Original Research Paper

Testing of Ethanol as an Alternative Fuel for IC Engine

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Abstract: Alternative fuel has become very significant and has an important role to play for both spark ignition and compression ignition engines, so the need to trim down dependency on gasoline as a fuel and its economic aspects has emerged as the reason of prime importance. Ethanol is one of the cost effective alternative fuel used to improve the performance of the engine. Various investigations carried out by the researchers, primarily focused on using alternative fuel to see the diminishing effect on the fuel consumption. The aim of the study is to analyze the performance of the engine by adding the ethanol with gasoline at certain percentages as ethanol-gasoline blend. The study is carried out in the existing SI engines by diagnosing various aspects such as air-fuel ratio, operating cylinder pressure ignition timing and compression ratio related to the performance parameters. Finally the performance of gasoline-ethanol blends (E10, E20, E25) are compared and analyzed with the gasoline. From the analysis it is noticed that the ethanol blends outperforms if the engine is modified as per the requirements.

Keywords: Compression Ratio, Ethanol, Alternate Fuel, SI Engine

Introduction

Internal combustion engines are most commonly used for mobile propulsion in automobiles, equipment and other portable machinery. In mobile scenarios internal combustion is advantageous, since it can provide high power to weight ratios together with excellent fuel energy-density. These engines have appeared almost all automobiles, motorcycles, boats and in a wide variety of aircrafts and locomotives. Where very high power is required, such as jet aircraft, helicopters and large ships, they appear mostly in the form of turbines. They are also used for electric generators and by industry. Petrol is the primary fuel used in the IC engines. Straight alcohols are not normally used in automobile engines except methanol in racing cars. It is the alcohol-gasoline fuel blends which is used on some scale and has bright future. The aim of alcohol-gasoline blends is to `stretch' the fuel available and to adopt the characteristics of S.I. fuels to different requirements. By addition of alcohol, octane number can be improved and the content of less and other anti-knock agents reduced. Due to the increase of IC engine applications and cost of petrol, there is a need to introduce an alternate fuel. Ethanol is identified as one of the alternatives to petrol in IC engine. The advantages of ethanol are it is a renewable source, reduces carbon dioxide emission and easily accessible. In this study the performance of IC engine with pure petrol is compared with petrol-ethanol blends of 10, 20 and 25% respectively. Various physical properties of Gasoline and Ethanol are given in Table 1.

Table 1: Comparison of gasoline and ethanol

Fuel	Ethanol	Gasoline
Density (kg m^{-3})	795.00	750.0000
Viscosity (mm^2 s^{-1})	1.52	0.4-0.8
Calorific value (MJ kg^{-1})	26.40	43.3000
Octane number	108.00	95.0000
Boiling point (°C)	78.00	30-1900
Oxygen content (%)	34.70	<2.7000

Due to the given properties ethanol blend can be used as a alternate fuel for SI engines

Literature Survey

In a modern era, ethanol-gasoline blended fuels play a promising role in the performance of IC engine. Hsieh *et al*. (2002) analyzed the engine performance and pollutant emission of an SI engine using ethanol-gasoline blended fuels. Palmer (1986) did the experiment on gasoline to know how much oxygen that the gasoline containing. Furey and Perry (1991) studied the composition and reactivity of fuel vapour emissions from gasoline-oxygenate blends. Abdel-Rahman and Osman (1997) did the experimental investigation on varying the compression ratio of SI engine working under different ethanol-gasoline fuel blends. Coelho *et al*. (1996) studied about the fuel injection components developed for Brazilian fuels. Bata *et al*. (1989) did the analyse on emissions from IC engines fuelled with alcohol-gasoline blends.

Naegeli *et al*. (1997) did the experimental study on surface corrosion in ethanol fuel pumps. Alexandrian and Schwalm (1992) did comparison of ethanol and gasoline as automotive fuels. Chao *et al*. (2000) did the analyse on effect of methanol containing additive on the emission of carbonyl compounds from a heavy-duty diesel engine. Rideout *et al*. (1994) showed the emissions from methanol, ethanol and diesel-powered urban transit buses (Rice *et al*., 1991) studied about the exhaust gas emissions of butanol, ethanol and methanol blends. Yuksel (1984) did the investigation of using ethanol as a fuel on the agricultural diesel engine. Yuksel and Yuksel (1996) showed the use of gasoline-ethanol blend as a fuel at the SI engine. Ferfecki and Sorenson (1983) experimented on the performance of ethanol blends in gasoline engines. Karaosmanoglu *et al*. (1992) studied about the effects of methanol-gasoline blends on exhaust emissions. From the above literature it is found that ethanol blend can be combined with gasoline as a fuel and there is little change in the performance. In most cases the performance is analyzed for diesel engines. Similarly the performance is compared only in terms BP. In this study various factors such as BP, TFC, SFC and IP are compared in petrol engine with percentage of ethanol blends.

Experimentation

The experimentation is carried out in the normal TVS Apache 150 bike engine. The type of the engine is 4-Stroke Air Cooled OHC. It is the air cool type engine with displacement 147.5 cc. The maximum power and torque of the engine is 13.7 bhp @ 8500 rpm and 12.3 Nm @ 6000 rpm respectively. The process of production of ethanol from sugar or grain is well known. In contrast with methanol production, the process does not require extreme temperature and pressure and thus very small units are possible. Basically, the starch in grain is converted to sugar by means of enzymes and the sugar is then fermented with yeast to produce a dilute alcohol solution. Distillation is used to separate and purify the alcohol to a maximum of about 190 proofs. If 200 proof is required an additional operation usually distillation with benzene is required. The only load applied to the engine is wheel, chain and other bearing weights in back side. The engine speed is maintained constant and the output speed of the wheel is measured by using tachometer for various gear ratios. At first the experimentation is done for 100% gasoline and then for E10, E20, E25 respectively. Then the output values were measured and tabulated.

Results and Discussion

The performance of the IC engine is tested with pure gasoline and ethanol blends. The degree of success is compared on the basis of specific fuel consumption, Brake mean effective pressure, specific power output, specific weight and Exhaust smoke and other emissions.

The Total Fuel Consumption (TFC) *vs* Break Power (BP) for pure gasoline and ethanol blend E10, E20 and E25 is shown in Fig. 1

From Fig. 1 it is noticed that TFC in Gasoline is little high compared with E Blend. It indicates that the E Blend yields better economy compared to pure gasoline. The Specific Fuel Consumption (SFC) *vs* Break Power (BP) for pure gasoline and ethanol blend E10, E20 and E25 is shown in Fig. 2.

From Fig. 2 it is ensured that the gasoline fuel has high SFC. The E Blends yields better fuel economy in various percentages. If percentage of E Blend increases SFC also increases. BP versus Indicated Power is plotted for gasoline and E Blends, which is shown in Fig. 3.

From Fig. 3 it is noticed that the value of IP is less for E10 Blend and the value increases if the percentage of Blend increases. The indicated thermal efficiency, brake thermal efficiency and mechanical efficiency of gasoline compared with E10 Blend ethanol is shown in Fig. 4.

After comparison of gasoline and the ethanol-gasoline blends as various perspectives the improved performance of ethanol-gasoline blends were obtained from the comparison graphs. From the Fig. 4 it is proved that there is a significant increase in the mechanical efficiency of E10 Blend compared with Gasoline. Figure 5 shows the BP *vs* efficiency of E20 Blends.

In mechanical efficiency point of view E10 only gives the better output. In other efficiencies the ethanol-gasoline blends provide better output compared with gasoline output. BP *vs* various efficiencies for E25 Ethanol is compared and plotted against pure gasoline in Fig. 6.

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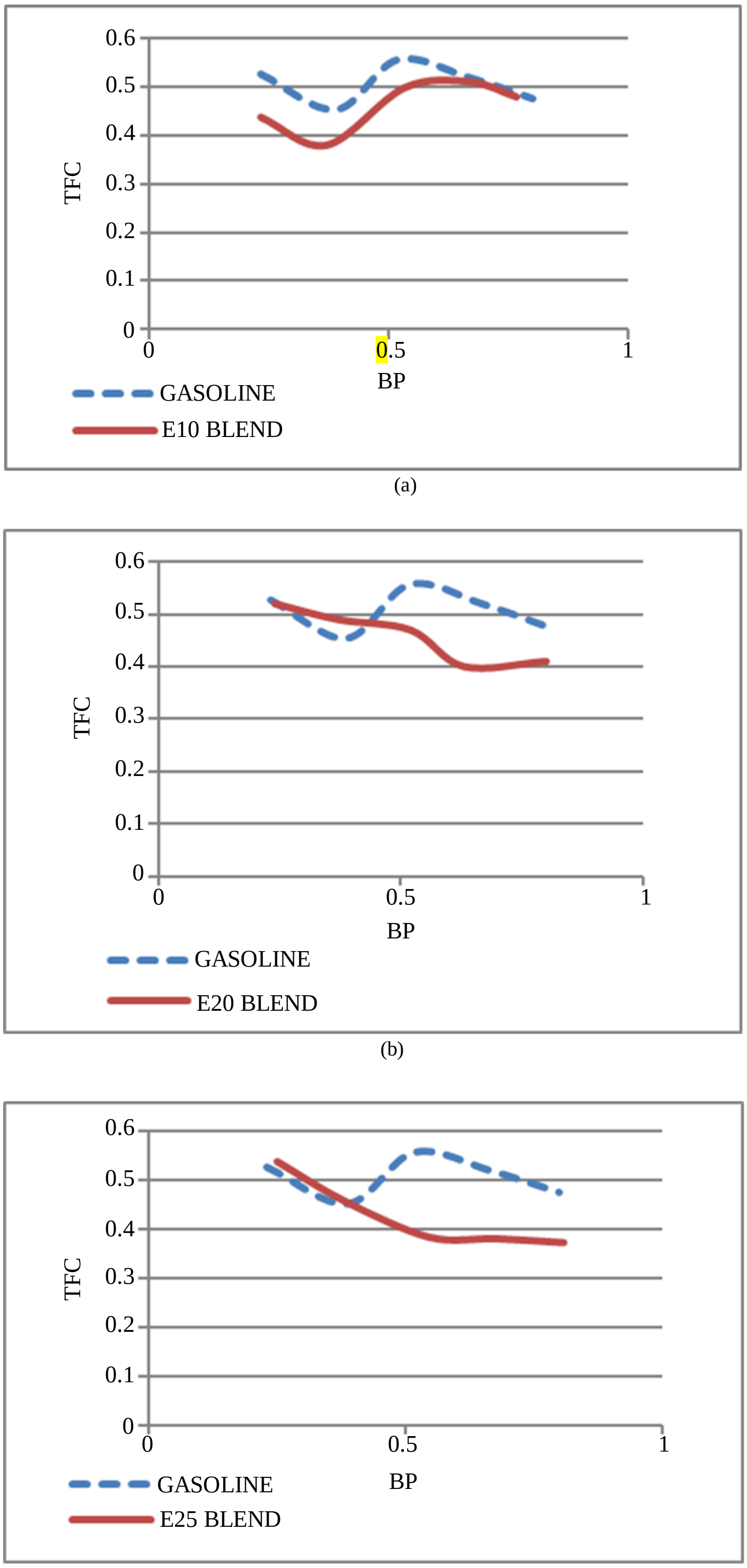

Fig. 1: (a) BP *vs* TFC (Gasoline *vs* E10 blend); (b) BP *vs* TFC (Gasoline *vs* E20 blend); (c) BP *vs* TFC (Gasoline *vs* E25 blend)

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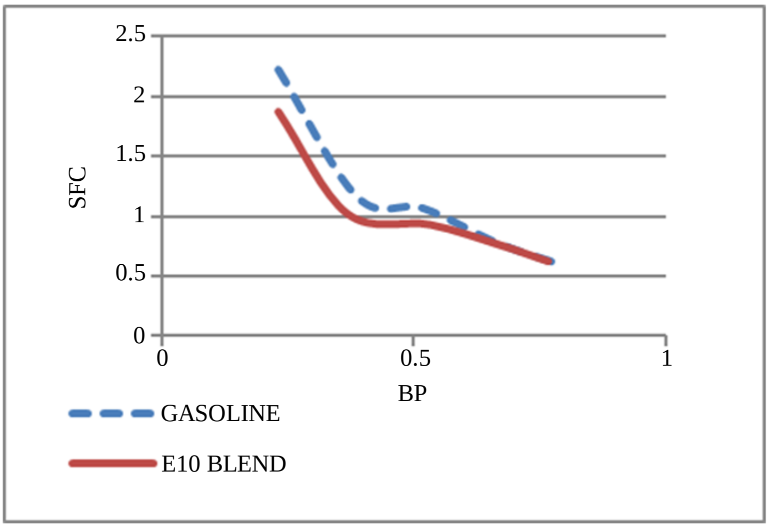

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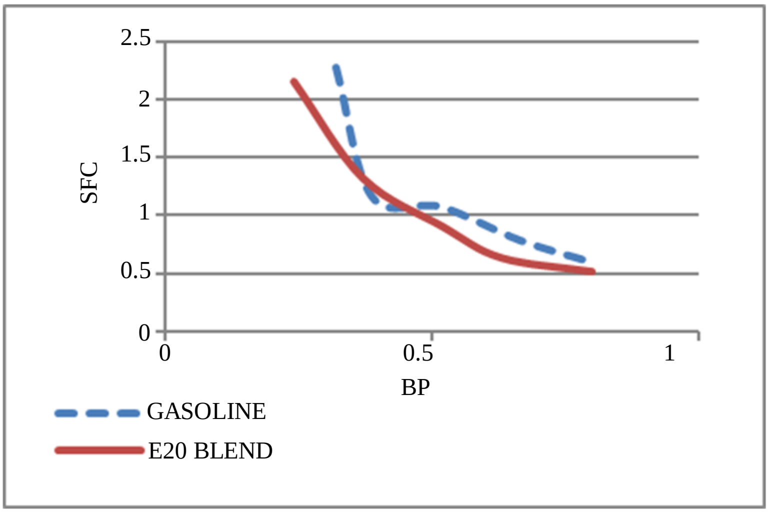

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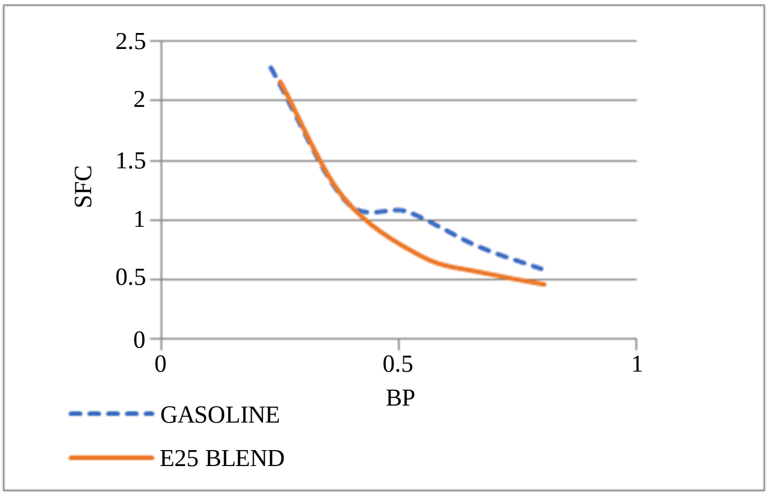

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Fig. 2: (a) BP *vs* SFC (Gasoline *vs* E10 blend); (b) BP *vs* SFC (Gasoline *vs* E20 blend); (c) BP *vs* SFC (gasoline *vs* E25 blend)

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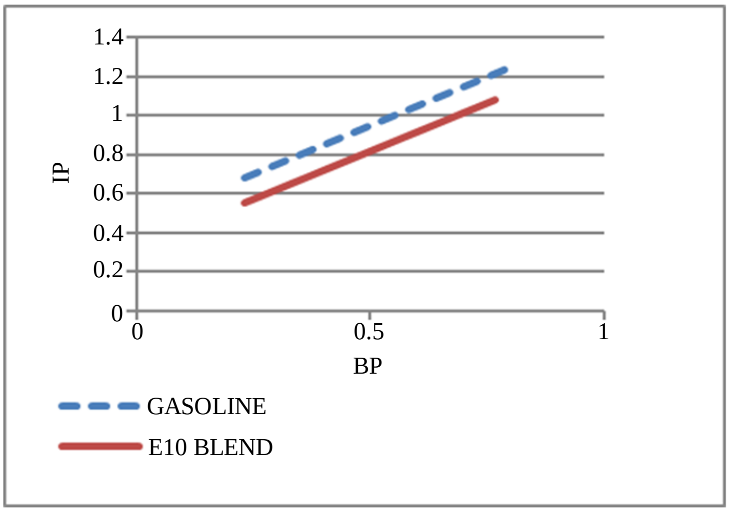

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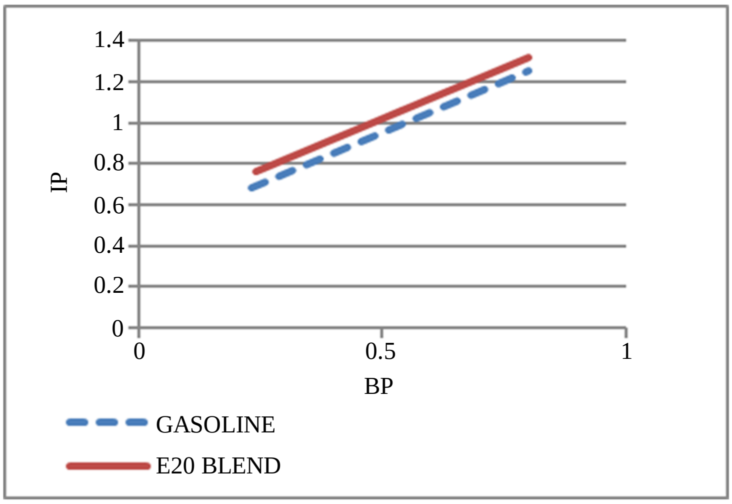

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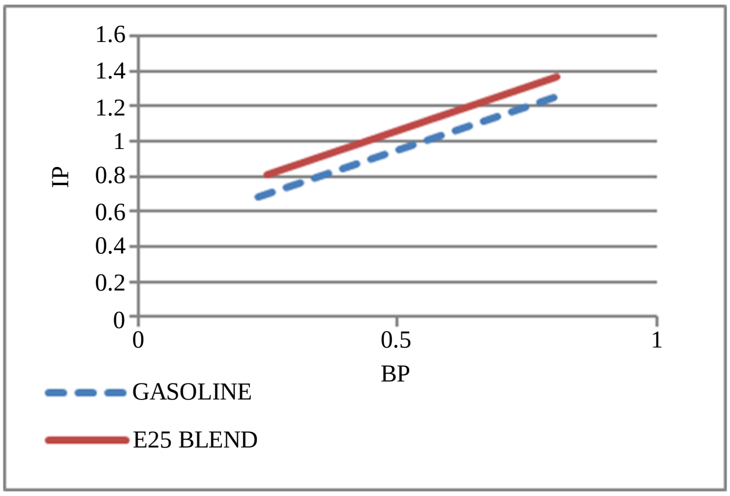

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Fig. 3: (a) BP *vs* IP (Gasoline *vs* E10 blend); (b) BP *vs* IP (Gasoline *vs* E20 blend); (c) BP *vs* IP (Gasoline *vs* E25 blend)

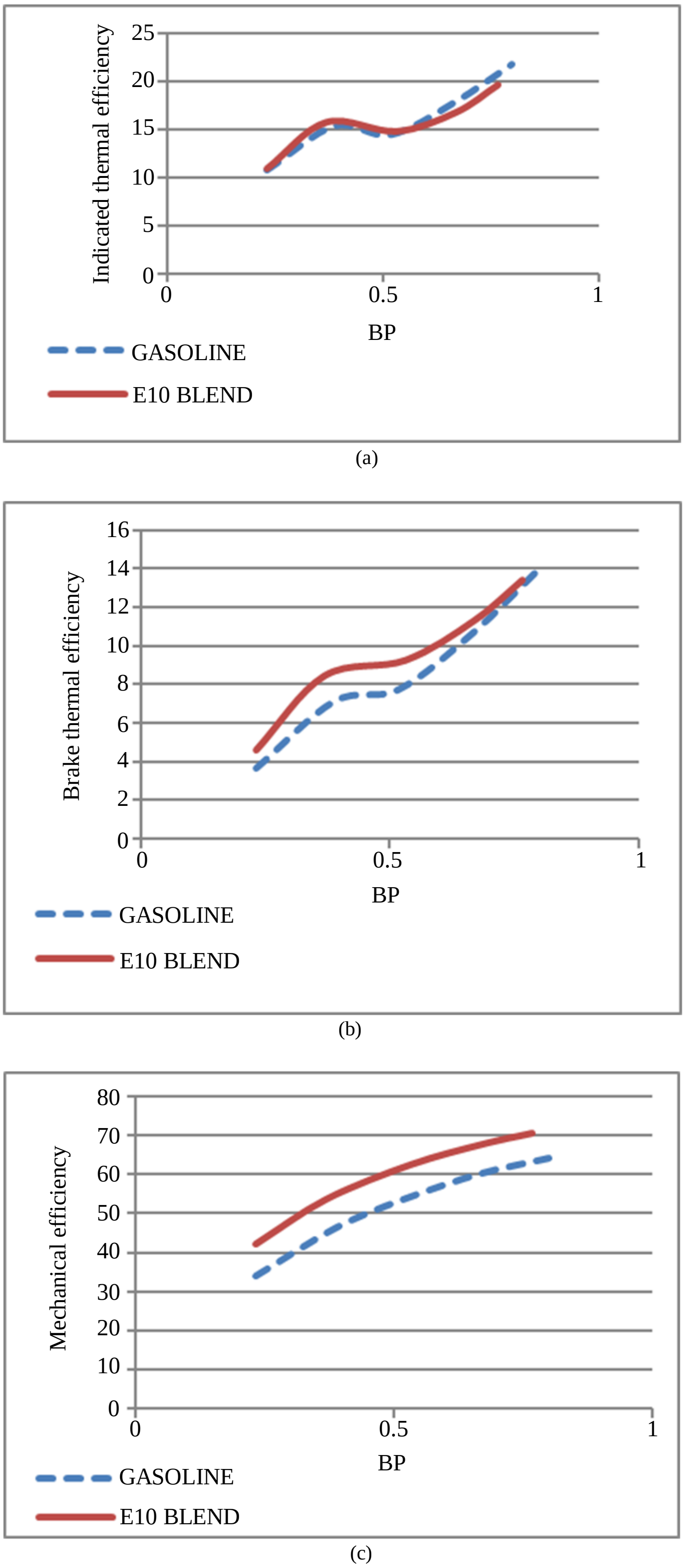

Fig. 4: (a) BP *vs* indicated thermal efficiency (Gasoline *vs* E10 blend); (b) BP *vs* brake thermal efficiency (Gasoline *vs* E10 blend); (c) BP *vs* mechanical efficiency (Gasoline *vs* E10 blend)

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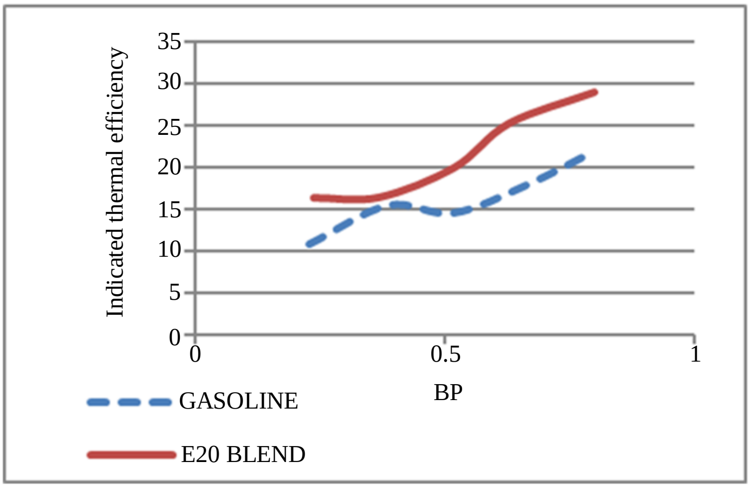

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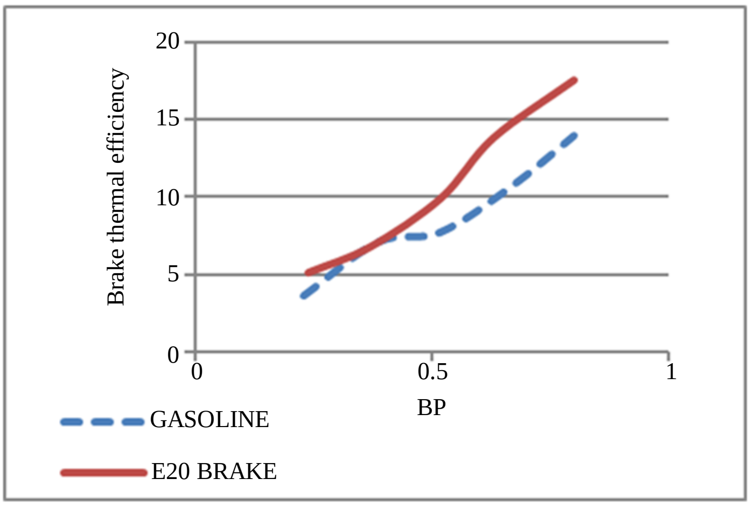

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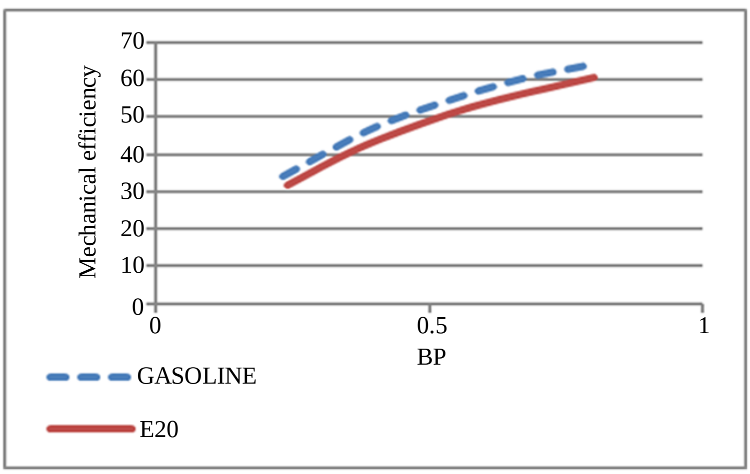

(c)

Fig 5: (a) BP *vs* indicated thermal efficiency (Gasoline *vs* E20 blend); (b) BP *vs* brake thermal efficiency (Gasoline *vs* E20 blend); (c) BP *vs* mechanical efficiency (Gasoline *vs* E20 blend)

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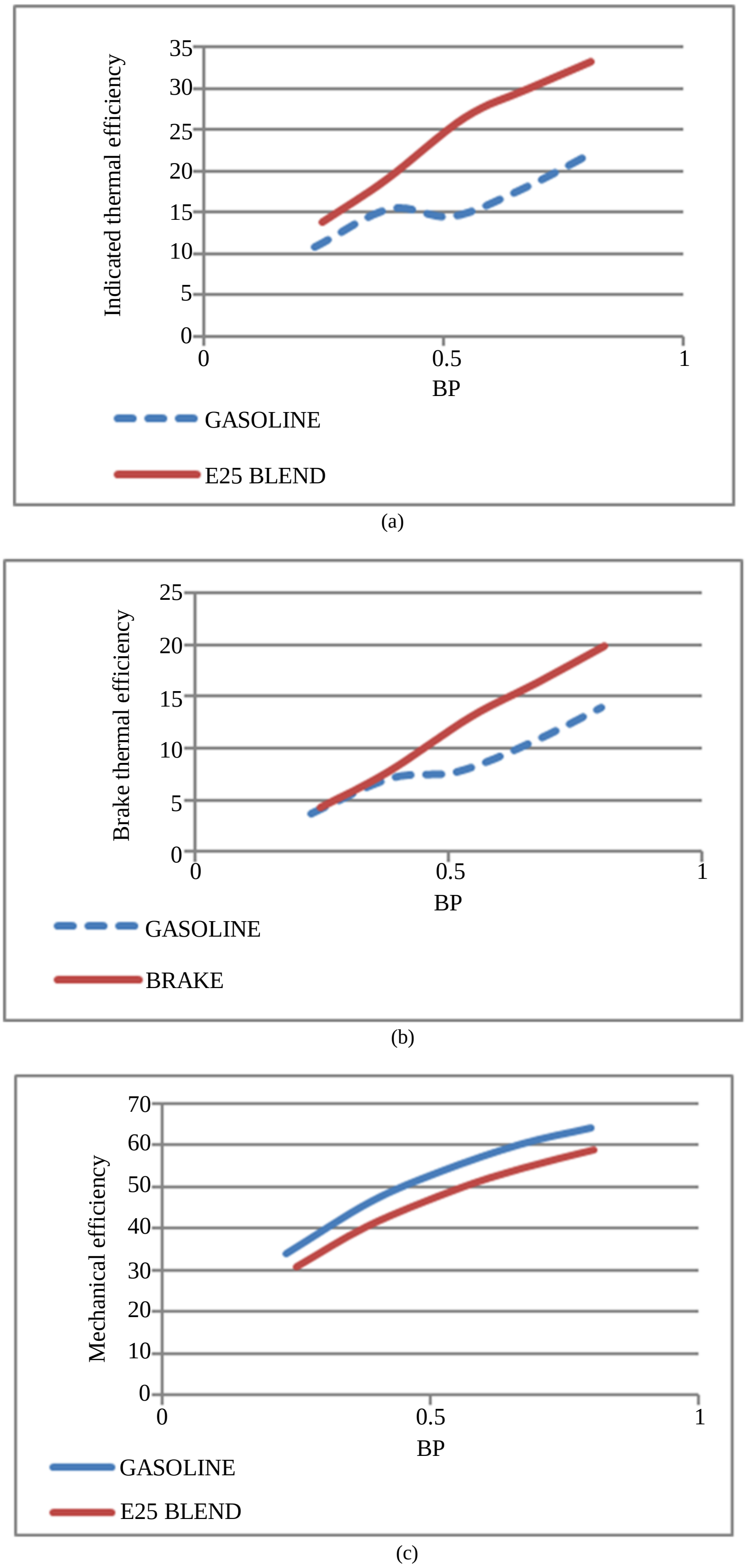

Fig. 6: (a) BP *vs* indicated thermal efficiency (Gasoline *vs* E25 blend); (b) BP *vs* brake thermal efficiency (Gasoline *vs* E25 blend); (c) BP *vs* mechanical efficiency (Gasoline *vs* E25 blend)

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At the final blend E25 the performance of the engine comparatively decreased. The main reason behind that is carburettor. It indicates that further addition of ethanol, will reduce the engine performance severely. It happens because of the over flow problem in carburetor. The modification in carburetor is required for more addition of ethanol and also, the perfect engine modification will give better performance in terms of efficiency.

Conclusion

The objective of the paper is to test whether the ethanol is good alternative fuel for gasoline or not. From this experiment the improved performance is obtained by adding the ethanol with gasoline at certain percentage as ethanol-gasoline blend. Every percentage addition of ethanol with gasoline gives more improved performance. Because the ethanol contains more oxygen content and a high octane number compared with gasoline. Ethanol blends outperforms if the engine is modified as per the requirements. From the analysis it is cleared that the usage of fossil fuels can be limited by the alternate fuel like ethanol. In future ethanol can be blended with other fuels to produce optimum performance.

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Author's Contributions

T. M. Chenthil Jegan: Preparing the Manuscript.
R. Chitra: Designing of the research plan.
Godwin Glivin: Overall supervision and checking.

Ethics

This article is original and contains unpublished works. The corresponding author confirms that all of the other authors have read and approved the manuscript with no ethical issues involved.

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