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# Study of Ethanol – Gasoline Blends for Powering Medium–Duty Transportation SI Engine

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***Abstract— As a lucrative fuel gasoline is widely consumed in country like India whose economy is very rapidly increasing. With the rapidly growing economy, demand is also going up sharply which is resulting in increased level of pollution and vehicular traffic. Amongst primary alcohol, ethanol is considered as the most promising alternative fuel candidate because of its quite similar chemical and physical properties with gasoline. Ethanol is completely miscible with gasoline in any proportion and forms a stable blend. Experiments are conducted on four cylinder engine to study the performance of the ethanol gasoline blended fuel. The ethanol is blended with 5%, 10%, 15%, 20% and 25% by volume with gasoline.***
***Keywords—Blends, Brake thermal efficiency, Ethanol, Gasoline, SI Engine***

## I. INTRODUCTION

The world is presently confronted with the twin crises of fossil fuel depletion and environmental degradation. Indiscriminate extraction and lavish consumption of fossil fuels have led to reduction in underground based carbon resources. The search for alternative fuels, which promise a harmonious correlation with sustainable development, energy conservation, efficiency and environmental preservation, has become highly pronounced in the present context [1].

Ethyl alcohol, which is one of the renewable energy sources and is obtained from biomass, has been tested intensively in the internal combustion engines Das *et al*. [2] revealed that due to the high evaporation heat, high octane number and high flammability temperature, ethyl alcohol has positive influence on the engine and increases the compression ratio. The low reid evaporation pressure enable to storage and transportation safely. Since the oxygen contain has positive effect on environment. In spite of its positive effect when used in gasoline engine as alternative fuel, it is necessary to make some modification on the engine. The fuel system requires more fuel.

The effects of ethanol and gasoline blends on spark ignition engine emissions were investigated by Hseih *et al*. [3]. In this study, test fuels were prepared using 99.9% pure ethanol and gasoline blended with the volumetric ratios of 0-30% (E0, E5, E10, E20 and E30). These percentages represent the ratios of ethanol amount in total blends. In the experiments performed at different throttle openings and engine speeds, nearly the same torque values were obtained when used different ratios of ethanol- gasoline blends compared with pure gasoline.

With increasing compression ratio up to 11:1, engine torque increased with E0 fuel, at 2000 rpm engine speed. Compared with the 8:1 compression ratio, the increment ratio was about 8%. At the higher compression ratios the torque output did not change noticeably. At 13:1 compression ratio, the highest increment was obtained for both fuels E40 and E60 as nearly 14% [4].

M. Bahattin Celik shows [5] the effect of various fuels on power and specific fuel consumption (SFC). As the ethanol content in the blend fuel increase, power also slightly increases. When compared to E0 fuel, the power increases of 3%, 6% and 2%are obtained with E25, E50 and E 75 fuels respectively. The heat of evaporation of ethanol is higher than that of gasoline. High heat of evaporation can provide fuel-air charge to cool and density to increase, thus higher power output is obtained to some extent. However, power increase starts to decrease when ethanol content is raised to more than 50%.

Costa and Sodre [6] studied the effects of compression ratio on the performance of an engine fuelled by hydrous ethanol and a blend of 78% gasoline and 22% anhydrous ethanol. Engine torque, BMEP and output power are substantially improved with increased compression ratios at high speeds for both, E22 and hydrous ethanol. However, increasing compression ratio significantly decreases SFC and increases thermal efficiency when hydrous ethanol is used. Increasing compression ratio increases the exhaust gas temperature when E22 is used, while the use of a low compression ratio slightly increases the volumetric efficiency when the engine is operated with hydrous ethanol.

Hasan [7] investigated the effect of ethanol- unleaded gasoline fuel blends on the performance of an SI engine (Toyota Tercel 3A). The results showed that when ethanol blended gasoline fuel was used, brake power, brake thermal efficiency and volumetric efficiency increased by 8.3%, 9% and 7% while brake specific fuel consumption and air-fuel ratio decreased by 2.4% and 3.7% respectively. Hasan stated that 20% ethanol fuel blend (E20) gave the best results in the engine performance.

Mustafa Koç *et al.* [8] investigated the effects of unleaded gasoline (E0) and unleaded gasoline-ethanol blends (E50 and E85) on engine performance and concluded that the lower energy content of ethanol-gasoline fuel caused some increment in brake specific fuel consumption of the engine depending on percentage of ethanol in the blend. Torque with blended fuels (E50 and E85) were generally found to be higher than that of base gasoline (E0) in all the speed range due to higher latent heat of evaporation of ethanol addition and oxygenated fuel.

Siddegowda *et al.* [9] investigated the effect of gasoline (E0) and gasoline-ethanol blends on the performance of MPFI engine. The results were revealed that on adding the 20% ethanol to gasoline there is increase in brake thermal efficiency and fuel consumption is slightly less as that of gasoline.

Fikret Yüksel *et al.* [10] investigated the effect of gasoline (E0) and gasoline-ethanol blends on the performance of SI engine. They revealed that In the blend fuel, an increase in the specific fuel consumption and a decrease in the engine torque and power output measurements. Although thermal efficiency of the engine showed no significant change relative to gasoline, the advantage of increased octane number could well be used in increasing the efficiency when the compression ratio of the engine was altered.

## II. PROPERTIES OF GASOLINE AND ETHANOL

| Properties | Gasoline | Ethanol |
|---|---|---|
| Chemical Formula | $C_4$-$C_{12}$ | $C_2H_5OH$ |
| Molecular Weight | 100-105 | 46 |
| Oxygen (Mass %) | 0-4 | 34.7 |
| Heating Value (MJ/kg) | 46.5 | 27 |
| Latent Heat (kJ/lt.) | 223.2 | 725.4 |
| MON | 82-92 | 92 |
| RON | 91-100 | 111 |

## III.EXPERIMENTAL SETUP

Experiments were conducted on a four-cylinder, four-stroke, water cooled, multi-point-fuel-injection (MPFI) medium duty spark ignition engine (Hindustan Motor) using gasoline-ethanol blends as test fuel and gasoline as baseline fuel. The experiments on SI engine were conducted without making any modification in the engine hardware. The schematic diagram of experimental set up is shown in the fig.1.

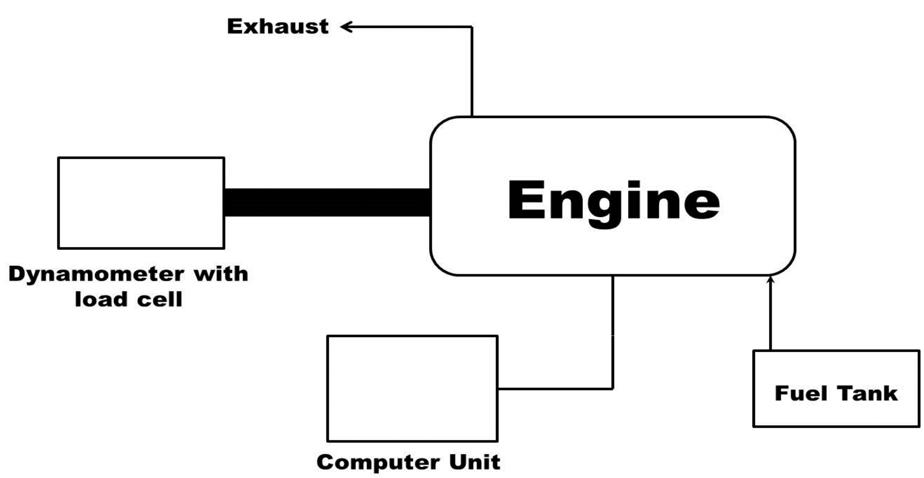


Fig. 1 Schematic diagram of experimental set up

Six test fuels were used in these experiments, which included gasoline as baseline fuel and five ethanol-gasoline blends (Ethanol 5, Ethanol 10, Ethanol 15, Ethanol20 and Ethanol 25). Ethanol XX represents XX percentage of Ethanol (v/v) in the test fuel and remaining gasoline. Load on the engine was applied using an eddy current dynamometer which was coupled to the test engine. Dynamometer is controlled using a dynamometer controller and is capable of loading the engine up to the rated engine load and speed.

## IV. ENGINE SPECIFICATION

| Parameters | Specifications |
|---|---|
| Model/Make | Ambassador/Hindustan Motor |
| No. Of Cylinders | Four |
| Bore/Stroke | 84/82 mm |
| Rated Torque | 130Nm@3000 rpm |
| Rated Power | 75 Bhp@5000rpm |
| Cooling System | Water Cooled |

## V. RESULTS AND DISCUSSION

Engine test are performed at different blends with the volumetric ratios of 0% to 25% with an increment of 5% ethanol. Engine was operated with each blend at constant speed with varying load. The mixture was prepared just before the experiments to prevent the reaction of ethanol with water vapour. The obtained results are given below.

### *A. Brake Thermal Efficiency*

The variation of brake thermal efficiency (BTE) with load for gasoline and its blends is shown in figure 2. The brake thermal efficiency is improved with increase in load for all blends with gasoline. This is due to reduction in heat loss and increase in power with increase in load. It is observed that the E 10 fuel gave the higher efficiency than the gasoline fuel for all load condition. For E 10 blend the maximum brake thermal efficiency is obtained as 24%.

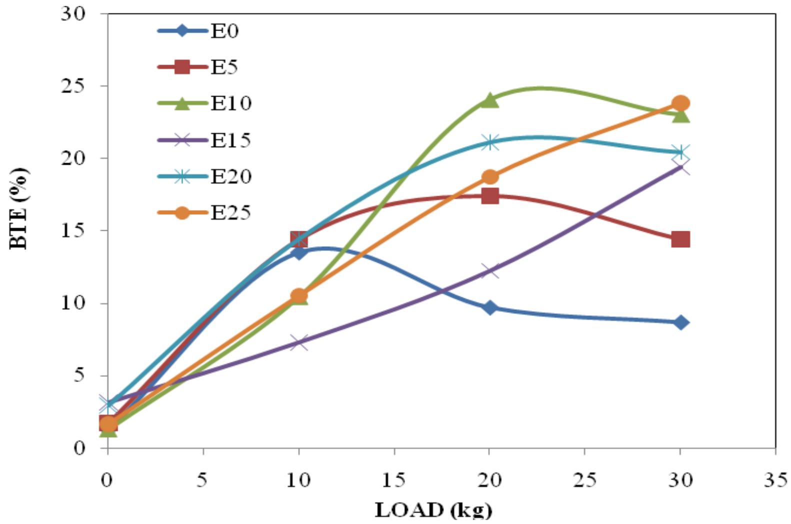


Fig. 2 Variation of BTE with load for various gasohol blends

The brake thermal efficiency gives a view about the capacity to convert the chemical energy of the fuel to the required thermal energy. The brake thermal efficiency of the engine was estimated for the Ethanol-gasoline blends and pure gasoline at various speeds is shown in figure 3. It is noted that the BTE increased with engine speed for ethanol- gasoline blends with respect to gasoline because of the higher octane number of the ethanol- gasoline blends. The brake thermal efficiency is found to be in increasing in case of E-25 with respect to engine speed while the maximum BTE is coming at E-10 blend.

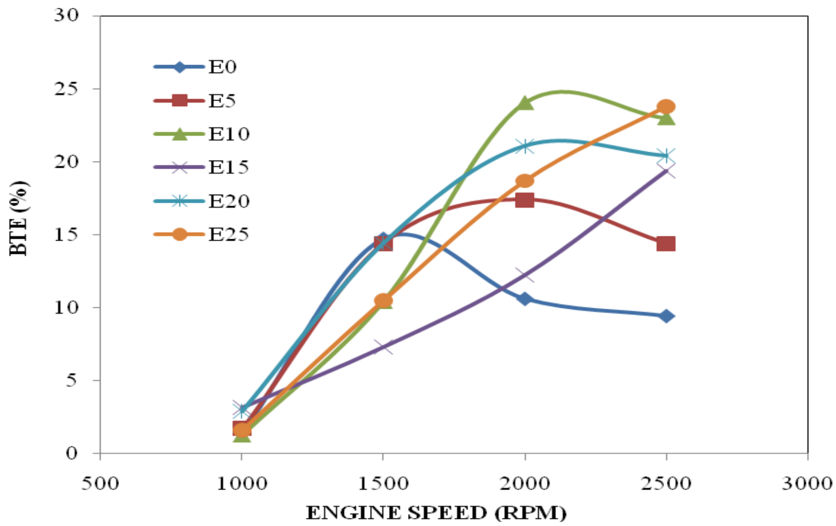


Fig. 3 Variation of BTE with engine speed for various gasohol blends

*B. Brake Specific Fuel Consumption*

The variation of brake specific fuel consumption with load for gasoline and its blends is shown in figure 4. All the blends show decreasing trend of BSFC with respect to load. The main reason for this is that the percentage increase in fuel required to operate the engine is less than the percentage increase in brake power due to relatively less portion of the heat losses at higher loads.

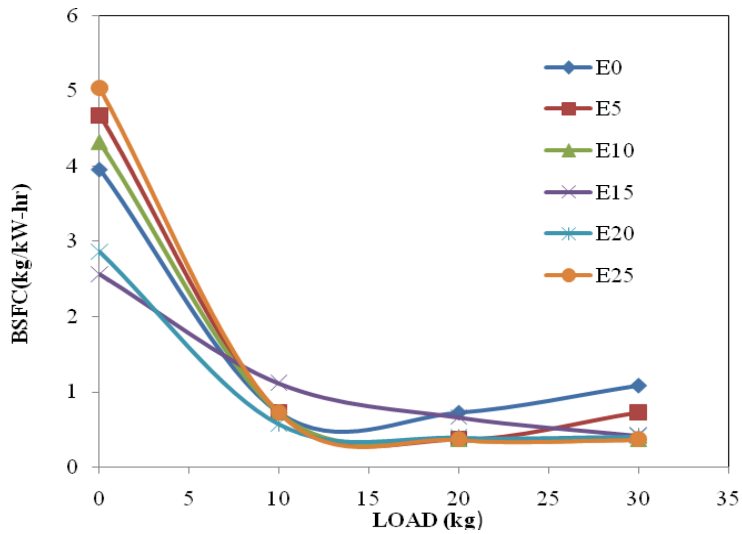


Fig. 4 Variation of BSFC with load for various gasohol blends

The variation of brake specific fuel consumption with engine speed for gasoline and its blends is shown in figure 5. It is observed that BSFC decreases with increase in speed of the engine. This is due to the fact that power produced is more at higher speeds. There is an increase in BSFC with the addition of ethanol compared to pure gasoline (E0). The calorific value of ethanol (27 MJ/kg) is lower compared to that of gasoline (47 MJ/kg). This leads to an increase in fuel consumption rate.

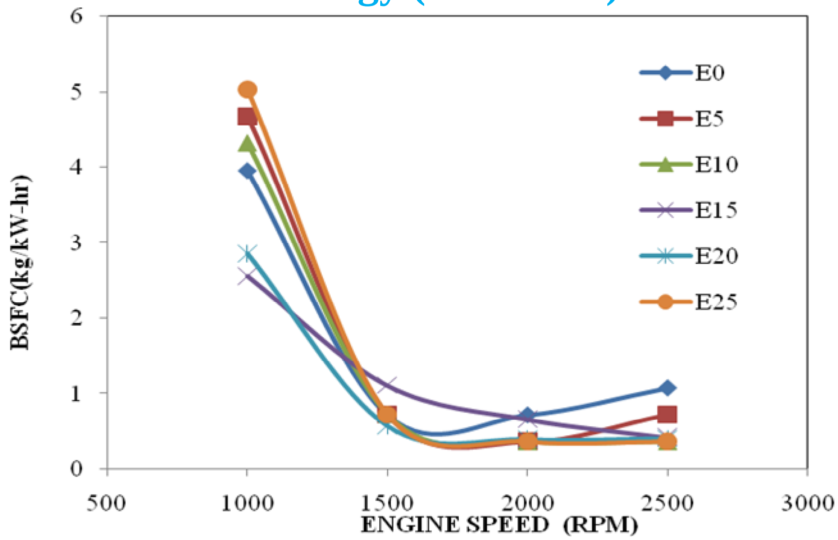


Fig. 5 Variation of BTE with engine speed for various gasohol blends

## VI. CONCLUSION

Giving the increasing trend of using higher contents of ethanol in gasoline-ethanol fuel blends, the results of this research highlighted the benefits of using ethanol in terms of the performance characteristics of the engine. The study concludes the behaviour of the engine with respect to the gasoline (E0) and gasoline-ethanol blends. The behaviour of gasoline-ethanol blends like E-15, E-20 and E-25 indicates that the fuel consumption rate and brake thermal efficiency of the engine is increasing which yields to the better combustion of the fuel inside the cylinder.

Overall, due to significant behaviour of the gasoline-ethanol on the engine performance, ethanol blends can be used as a partial replacement of gasoline, without any significant hardware modification or sacrifice in engine performance in the existing transportation SI engine.

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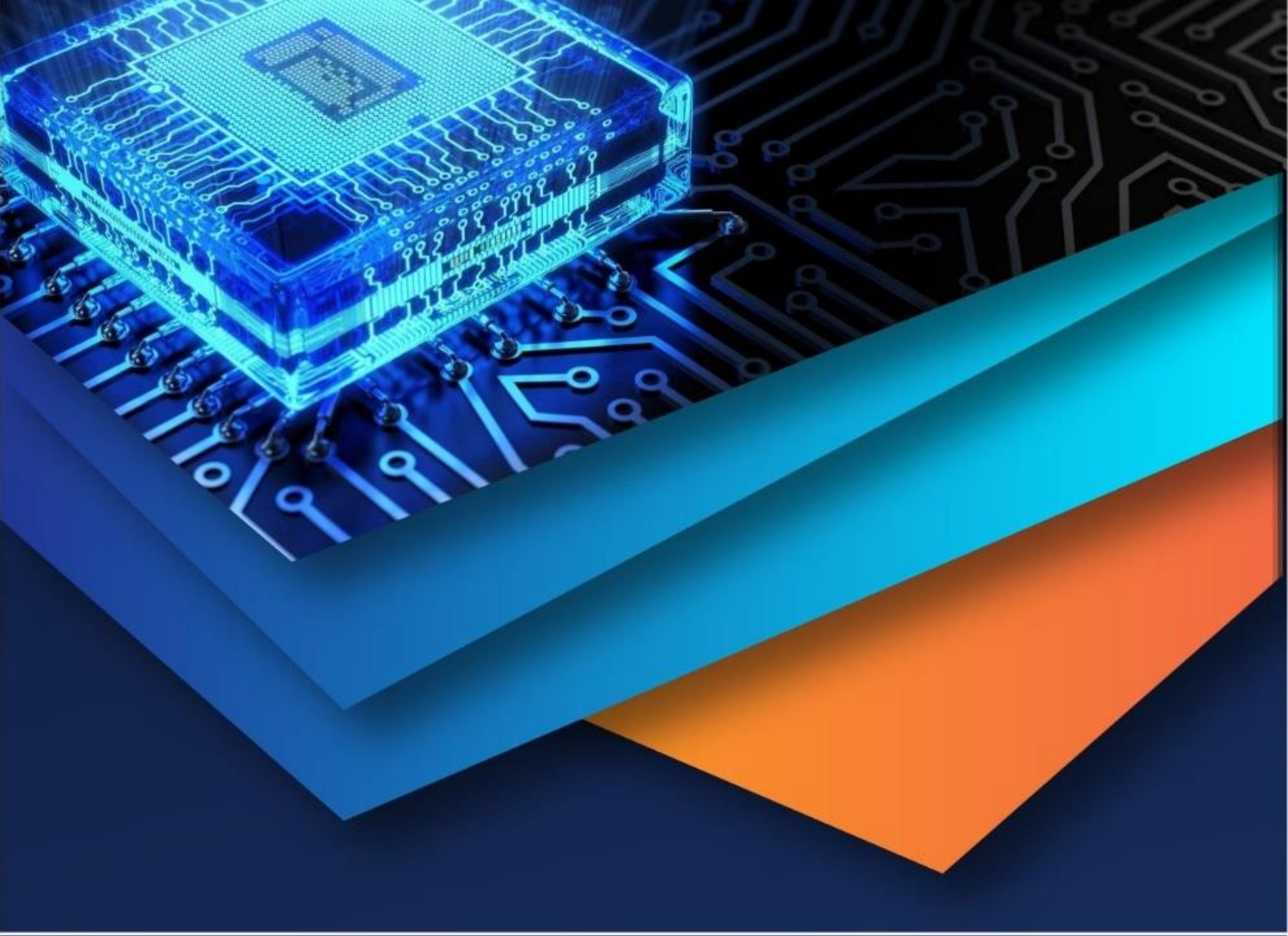


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