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Performance and Experimental Analysis of Two Stroke Petrol Engine Using Ethonal as an Alternative Fuel

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ABSTRACT

Increasing global concern due to air pollution and to the limited oil reserves has generated much interest in the environmental friendly fuels alternative to petroleum based fuels. In particular for the transport sector in which the energy consumption depends almost exclusively on fossil fuels. The rapid depletion of petroleum fuels and ever increasing price of them has led to an intensive search for alternative fuels. Bio-fuels being renewable and eco-friendly are attracting growing interest around the world.

Ethanol alcohol found to be a promising alternative fuel for gasoline engine. In this project we are dealing with ethanol as bio- fuel and it is blended in different ratio with petrol. Here the variable compression ratio (VCR) SI engine will run on blend containing 5%,10%,15%,20% and 25% ethanol in different load and at different compression ratio (6and 8) and performance parameter will be evaluated. The performance parameters to evaluate are torque brake mean effective pressure, brake power, specific fuel consumption and thermal efficiency. We can conclude from the result that using 15% ethanol blend is most effective and we can utilize it further using SI engines with little constrain on material used to sustain little increase in pressure.

INTRODUCTION

CONVENTIOANL FUELS

Energy is considered as a critical factor for economic growth, social development and human welfare. Since there exploration, the fossil fuels continued as the major conventional energy source with increasing trend of modernization and industrialization, the world energy demand is also growing at a faster rate. To cope up the increasing energy demand is also growing at faster rate. To cope up the increasing energy demand, majority of the developing countries import crude oil apart from indigenous production [1-3]. This puts extra burden on their home economy. Hence, it is utmost important that the options for substitution of petroleum fuels be explored to control this burgeoning import bill.

There is a limited reserve of the fossil fuels and the world has already faced the energy crisis of seventies concerning uncertainties in their supply of fossil fuels currently the dominant global source of CO_2 emissions and their combustion is stronger threat to clean environment increasing environment industrialization, growing energy demand, limited reserve of fossil fuels and increasing environmental pollution have jointly necessitating exploring some alternative of conventional liquid fuels. Among the possible options of the conventional liquid fuels, the ethanol has been considered as appropriate alternative due to prevalent fuel properties. Ethanol has been known as a fuel for many decades. However, it is not widely used because of its high price. But as a fuel for spark-ignition engines, ethanol has some advantages over gasoline, such as better anti-knock characteristics and the reduction of CO and HC emissions. It has the ability to reduce the greenhouse exhaust emissions. Ethanol is the best alternative to the gasoline. It is also called as “Gasohol” when mixed with gasoline [5].

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Ethanol can be used in variable compression ratio spark ignition engines by various techniques such as ethanol-gasoline blends.

NEED FOR ALTERNATIVE FUELS:

The increasing industrialization and motorization of the world leads to a steep rise in the demand of petroleum products. Petroleum based fuels are stored fuels in the earth. There are limited fuels of these stored fuels and they are irreplaceable. With our present known reserves and the growing rate of consumption, it is feared that they are not going to last long.

These finite resources of petroleum are highly concentrated in certain regions of the world has given rise to frequent disruption and uncertainties in its supply and as well as price.

Many countries today solely dependent on imports to meet their fuel oil requirements and many more will be added in future as their limited reserves of petroleum deposits get exhausted. The situation is very grave in developing countries like India which import 70% of the required fuel, spending 30% of her total foreign exchange earnings on oil imports. This situation has created a problem to increase the price of these oils more than two folds in last 5 years. As time passes, these trends will be aggravated further causing greater scarcity and hardships [4].

Petroleum fuelled vehicles discharge significant amount of pollutants like CO, HC, NO_x, soot, lead compounds and aldehydes. Oxides of nitrogen and unburned hydrocarbons from the exhaust cause environment fouling by forming photo-chemical smog. Their interaction involves formation of certain formaldehydes, peroxides, peroxylnitrate [6] which cause eye and skin irritation, plant damage and reduced visibility.

In view of these problems of fast dwindling reserves of irreplaceable petroleum fuels and the hazards of environmental pollution caused y their combustion, attempts must be made to develop the technology of alternate clean burning synthetic fuels. These fuels should be such that they have attributes of perennial renewal, they perform well in engine and their potential for environmental pollution should be quite low.

ADVANTAGES AND DISADVANTAGES OF ETHANOL

ADVANTAGES:

- Ethanol and ethanol blends are non-toxic.
- They are renewable.
- Good for environment.
- They produce lower carbon monoxide and carbon dioxide emissions, and the same or lower levels of hydrocarbon and oxides of nitrogen emissions.
- Ethanol is widely available and easy to use.
- Ethanol is good for the economy.
- Ethanol has biodegradable nature.
- Ethanol is a ready-to-use fuel that can be blended directly into gasoline.

DISADVANTAGES:

- Ethanol has a lower heat of combustion (per mole, per unit of volume, and per unit of mass) that petroleum.
- Major environmental problems would arise out of the disposal of waste fermentation liquors.
- Producing ethanol and other biofuels [8] takes more energy than the fuel can generate.
- Ethanol has a smaller energy density than gasoline.
- It is more expensive when compares to gasoline.
- Transportation requires special management.

PROBLEM DEFINITION

DIFFERENT PHASE OF PROBLEM:

In present situation, there are more problems regarding the fuel consumption, emission and less thermal efficiency. This is the need of present world to improved engine performance, efficiency. To save the environment, to be economical in automobile and to maintain the healthy life of mankind these problems

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from more fuel consumption the alternate method should be taken to save these things. The VCR is the technique to avoid such problems and to save the environment as well as the money of human being [9].

The work done so far in this field is mostly related to the blending of the Ethanol with gasoline, and finding the parameters governing the engine performance.

The Ethanol is mixed with gasoline with various percentages (5%, 10%, 15%, 20%, and 25%) at two different compression ratio (6&8). First, the investigation is carried out by using gasoline (only) on VCR SI engine and the performance parameters are calculated.

The second process is as same as first, but the fuel is changed i.e. ethanol blends. E5 is filled in the fuel tank and the investigation is done.

Similarly, E10, E15, E20, E25 are used one by one on VCR SI engine and performance is carried out.

The Results hence obtained are satisfactory are very encouraging and so further study is carried out for better results.

PERFORMANCE OF VCR SI ENGINE

PERFORMANCE OF VCR SI ENGINE:

Brake power: The power actually developed by the engine is called brake power. It is also referred as a shaft power. In other words, the brake power is the energy available at the crankshaft. It is designated as "BP".

$$\mathbf{BP} = \frac{2\pi NT}{60000} \quad kW$$

Where,

BP = Brake power in kW
N = Speed in rpm
T = Torque in N-m

Mass of fuel consumption: It is designated as "m_f".

$$\mathbf{m_f} = \frac{5}{t} \times \frac{(\text{Specific gravity of fuel})}{1000} \times 60 \quad kg/\ min$$

Where,

m_f = Mass of specific fuel consumption in kg/ min
t = Time for 5cc of fuel consumption in sec

Total fuel consumption: It is designated as "TFC".

$$\mathbf{TFC} = m_f \times 60 \quad kg/\ hr$$

Where,

TFC = Total fuel consumption in kg/ hr
m_f = Mass of specific fuel consumption in kg/ min

Heat Input: It is designated as "HI".

$$\mathbf{HI} = \frac{TFC \times CV}{60 \times 60} \quad kW$$

Where,

HI = Heat Input in kW
TFC = Total fuel consumption in kg/ hr
CV = Calorific Value of fuels in kJ/ kg

Indicated Power: The energy actually developed or produced at the combustion chamber i.e. the power developed inside the engine cylinder is called indicated power. It is also defined as the sum of the brake power and indicated power. It is designated as "IP".

$$\mathbf{IP} = BP + FP \quad kW$$

Where,

IP = Indicated power in kW
BP = Brake power in kW
FP = Frictional power in kW from William's Line diagram which is obtained from graph (TFC V_S BP).

Brake Specific Fuel Consumption: The fuel consumption on the basis of the brake power is called brake specific fuel consumption. It is designated as "BSFC".

$$\mathbf{BSFC} = \frac{TFC}{BP} \quad kg/\ kW\text{-}hr$$

Where,

BSFC = Brake specific fuel consumption in kg/ kW-hr
TFC = Total fuel consumption in kg/ hr
BP = Brake power in kW

Indicated Specific Fuel Consumption: The fuel consumption on the basis of the indicated power is called indicated specific fuel consumption. It is designated as "ISFC".

$$\mathbf{ISFC} = \frac{TFC}{IP} \quad kg/\ kW\text{-}hr$$

Where,

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ISFC = Indicated specific fuel consumption in kg/ kW-hr
TFC = Total fuel consumption in kg/ hr
IP = Indicated power in kW

Brake thermal efficiency: The ratio of energy in the brake power to the input fuel energy in appropriate units is called brake thermal efficiency. It is designated as "η_{bth}".

$$\eta_{bth} = \frac{BP}{HI} \times 100 \ \%$$

Where,

η_{bth} = Brake thermal efficiency in %
BP = Brake power in kW
HI = Heat Input in kW

Indicated thermal efficiency: The ratio of energy in the indicated power to the input fuel energy in appropriate units is called indicated thermal efficiency. It is designated as "η_{ith}".

$$\eta_{ith} = \frac{IP}{HI} \times 100 \ \%$$

Where,

η_{ith} = Indicated thermal efficiency in %
IP = Indicated power in kW
HI = Heat Input in kW

Mechanical efficiency: The ratio of brake power (delivered power) to the indicated power (power provided to the piston) is called mechanical efficiency. It is designated as "η_m".

$$\eta_m = \frac{BP}{IP} \times 100 \ \%$$

Where,

η_m = Mechanical efficiency in %
BP = Brake power in kW
IP = Indicated power in kW

These are the performance parameters of VCR SI engine.

VCR SI ENGINE SET UP

The experimental setup consists of four cylinders, four strokes, and Variable Compression Ratio SI (petrol) engine connected to eddy current type dynamometer for loading [6]. Provision is also made for interfacing airflow, fuel flow, temperatures and load measurement. The set up has stand-alone panel box consisting of air box, fuel tank, and manometer. Rota meters are provided for cooling water and calorimeter water flow measurement. The setup enables study of engine performance for brake power, indicated power, frictional power, brake thermal efficiency, indicated thermal efficiency, Mechanical efficiency, and specific fuel consumption [7].

The detailed specification of the engine is shown in Table 1. The experimental set up is shown in Fig 7.1.

Fig.7.1: Variable Compression Ratio SI Engine – Experimental Setup

SECIFICATION OF VCR ENGINE:

Table 7.2.1Specifications of VCR SI Engine

Make	Greaves
Stroke, L	66.7 mm
Bore, D	70 mm
Swept volume, V	256 cm^3
Rated R.P.M	3000 rpm
Output	2.2 kW
Compression ratio, CR	2.5:1 to 8:1
Fuel	Petrol
Specific Gravity of petrol	0.716
Calorific Value of petrol	47100 kJ/ kg
Starting	By rope
Loading	Eddy current dynamometer loading
Cooling	Forced Air cooling
Orifice diameter	20 mm

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RESULTS

EFFECT OF ETHANOL BLENDS ON BSFC

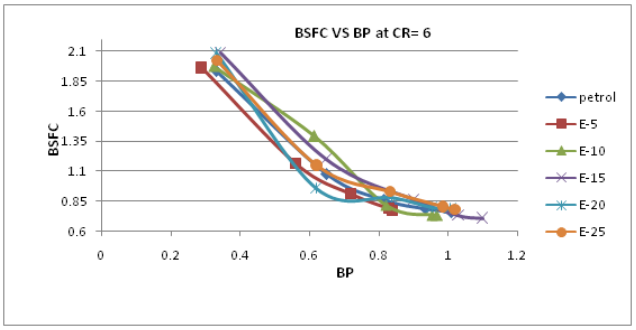

Fig.9.2.1Variation of brake specific fuel consumption with brake power at CR=6

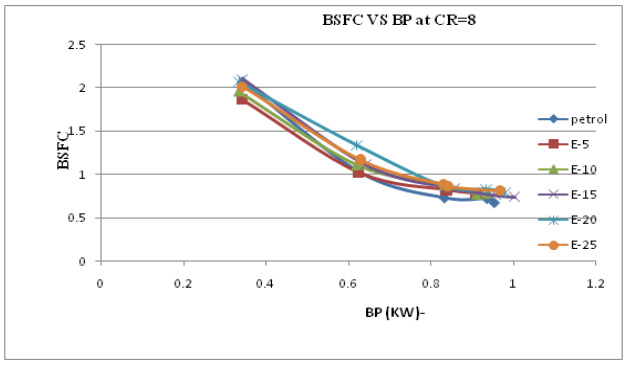

Fig.9.2.2: Variation of brake specific fuel consumption with brake power at CR=8

The above graph is plotted between brake specific fuel consumption and brake power. The sequence of fuels used is E5, E10, E15, E20, and E25. But among all ethanol blends, bsfc of E15 is increasing at both compression ratio (6&8) when the loads are increasing. Thus according to this graph E-15 is the best blends among 5 blends [4].

EFFECT OF ETHANOL BLENDS ON BRAKE THERMAL EFFICIENCY:

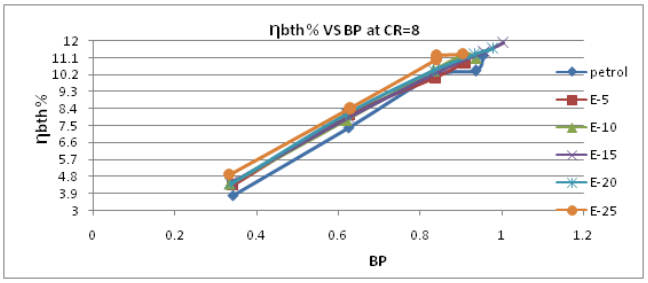

Fig.9.3.1: Variation of brake thermal efficiency with brake power at CR=8

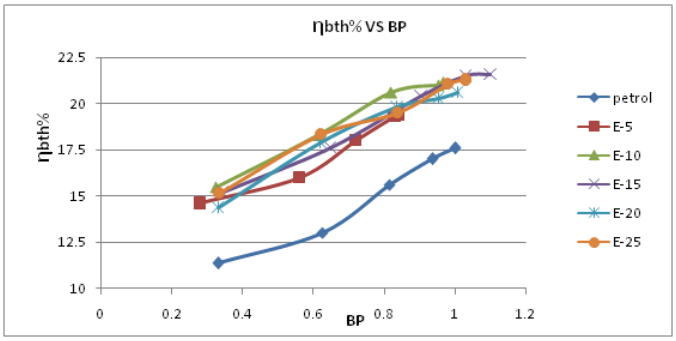

Fig.9.3.2: Variation of brake thermal efficiency with brake power at CR=6

The graph plotted between brake thermal efficiency and brake power shows clearly that with increase in brake power, brake thermal efficiency increases. As brake thermal efficiency should be high for better engine performance [2]. Therefore engine performs with efficiency for E15 at both compression ratios at 5 kg load is superior to all other ethanol blends.

EFFECT OF ETHANOL BLENDS ON MECHANICAL EFFICIENCY

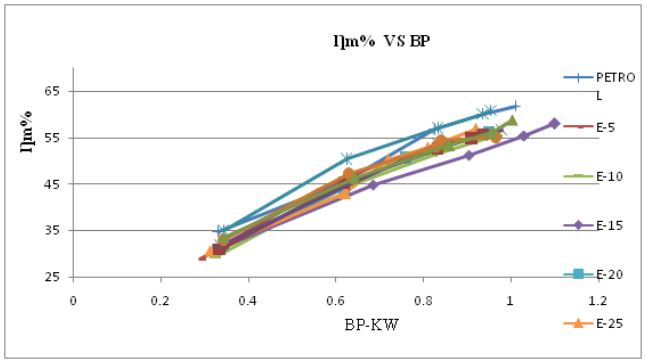

Fig.9.4.1: Variation of mechanical efficiency with brake power at CR=8

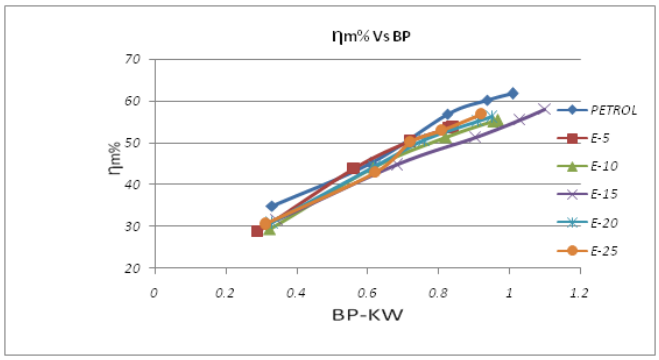

Fig.9.4.2: Variation of mechanical efficiency with brake power at CR=6

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The graph plotted between mechanical efficiency and brake power shows clearly that with increase in brake power, mechanical efficiency increases. As mechanical efficiency should be high for better engine performance. Therefore engine performs with efficiency for E15 at both compression ratios at 5 kg load is superior to all other ethanol blends.

CONCLUSION:

The main conclusions deduced from these investigations are as follows:

The experimental study was conducted concerning the performance characteristics of various Ethanol blends on Variable Compression Ratio (VCR) SI Engine. The effects of these fuel blends on the engine performance at different compression ratio were compared with petrol. The tests blends were from 5%, 10%, 15%, 20% and 25% Ethanol by volume. The engine was operated on varying speed and varying loads.

The test results revealed that overall better performance in case of E15 fuel blends in both compression ratio (6&8) . Hence, 15 percent ethanol blend was found to be the beneficial substitution that achieves satisfactory engine performance.

As the world is already facing fuel energy crisis, there is a compulsory need of using alternative fuels. From this study, it is observed that E15 is having better performance in fuel consumption, brake thermal efficiency and mechanical efficiency.

FUTURE SCOPE:

Hence, using not only E15 fuel, further we may also try to investigate by blending other different percentages. So that, the specific fuel consumption and efficiency should get satisfied.

As the cost of the ethanol blend fuels are more when compared to petrol, its usage is less in India. But, if once its cost decreases then it can be used widely and can even be helpful to common man too.

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