Experimental Investigation of using Ethanol Petrol Blends in 2-Stroke SI Engines

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ABSTRACT
India is a developing country with an increasing workforce. A large part of transportation, movement etc depends on SI engines. Even agriculture today is largely dependent on SI engines. However in recent past we have witnessed a rapid increase in petrol prices. This price rise has not only affected commuters but also farmers and industries. Today's fuel research is completely based on finding alternative fuel, however more availability of heat from fuel is not acceptable. It is the ability to transform into mechanical work that matters the most. Meanwhile until some substitute is chalked out, researchers are concentrating on petrol blends (generally alcohol blended). Although a variety of alcohols can be chosen, it has been found that heat from ethanol can be transformed to mechanical work more efficiently. In this paper, facts supporting use of ethanol and petrol blends have been discussed. Results obtained from experimental tests have been discussed too.

KEYWORDS
alternative fuel; petrol blends; SI engine.

1. INTRODUCTION
The recent shortage of refined Petroleum Products occasioned by the long queues of vehicles at Petrol retail outlets around the country has necessitated more importation of gasoline. Efforts to satisfy the national sufficiency and consumption levels have led importers and marketers of petroleum products to import bio ethanol blended fuels (oxygenated gasoline) to augment the distribution of regular unleaded gasoline.

The global fuel crisis has triggered the awareness amongst many countries to focus on the development of alternative fuels. An extensive worldwide search is underway for alternative fuels to replace the conventional oil based fuels. The main reason is the increased prices, the very limited resources for such fossil fuels and increasing stringent environmental regulations. Growing concerns about greenhouse gas emissions will lead to an increase in bio-fuels and oxygenated fuels production. The application of bio-fuels and oxygenated fuels plays an important role in the alternative fuel for the internal combustion engines. The possible alternative fuels available in the market are diverse. Among the alternatives, ethanol usually comes from biomass that includes crops rich in sugar, starch or cellulosic material. In India 5% Ethanol blending (E5) is mandatory which is proposed to be 10% (E10). Ethanol and gasoline have differences in some critical properties such as octane number, vapour pressure but their blends known as gasohol shows higher vapour pressure and octane compared to base components.

LAWS OF THERMODYNAMICS AND FUEL SELECTION
Second law of thermodynamics introduces the concept of anergy and exergy. Anergy refers to that part of energy that is not available and remains stored as internal energy. On the other hand Exergy is that part of energy that is available to us and can be transformed. This availability is represented as Entropy (S). Going further it is has been found that variety of fuel alternatives are present which have quite a large Calorific value but their transforming capabilities have been deciding factors. In case of alcohols blends a variety of alcohols can be used however it have been found that with increasing order of carbon although Calorific value rises still the energy transformation efficiency decreases. This transformation is most important aspect because it is not the heat in which we are interested, rather it is the mechanical work that matters the most. The explosion of burning fuel should drive the piston if not the fuel is of no use. Ethanol heat shows better transformation capability than other members of alcohol family, it is this advantage that supports the use of ethanol on a large scale.

2. INDIAN ENERGY SCENARIO AND SIGNIFICANCE OF BIOFUELS
India ranks sixth in terms of energy demand accounting to 3.6% of total global energy demand. While the energy demand is expected to grow at 4.8% a year , a large part of India's population , mostly in the rural area, doesn't have even access to it . India is the second most populous country with rapidly urbanizing economy, our dependence on oil import will increase enormously in the near future. In 2003-04 India which is 70% import dependent for meeting its crude oil requirement, spent 18.36 billion dollars (Rs. 84,236) cores on importing more than 90 million tons of crude oil. It is predicted that if India continues at this rate, we would be consuming 5.6 million barrel of oil /day by 2030,out of which more than 94% will be met through oil imports .The greatest increase in energy demand occurs in the transportation sector were more than 95% of the demand is met by fossil fuels which contributes to environmental impairment to a momentous level. In fact, increased environmental degradation do remind that our ways to meet energy demand should be designed as an element of sustainable development as well securing long term supply of energy sources requires not only existing fuel resources that be utilized economically as possible but also energy source used in this fuel system must be diversified .

In the coming years we have to be at a point in our development , were the nation is less dependent on fossil fuel for our energy generation keeping this point in view , bio fuels (ethanol , methanol & biodiesel) are recognized as a major player for ensuring energy security in the future of country. The supreme court of India informed the government to use compressed natural gas as an alternative fuel to petrol and diesel for fuelling automobiles to reduce environmental pollution.

However, considering the reduced output by oil and natural gas corporation (ONGC) and thereby likely shortages of CNG in the future the government of India has made it blend petrol and diesel with ethanol. Government of India made the resolution with effect from 1-1-2003, 5% ethanol doped petrol will be supplied in the nine states & four union territories and it gradually increase to 10% in the second phase.

3. TEST FUEL

Gasoline (E5) available in market was blended with ethanol to prepare five different blends. These are E5 (5% Ethanol + 95% gasoline), E10 (10% Ethanol + 90% gasoline), E15 (15% Ethanol + 85% gasoline), E20 (20% Ethanol + 80% gasoline), E25 (25% Ethanol + 75% gasoline). Initially density of E5 is known from which density of different blends were calculated. Same is done for getting calorific value of all the blends.

TABLE I. DENSITY AND CALORIFIC VALUE OF TEST BLENDS

Blend	Density (Kg/m^3)	CV (MJ/Kg)
E5	738.59	44.25
E10	741.30	43.5
E15	744.00	42.75
E20	746.71	42
E25	749.42	41.25

Lubricating oil used is HP Racer 2 (Semi synthetic 2-S Single oil).

A. Ethanol Petrol Property

The physical and chemical properties of ethanol and petrol are:-

TABLE II. THE PHYSICAL AND CHEMICAL PROPERTY OF ETHANOL AND PETROL

Sr. No	Character	Ethanol	Petrol
1	Molecular Weight	46.07	100-105 avg.
2	Composition by mass	w(C)=52% w(H)=13% w(O)=35%	w(C)=85 % w(H)=15 %
3	Sp. Gravity	0.794	0.7-0.78
4	Density Kg/m^3	790	700-780
5	Boiling Temp (^0C)	78	27-255
6	Freezing Point (^0C)	-114	-57
7	Ignition Temp (^0C)	423	390-420
8	Theoretical air fuel ratio(Kg/Kg of air)	9.0	14.7
9	Octane number	100	80-99
10	Cetane number	8	0-10
11	Low heating Value at 20^0c MJ / L	21.09	32.17
12	Mixed gas calorific value(/$MJ.Kg^{-1}$)	3.87	3.73-38.3
13	Reid vapour pressure of 10 % blend m bar against petrol	570	51

Ethanol is similar in nature with gasoline with high octane number. Both are liquid in nature thus storage and transportation are much similar. Both can be mixed easily and burnt.

Ethanol has small molecular weight, large oxygen content and high H/C ratio. Octane number for ethanol is 100. Ethanol is oxygenated fuel with small molecules; it can burn fast and fully with oxygen inside. These characters can help to improve thermal efficiency as well as to achieve the cleanliness inside the engine and to reduce exhaust.

With low boiling point ethanol is easy to burn and form the mixture gas which is conducive for gasoline to burn completely. Latent heat of vaporization of ethanol is three times bigger than that of petrol. So when ethanol is vaporizing, it absorbs a large amount of heat, meanwhile, the temperature of the mixed gas is lowered down. Although calorific value of ethanol is low, the heat, which the mixed gas of ethanol and gasoline produces under theoretical air fuel ratio is roughly the same as that of petrol.

4. TEST EQUIPMENT AND TEST METHOD

A. Test Equipments

As shown in figure 1, the test equipment is composed of a 150 CC 2-S Bajaj Chetak engine, a rope brake dynamometer (tongue buckle for loading and unloading purpose), two spring balances (for measuring loads on tight and slack side). Emission tester used is NETEL – EPID make, exhaust 2 gas analyser, model - NPM-CH1.

Fig. 1 Experimental setup

TABLE III. ENGINE SPECIFICATIONS

Engine make and model	Bajaj Chetak
Engine type	Single cylinder 2 Stroke petrol engine
Displacement	145.45CC
Maximum power	7.5bhp @ 5500rpm
Gears	4
Clutch	Multidisc
Ignition	CDI electronic
Lubrication	Wet sump forced lubrication
Gear Ratios	
1st Gear	17.33:1
2nd Gear	10.82:1
3rd Gear	7.43:1
4th Gear	6.10:1
Primary Gear ratio	2.75:1

B. Test Method

First of all different blends were prepared in chemical laboratory and lubricating oil was added in the ratio 20ml per litre. For emission testing throttle of the engine was fixed and CO and HC emissions were tested at no load condition for different blends.

For torque and power measurements, first engine is started on desired fuel blend. Then Tongue buckle is tightened to apply load on the shaft. Applied load can be measured by calculating difference between the readings in both spring balances. Fuel consumption is measured via metred measuring jar for running engine. The consumption is measured for certain interval of time so that we can get consumption wrt time. The procedure is repeated for E5, E10, E15, E20 and E25 blends.

5. EXPERIMENTAL RESULT AND ANALYSIS

A. BSFC

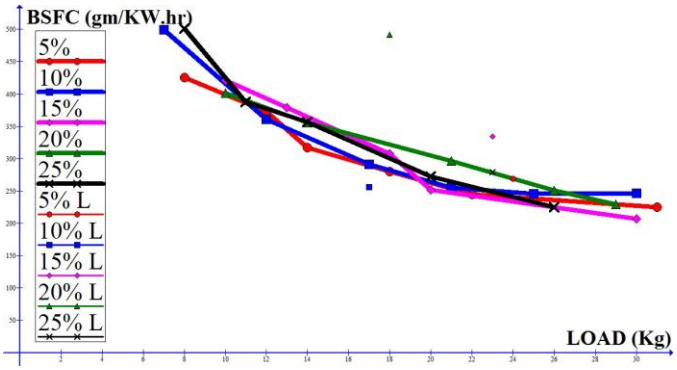

Fig. 2 BSFC – Load graph

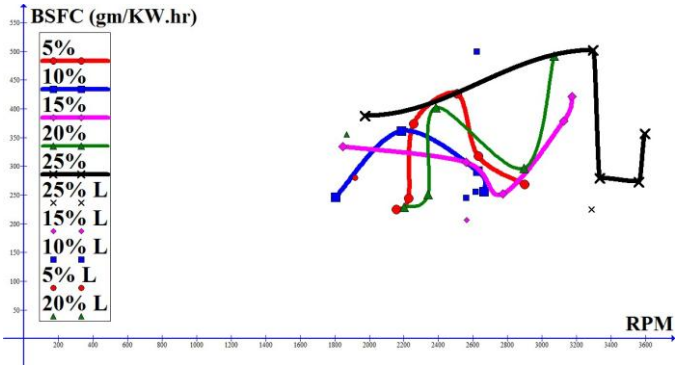

Fig. 3 BSFC – Rpm graph

B. Thermal Effisiency

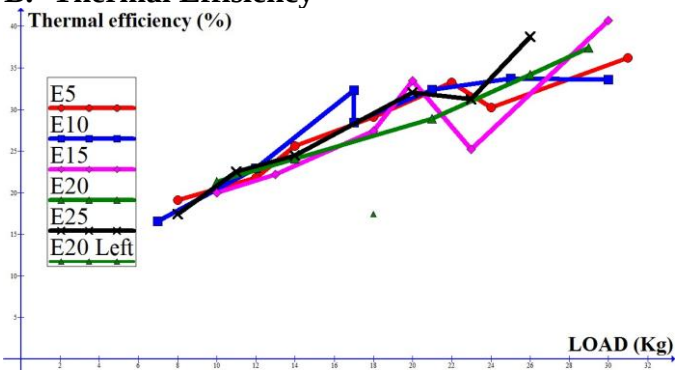

Fig. 4 Thermal Efficiency - load graph

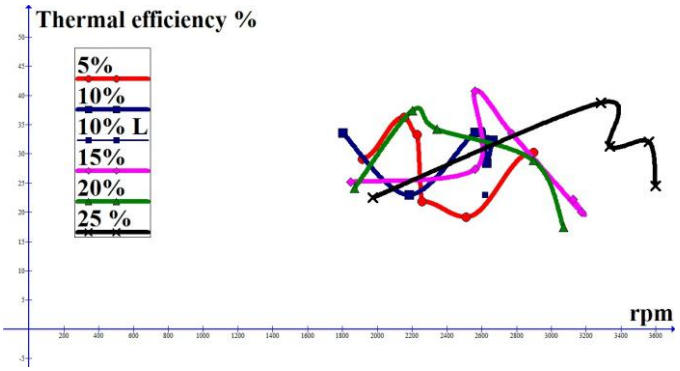

Fig. 5 Thermal Efficiency - RPM graph

C. CO Emission

Carbon monoxide emission characteristics of different blends have been shown in Fig. 6. These characteristics have been measured at no load and initial throttle position.

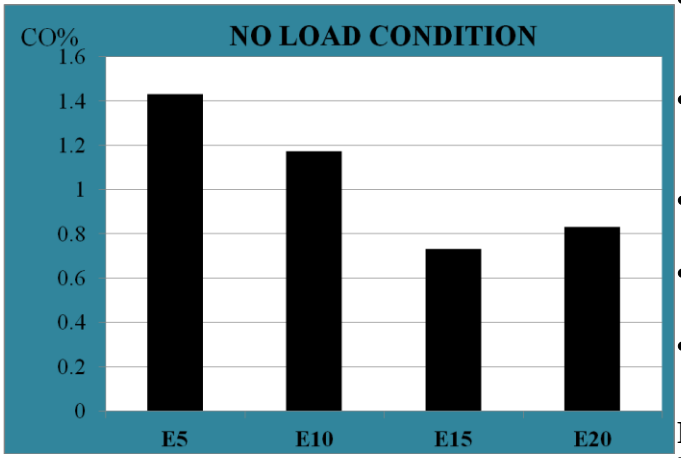

Fig. 6 CO graph

D. HC Emission

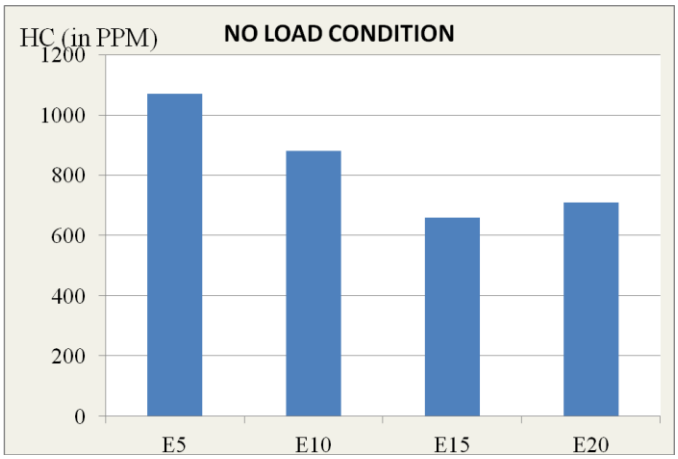

Fig. 6 HC graph

6. CONCLUSIONS

- It is not only the price reduction by Ethanol blending that matters but also the millions of litres of petrol that we save for future.
- Various properties of petrol and ethanol like density, ignition temperature are similar. Also the two liquids can be mixed easily without any external agent.
- Ethanol helps in clean and complete combustion as it provides oxygen during combustion and gives water as product of combustion.
- Ethanol blends help with higher octane rating and lower exhaust emissions.
- Ethanol blends produces higher torque, compared with petrol at all speeds.
- CO and HC emissions are lowered when ethanol percentage in petrol increases.

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