times SPECIFIC\ GRAVITY}{TIME\ (SEC) \times 1000}$ (kg/sec) the initial and final reading represents the level of fuel consumed which was fixed for each reading that is 10ml.The time taken in sec was the time taken to consume 10ml of fuel. The specific gravity of a fuel also plays an important role here due to which there was a slight variation observed in BSFC.At 5kg load E10 showed the lowest BSFC.at 10 kg load Gasoline showed more BSFC as compared to other fuel mixtures due to change in specific gravity of fuel mixture that is 0.765 and time taken to consume 10 ml of fuel which was observed to be 20.9 sec.

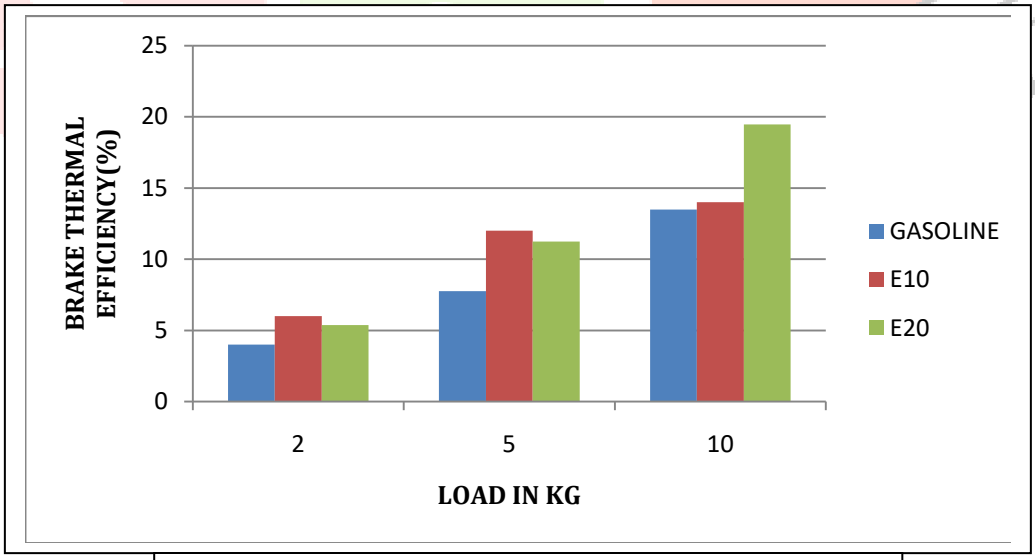

Figure 5:-LOAD VS BRAKE THERMAL EFFICIENCY

Figure 5 represents BRAKE THERMAL EFFICIENCY at different loads 2kg, 5kg and 10kg for various fuel mixtures used along with gasoline. At 2kg load, E10 showed maximum brake thermal efficiency. At 5kg load, E10 showed maximum brake thermal efficiency and minimum was observed for gasoline that is 7.75%.At 10 kg load, maximum brake thermal efficiency was observed for E20 that is 19.47%.Now the value of BRAKE THERMAL EFFICIENCY is derived from the formula =$\frac{B.P}{TFC \times CV} \times 100$here B.P represents brake horsepower in watts, TFC represents total fuel consumption and CV represents the calorific value of fuel used. Now

for almost the same brake horsepower the efficiency will definitely be affected by the change in calorific value and total fuel consumed which is different for different fuel types used.

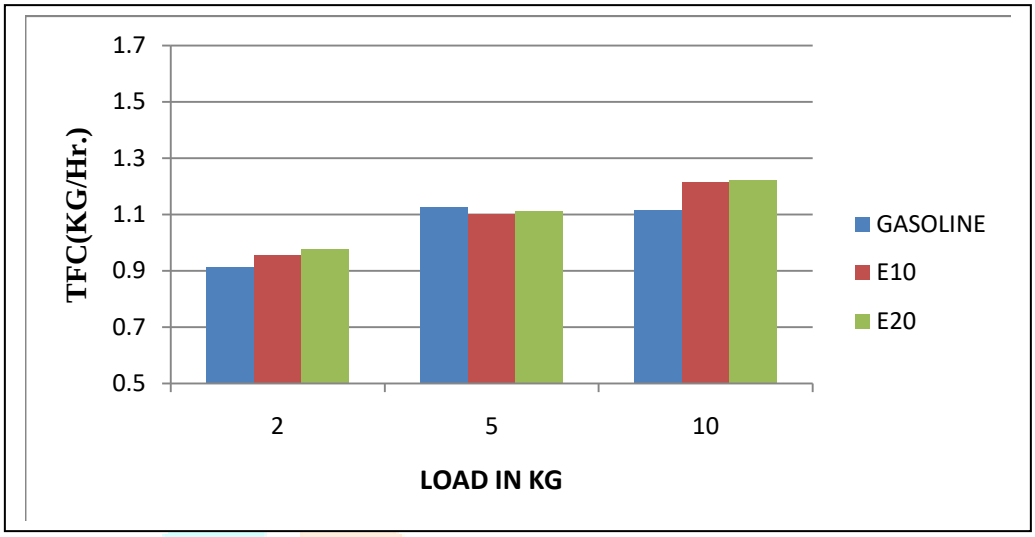

Figure 6:-LOAD VS TOTAL FUEL CONSUMPTION (KG/HR)

Figure 6 represents TOTAL FUEL CONSUMED at different loads 2kg, 5kg and 10 kg for different fuel mixtures.at 2kg load total, fuel consumption was more in case of E20 and minimum in case of Gasoline.at 5kg load total fuel consumption was more in case of gasoline and minimum is case of E10.at 10 kg load total fuel consumption was more in case of E20 and minimum in case of gasoline. The value of the total fuel consumed depends upon the specific gravity of fuel and time taken to consume 10 ml of fuel. The total fuel consumed increased in case of butanol was because its consumption rate for 10 ml of fuel was slightly quicker than other fuel mixtures and a slight change in the value of specific gravity.

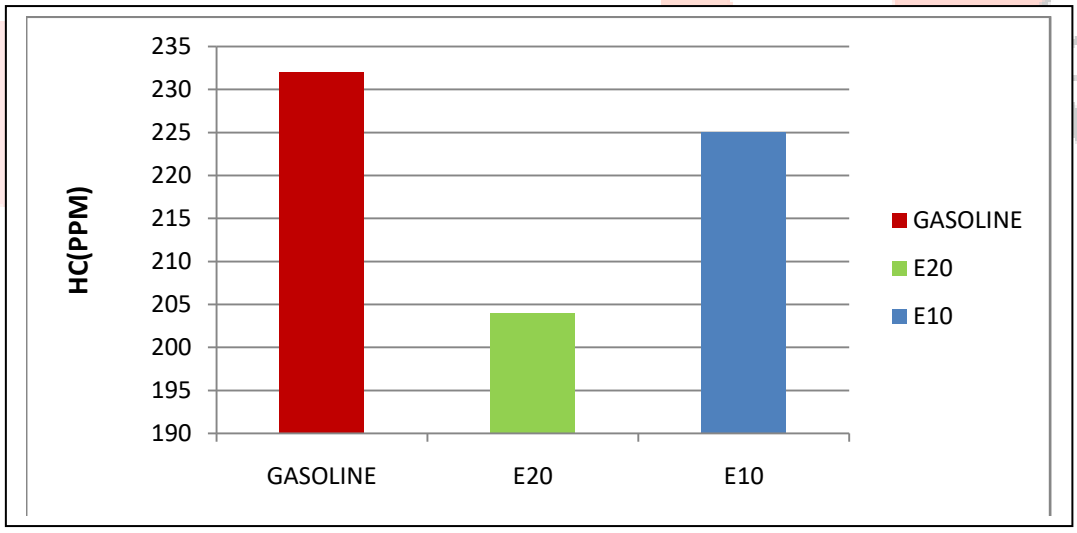

Figure 7:-VARIOUS FUELS VS HC (PPM)

Figure 7 represents the HC (ppm) emission rating of various fuel mixtures. Gasoline showed the maximum HC Rating as compared to other fuel mixtures and the lowest emission was observed for E20 without using catalytic converter

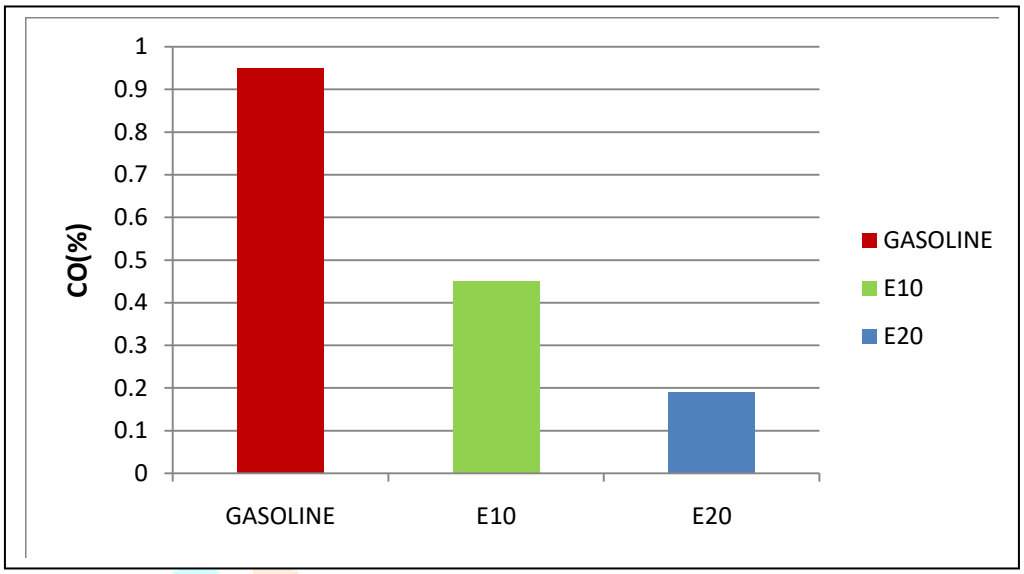

Figure 8:-VARIOUS FUELS VS CO (%)

Figure 8 represents the CO (%) emission for various fuel mixtures maximum was for Gasoline and minimum was for E20.

6. CONCLUSIONS

The engine performance was evaluated on gasoline as well as gasoline blends with Ethanol at various loads:-2KG, 5kg, 10kg and the blends used were E10, E20 also Emission testing was done and CO, HC ratings were also checked for E10, E20 and Gasoline as well. The blends E10, E20 Showed more BHP at 10 kg load as compared to gasoline.

1. The performance parameters like BSFC were good and nearly equal to pure gasoline.at 5 kg load E10 showed lower BSFC rest was equally good as compared with pure gasoline.
2. At 2 kg load TFC of rest of blends were slightly more but at 5kg load, TFC of rest of blends were lower as compared with pure gasoline.at 10 kg load TFC of the blends were slightly more as compared with pure gasoline.
3. The brake thermal efficiency at various loads for E10 and E20 was Slightly more as compared with pure gasoline. The brake thermal efficiency at rest of loads was slightly more than pure gasoline.
4. The volumetric efficiency of blends at 10 kg load was more as compared with pure gasoline.
5. The HC emission of the blends was lower as compared to pure gasoline without the use of a catalytic converter. E20 showed the lowest HC emission that was 204(ppm).
6. The co (%) emission of the blends was lower and better than gasoline. Gasoline showed 0.95% of co emission while the emission ratings of other blends were lower. The lowest co (%) emission was of E20 which was 0.19%.

Considering the emission results of various fuel mixtures all fuel mixtures showed fewer emission ratings as compared to Gasoline so these fuel mixtures greatly help to reduce exhaust gas emissions. Some of the fuel mixtures like E10 showed more brake thermal efficiency than any other fuel mixture used, the blends used almost matched all the parameters that gasoline showed at same loads.so these fuel mixtures provide us with a great scope in future to use them as an alternative fuel mixture as compared with pure gasoline.

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