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# RESEARCH ARTICLE

# A REVIEW PAPER ON PERFORMANCE EVALUTION OF SINGLE CYLINDER 4-STROKE PETROL ENGINE USING PETROL-ETHANOL BLENDS

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## ABSTRACT

This paper is based on the available evidence for the performance evaluation of single cylinder 4-stroke petrol engine using petrol-ethanol blend fuels and also focuses on regulated and unregulated air pollutant emissions from vehicles running on petrol-ethanol blended fuels. Automobile have become a very important part of our modern life style. But the future of automobile based on internal combustion engines has been badly affected by two major problems. That is less availability of fuel and environmental degradation. So it is very important to found some new renewable non polluting alternative fuels to ensure the proper and safe survival of internal combustion engines. In present study we evaluate the performance of four stroke single cylinder spark ignition engine with different percentage ratio of ethanol and petrol by volume. This study is an attempt towards finding the effect of alternative fuel (particularly ethanol) as substitute over petrol, in petrol engine to reduce petrol consumption and also most outstanding result of using ethanol additive is significant reduction in pollutions emitting from engine.

***Key Words:*** *Ethanol,* 4-storke petrol engine, emission etc.

## INTRODUCTION

The energy requirements of ever growing population and subsequent growing sector of transports, mostly depend on reserves of crude oil which are depleting at rapid rates and expected to exhaust in future which is not very distant. Foreign exchange expenditure for import of crude oil, fluctuations of their prices and increasingly stringent exhaust emission legislation have led to rise in necessity of using alternative fuels in internal combustion engines. When evaluating different alternative fuels, one has to take into account many aspects:

- Adequacy of fuel supply
- Process efficiency
- Fuel economy
- Ease of transport and safety of storage
- Modifications needed in the distribution/refueling network in the vehicle
- Fuel compatibility with vehicle engine (power, emissions, ease of use, and durability of engine).

Ethanol is a clear liquid alcohol that is made by the fermentation of different biological materials. This alcohol is known to have many uses, but one in particular is becoming More popular. Ethanol, the most widely used bio fuel, is made in a process similar to brewing beer. The ethanol in the end is blended with petrol to improve vehicle performance and reduce air pollution. Ethanol fuel is ethyl alcohol ($C_2H_5OH$) the same type of alcohol beverages. Ethanol is high performance biomass fuel.

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It is considered the most suited alcohol to be used as a fuel for spark ignition engines. The most attractive properties as ethanol include its ability to be produced from renewable energy sources 'it's high octane number and its high laminar flame speed. The present cost of ethanol is high due to the manufacturing and processing requird. Today ethanol accounts for a substantial part of the alternative fuel market, especially in Brazil, the USA and Sweden. The advantages of ethanol are that it can.

1) Provide available alternative to reduce the greenhouse effect.
2) Be easily mixed with petrol.
3) Create new job in the century related to its production.

In present study, the operation parameter for a four-stroke petrol or petrol engine such as delivery ratio, thermal efficiency, mechanical efficiency etc. are investigating experimentally when its fuel is blending with ethanol additives also the amounts of emitting pollutants (HC,CO,CO2&NOx) from this engine are measuring in various engine velocity and load.

### Ethanol as an Alternative Fuel

Alcohol is a good substitute as alternative fuel for use in SI engine. It has good compatible property with petrol fuels. Their octane rating is also more than 100. It can be considered as renewable energy under the environmental consideration, using ethanol blended with petrol is better than methanol because of its renewability and less toxicity. If alcohols are added in a small amount with petrol in SI engine then there is no need to make any modification in engine. As we all know that modification in engine and change in composition of fuel are two methods by which we can improve the performance of an engine and can reduce the environmental pollution.

Here in this experiment we tried to change the composition of fuel by blending of ethanol with petrol in a suitable amount to improve the performance of engine. In recent years several researches have been carried out to the influence of methanol and ethanol on the performance of spark ignition engines. Development of alcohol fuel would be of great significance in many aspects. For instance it can protect environments by reducing the emissions. Alternative fuels such as biodiesel and ethanol can satisfy the demands for renewable energy sources with low environmental impacts. Now ethanol has been as a total or partial substitute fuel for petrol in many countries. The use of alternative fuels has received considerable attention due to increased demand for energy and more rigorous emission regulations.

Some properties of ethanol with comparison to petrol are given in Table 3. The reduction of CO emission is apparently caused by the wide flammability and oxygenated characteristic of ethanol. Therefore, improvement in power output, efficiency and fuel economy. On the other hand, the auto-ignition temperature and flash point of ethanol are higher than those of petrol and the low Reid evaporation pressure which makes it safer for transportation and storage also causing lower evaporative losses. The latent heat of evaporation of ethanol is 3–5 times higher than that of petrol and this provides lower temperature intake manifold and increases volumetric efficiency. It contains 35% oxygen that helps in complete combustion of fuel and thus reduces harmful tailpipe emissions. Although having these advantages, due to limitation in technology, economic and regional considerations ethanol as a fuel still is not used extensively. Since using ethanol-petrol blended fuels can reduce emissions of pollutants and the depletion of fossil fuels at the same time, many researchers for many years has been dedicated to studying the influencing of these fuels on the performance of an engine and on pollutants emissions.

**Table 1. Properties of ethanol and petrol**

| Characteristics | Ethanol | Petrol |
|---|---|---|
| Boiling point( C) | 78 | 30-225 |
| Molecular Weight (kg/kmol) | 46.07 | 114.2 |
| Density at 15oC(kg/l) | 0.79 | 0.7322 |
| Research octane number | 108.6 | 96-98 |
| Stoichiometric air fuel ratio | 9 | 14.7 |
| Upper flammability limits in air (%vol.) | 19 | 7.6 |
| Lower flammability limits in air (%vol). | 4.3 | 1.3 |
| Calorific value (kJ/kg) | 27000 | 43000 |

## Experimental Setup

The setup consist of single cylinder, four stroke, water cooled petrol engine coupled to eddy current dynamometer with the help of flexible rubber coupling is mounted on centrally balanced base frame made of ms channel .The set up has stand-alone fully powder coated panel box consisting of air box, fuel tank, manometer, fuel measuring unit, digital indicators and transmitters for measuring various parameters. The overhead cylinder head made of cast iron is water cooled externally. It is also provided with necessary sensors with transmitters for combustion pressure and crank angle measurements. All these signals are interfaced to computer through signal conditioner and signal converter for computerization. (Above experimental setup universal for all engine performance testing)

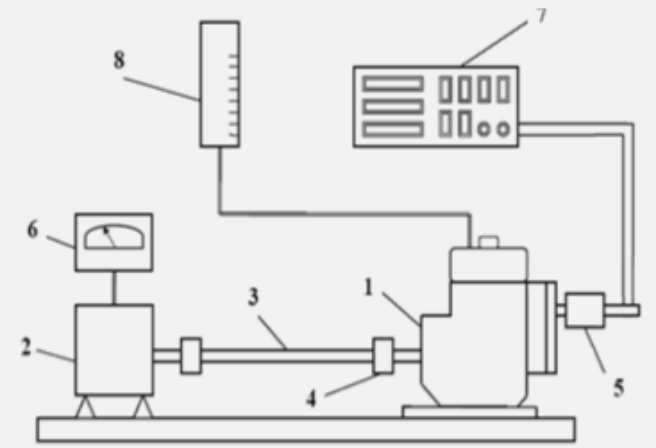


**Fig. 1. Schematic of the experiment setup**

## Component Name

1)Dynamometer coupled with engine 2)single cylinder petrol engine 3)propeller shaft 4)universal joint 5)Exhaust gas outlet 6)computer based Petrol Engine Test Rig measuring panel 7)Exhaust gas analyzer 8)Fuel flow gauge.

## Literature Survey

A number of researches connected with exploitation of mixture of ethanol-petrol in spark ignition engines are performed in stationary conditions on motor power stands. In these experiments specific fuel consumption, composition of exhaust gases and other parameters at constant motor speed are established. Regimes of experiments not always can describe real condition of exploitation of motor vehicle in field. Acquired results in several researches are different.

Mohsen Ghazikhani *et al* 2013, studied experiment investigation of performance improving and emissions reducing in two stroke SI engine by using ethanol additives by varying parameter velocity (2500, 3000, 3500 & 4500 rpm) and load (25%, 50%, 75% full load).It was observed that due to ethanol evaporation 10% & 15% ethanol addition an increase delivery ratio and subsequently scavenging efficiency (approximately 40%) is observed. But trapping efficiency has been decreased about 15%.using ethanol reduced HC level in all cases and for each 5% ethanol, HC approximately 6% decreased as well as NOx reduction which is reduced 83% when high percentage of ethanol (15%). Shane Curtis *et al* [10], studied Effect of Ethanol Blends on a Spark Ignition, 4-Stroke, Internal Combustion Engine. 10% ethanol-petrol blends can be used in spark ignition engines without any major modifications to the air/fuel system. The 10% ethanol blend produces similar fuel conversion efficiency, brake work, and bsfc to that of pure petrol. CO emissions for 10% ethanol blends are much lower than CO emissions from petrol.

NOx and CO emissions for 10% ethanol blends and petrol are similar. 20% ethanol-petrol blends do not perform as well as pure petrol does in spark ignition engines that are calibrated to run on petrol. The fuel conversion efficiency and brake work both decrease for an engine operating on a 20% ethanol blend, while bsfc increases. CO emissions for 20% ethanol blends are

much lower than CO emissions from petrol. The NOx emissions for 20% ethanol are similar to those of pure petrol. CO2emissions are higher for 20% ethanol blend than for what is produced by petrol. Mustafa Koc, Yakup *et al.* (Mustafa Koc, 2009)**,** investigated experimentally in a single cylinder four-stroke spark ignition engine at two compression ratios (10:1 and 11:1) the effects of ethanol-unleaded petrol blends on engine performance and exhaust emission in SI engine. The effects of unleaded petrol (E0) and unleaded petrol– ethanol blends (E50 and E85) on engine performance and pollutant emissions were observed. The engine speed was changed from 1500 to 5000 rpm at wide open throttle. Ananda Srinivasan *et al.* (Ananda Srinivasan and Saravanan, 2010), studied the effects of ethanol-blended petrol with oxygenated additives on multi-cylinder SI engine. He found that the blend increased brake thermal efficiency more than petrol.

The emission tests found that the CO slightly decreased, while HC and O2 increased moderately and CO2 and NOx appreciably decreased. In addition, combustion analyses were made with the help of combustion analyzer, in which cylinder pressure and heat release rate were analyzed. Dhanapal Balaji *et al.* (Dhanapal Balaji *et al.,* 2010)**,** investigated the effects of using unleaded petrol and additives blend on SI engine combustion and exhaust emission. It was found that, using ethanol-unleaded petrol blend leads to a significant reduction in exhaust emissions. On the other hand blending of all ethanol fuels the CO2 concentration increases. With addition of ethanol to unleaded petrol the maximum pressure reduced, the flame speed increased, so that the spark timing of ethanol blends has to be optimized. By adding the ethanol with pure petrol with increasing percentages the octane numbers of ethanol blends was increased. This allowed increasing the compression ratio and powering output. Thus, the brake thermal efficiency of ethanol blends was increased. Ibrahim Thamer Nazzal *et al.* (Ibrahim Thamer Nazzal, 2011)**,** studied the effect of petrol-alcohol blend on the performance of SI engine. The results were presented in terms of speed. When ethanol–petrol and methanol–petrol blended fuels were used, the brake power of the engine slightly increased while the brake thermal efficiency increased as compared to that of petrol fuel.

Also it was found that BSFC decreased up to a certain compression ratio as compared to that of petrol fuel. The exhaust gas temperature decreased compared with petrol fuel. The addition of methanol to petrol increased the octane number. Rong Horng Chen *et al.* (Yan Zhang *et al.,* 2013)**,** investigated the effects of ethanol-petrol blended fuel on cold-start emission of an SI engine. More ethanol content in the blended fuel makes the air-fuel mixture leaner. The engine could be started stably with E5, E10, E20, and E30. The HC and CO emissions decreased significantly with more ethanol than 20% added. However, for E40 the engine idling became unstable because the air-fuel mixture was too lean. Therefore, the ethanol content in petrol for best cold-start emissions was determined to be at least 20% but no greater than 30%. C.Ananda Srinivasan *et al.*[9], investigated Emission reduction in SI engine using ethanol – petrol blends on thermal barrier coated pistons. From the study, the following conclusions can be deduced:

1. Coated pistons with ethanol blend and oxygenated additive to petrol causes improvement in engine performance and reduces exhaust emissions.
2. Coated pistons with Ethanol addition and oxygenated additive results in the increase in brake thermal efficiency with 32 % at 2600 rpm with coated pistons gives the best Results for the engine performance.

**Conclusion**

General conclusions arrived from the above literature review are that ethanol can be produced abundantly and economically and it will be an attractive alternative fuel for S.I. engines. It can be used either as a pure fuel or as a petrol additive. Petrol ethanol blends including ethanol at low proportions can be used without any modifications in the engine but pure ethanol usage requires major modifications to the engine design and fuel system. This paper aims at running the engine with different percentage of blending of petrol and ethanol on SI engine to analyze the performance, combustion analyses and exhaust emissions.

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