International Journal of Scientific & Engineering Research Volume 9, Issue 7, July-2018
ISSN 2229-5518

Performance Study on Two Stroke Spark Ignition Engine Using Petrol Blended With Ethanol

Gangadharan Nair[1], Shivaramu H T[2] and Rajeshwari [3]
[1,2, 3] Department of Mechanical Engineering, K. V. G College of Engineering,Sullia, Karnataka State, India.

Abstract: *In this work, various percentages of blends were tested in a typical two -stroke engine for various operating conditions to study the performance of the engine. The study conducted at 4, 8,12,16,20,24,28,32 at rated speed of the engine. As the load increases, brake thermal efficiency, mechanical efficiency and volumetric efficiency increases for all blends of ethanol. As the load increases, SFC decreases for all blends of ethanol. Brake thermal efficiency increases for the selected blends, as compared to petrol. SFC decreases for selected blends, as compared to petrol. It is observed that at the rated load condition, mechanical efficiency is maximum and brake thermal efficiency is maximum an SFC is minimum at around 24% blend . Hence study reveal that the blend has scope. The crude oil demand of the country is met by importing 80 % oil from gulf countries*

Key words: *Ethanol, SI Engine.*

1. INTRODUCTION

Increase in the consumption of fossil fuels as economies grow and the nearing depletion of such fuels lead to search for their alternatives worldwide. Bio fuels have emerged as a substitute for fuel oil. The most important advantage of these fuels is that they are renewable, and are being seen as sustainable sources of energy. Some studies have also pointed out that bio fuels help to reduce environmental emissions, apart from addressing the problem of rising import cost of fuel oil. Among liquid fuels, there are mainly two types of bio fuel: alcohols (ethanol and butane) and diesel substitutes (such as biodiesel and hydro-treated vegetable oils). They can be used either individually as fuels or for blending in petrol or diesel. While biodiesel is mainly manufactured by transesterification of vegetable oil, ethanol is produced from starch contained in crops such as corn and sorghum or through fermentation of sugarcane, molasses, and sugar-beet. In India, ethanol production is mainly done using sugarcane as feedstock. Transport has been identified as a major polluting sector and hence the use of bio fuels is important in view of the tightening of emission norms. It is argued that blending ethanol with petrol or diesel will reduce import dependence on crude oil, saving on foreign exchange outflows to that extent. However, energy security can be addressed only if the supply of ethanol available to industry is adequate.

Lot of work have been done on ethanol blends with petrol or diesel. Various percentages of blends were tested in 2-stroke as well as 4-stroke engines to study the performance of the engine. Present work aims to study the performance of ethanol blended petrol on 2-stroke S.I engine for various operating conditions. Because of the increasing industrialization and modernization of the world, demand of the petroleum product is increasing day by day. In India itself, energy demand is increasing at a rate of 6.5% per annum. The crude oil demand of the country is met by importing 80% oil from gulf countries. As per the data, world fossil fuel reserve may end soon. So to overcome this problem it is necessary to look forward for any other source of energy. Use of gasoline and alcohol fuels blend as an alternative fuel in gasoline engine is becoming a need. Considering the energy crises and pollution problems today, investigations have concentrated on decreasing fuel consumption by using alternative fuels and on lowering the concentration of toxic compon nts in combustion products. Ethanol is a likely alternative automotive fuel. It has properties that would allow its use in present S.I engines with minor modifications. As a fuel for spark-ignition engines, ethanol has some advantages over gasoline, such as better anti-knock characteristics

2. PROBLEM IDENTIFICATION

Government around the world has set forth many regulatory laws to control the emissions. One of the serious problems facing the modern technological society is the drastic increase in environmental pollution by internal combustion engines (IC engines). All transport vehicles with SI and CI engines are equally responsible for the emitting different kinds of pollutants. Some of these are primary kinds having direct hazardous effect such as carbon monoxide, hydrocarbons, nitrogen oxides etc, while others are secondary pollutants such as ozone, etc., which undergo a series of reactions in the atmosphere and become hazardous to health [3]. The emissions exhausted into the surroundings pollute the atmosphere and cause global warming, acid rain, smog, odours, and respiratory and other health hazards. The urgent need for alternative fuel is essential to replace the supplement conventional fuels. Oxygenated fuel technology is mature, in which promoting alcohol as the fuel is focused recently. Use of gasoline and alcohol fuels blend as an alternative fuel in gasoline engine is becoming a need. Considering the energy crises and pollution problems today, investigations have concentrated on decreasing fuel consumption by using alternative fuels and on lowering the concentration of toxic components in combustion products. Ethanol is a likely alternative automotive fuel. There were lot of attempts done to study the performance characteristics of ethanol-petrol blends at various operating conditions, leading to various results and conclusions.

3. OBJECTIVES

The objective of the present work is to study the performance variation with various percentages of ethanol blends at various loads on: Brake thermal efficiency, volumetric efficiency, Mechanical efficiency and Specific fuel consumption. To identify the optimum percentage of ethanol blends for the best performance of engine. To study the effect of using ethanol blends in S.I engine operation.

4. FEATURES OF ETHANOL-PETROL BLENDS

It can be realized from the literature that ethanol-petrol blends can effectively reduce the pollutant emissions, compared to the neat petrol.

The stoichiometric A/F ratio for pure petrol is about 14.8 and those for the blended fuels are lower. When blended fuels are applied, the engine fuel system will supply similar fuel quantity as in petrol condition. This ultimately makes the A/F mixture of the ethanol–petrol blended fuel being leaner, in addition to the leaning effect due to their nature oxygen contents. However, as petrol content increases in the blends, the fuel needs larger time to be burnt and, in turn, more emissions are introduced. The Power and fuel economical efficiency of the engine is enhanced when it is supplied with the mixture of ethanol and gasoline.

The higher boiling point of petrol fuel may also be given a precious reason for its higher CO and UHC emissions, compared to ethanol–petrol blends; the boiling points, ethanol and gasoline are respectively, 78 and 38 – 204 °C. Because a high boiling point causes that the fuel may comprise fractions or components that may not be completely vaporized and burnt, thereby increasing CO and UHC emissions. This may refer to that ethanol has single boiling point, due to having one type of hydrocarbon, however, unlike for the gasoline fuel.

Property	Gasoline	Ethanol	10% ethanol gasoline blend	20% ethanol gasoline blend
Specific gravity @ 15 °C	0.72-0.75	0.79	0.73-0.76	0.735-0.765
Heating value (MJ/kg) (BTU/lb)	43.5 18,700	27.0 11,600	41.9 18,000	40.0 17200
Heating value (MJ/lt) (BTU/gal)	32.0 117,000	21.3 76,000	30.9 112,900	29.9 109,000
Approx. Reid vapour pressure @ 37.8 °C (Kpa)	59.5	17	64	63.4
Stoichiometric Air/fuel ratio	14.6	9	14	13.5
Oxygen content (% by weight)	0.00	35	3.5	7.0

Table4.1: Properties of gasoline, ethanol, and mixtures of 10% and 20% (by volume)

5. EXPERIMENTAL SET UP

The main systems of experimental setup are the following: Engine Control panel DC generator Bulb loading panel

The specification of engine and other details of setup are given below:

Engine: Bajaj Chetak
Power: 1.864 kW (2.5 HP)
Rpm: 2800 rpm

Fig. 5.1 Bajaj Chetak engine

4. RESULT AND DISCUSSIONS

Fig 4.1 shows the variations of efficiencies (η_v, η_{mech}, &η_{bth}) with load at 900 rpm

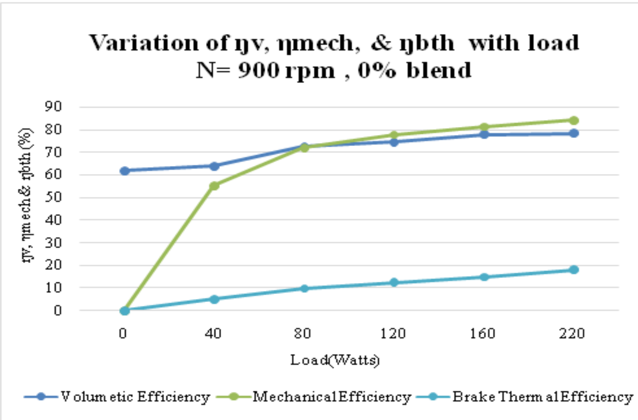

Fig 4.1 Efficiencies (η_v, η_{mech}, &η_{bth}) v/s load

The above graph shows that volumetric efficiency of engine increases with the increase in load on engine from 61.8% at no load to 78.5% at maximum load, i.e 220W. Mechanical efficiency increases with increase in load on engine from 0% at no load to 84.22% at full load. Similarly the brake thermal efficiency also increases with load on engine from 0% at no load to 18.02% at full load

Fig 4.2 shows the Variation of SFC with load at 900 rpm

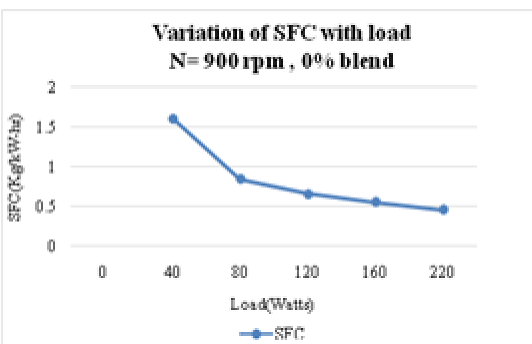

Fig 4.2 SFC v/s load

From the above graph the specific fuel consumption decreases from 1.609 kg/kW-hr at 40 Watts to 0.846 kg/kW-hr at 80 Watts suddenly, but as the load increases further the specific fuel consumption decreases gradually from 0.846 kg/kW-hr at 80 Watts to 0.458 kg/kW-hr at

Fig 4.3shows the variations of efficiencies (η_v, η_{mech}, &η_{bth}) with load at 900 rpm, in 4% blend.

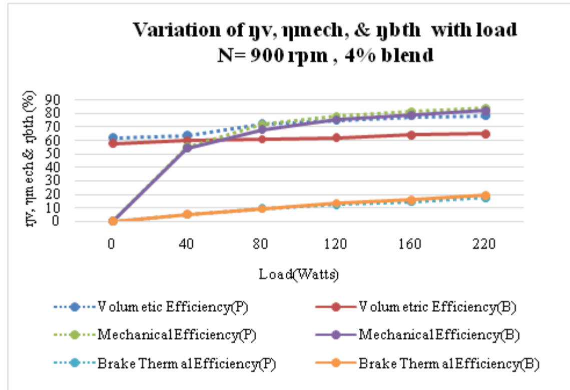

Fig4.3 Efficiencies (η_v, η_{mech}, &η_{bth}) v/s load

The above graph shows the comparison of efficiencies between petrol and petrol blended ethanol (E4%). As compared to petrol the volumetric efficiency of the blend has reduced by 4% at no load to 13.5% at full load. Mechanical efficiency initially remains zero at no load and increases as the load increases to 82.24%, but when compared to petrol as the load on engine increases mechanical efficiency gets reduced slightly throughout all the loads. Brake thermal efficiency initially remains zero at no load, but gradually goes on increasing as the load on engine increases compared to that of petrol by 1.58% at full load.

Fig 4.4 shows the Variation of SFC with load at 900 rpm, in 4% blend.

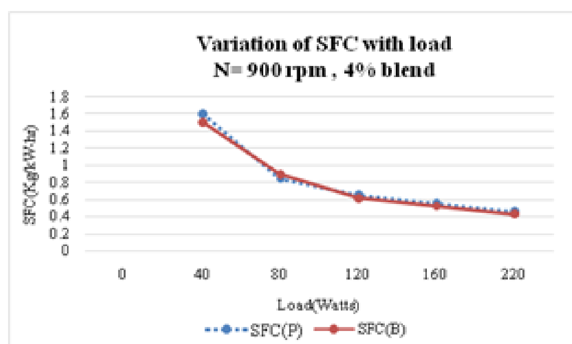

Fig 4.4 SFC v/s load

The above graph shows the comparison of specific fuel consumption between the petrol and blend (E4%). The rate of specific fuel consumption as compared to petrol has reduced by 0.099kg/kW-hr to 0.03 kg/kW-hr from 40W to full loadi.e 220W respectively.

Fig 4.5shows the variations of efficiencies (η_v, η_{mech}, &η_{bth}) with load at 900 rpm, in 8% blend.

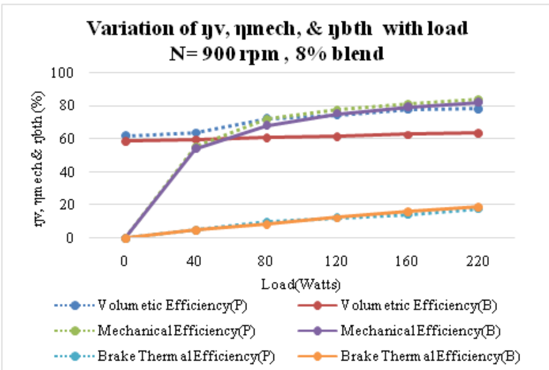

Fig 4.5Efficiencies (η_v, η_{mech}, &η_{bth}) v/s load

The above graph shows the comparison of different efficiencies between petrol and petrol blended ethanol (E8%). As compared to petrol the volumetric efficiency of the blend has reduced by 3% at no load to 14.5% at full load. Mechanical efficiency initially remains zero at no load and increases as the load increases to 82.24%, but when compared to petrol as the load on engine increases mechanical efficiency gets reduced slightly throughout all the loads. Brake thermal efficiency initially remains zero at no load, but gradually increases as the load on engine increases compared to that of petrol by 1.05% at full load.

Fig 4.6 shows the Variation of SFC with load at 900 rpm, in 8% blend.

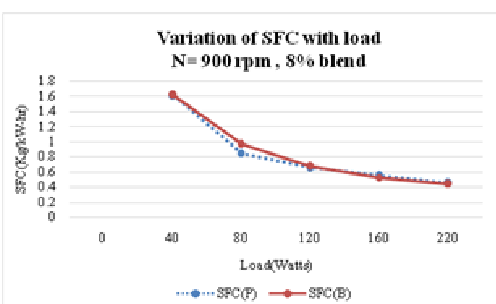

Fig4.6 SFC v/s load

The above graph shows the comparison of specific fuel consumptionbetween petrol and blend (E8%). The specific fuel consumptionhas increased initially by 0.013kg/kW-hr at 40W and increases by 0.121 kg/kW-hr at 80W as compared to that of petrol, butas the load increases it getsreduced by 0.013kg/kW-hrat full

Fig 4.7shows the variations of efficiencies (η_v, η_{mech}, &η_{bth}) with load at 900 rpm, in 12% blend.

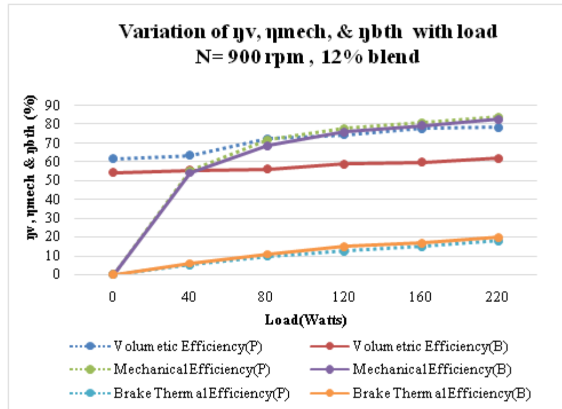

Fig 4.7Efficiencies (η_v, η_{mech}, &η_{bth}) v/s load

The above graph shows the comparison between petrol and petrol blended ethanol (E12%). As compared to petrol the volumetric efficiency of the blend has reduced by 7.31% at no load to 16.6% at full load. Mechanical efficiency initially remains zero at no load and increases as the load increases to 82.9%, but when compared to petrol as the load on engine increases mechanical efficiency gets reduced slightly throughout all the loads. Brake thermal efficiency initially remains zero at no load, but gradually increases as the load on engine increases compared to that of petrol by 1.71% at full load.

Fig 4.8 shows the Variation of SFC with load at 900 rpm, in 12% blend.

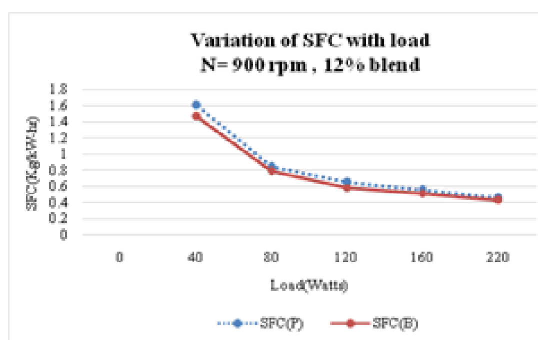

Fig 4.8 SFC v/s load

The above graph shows the comparison of specific fuel consumption between petrol and blend (E12%). The specific fuel consumption as compared to petrol has reduced by 0.137kg/kW-hr to 0.024kg/kW-hr from 40W to full load respectively.

Fig 4.9shows the variations of efficiencies (η_v, η_{mech}, &η_{bth}) with load at 900 rpm, in 16% blend.

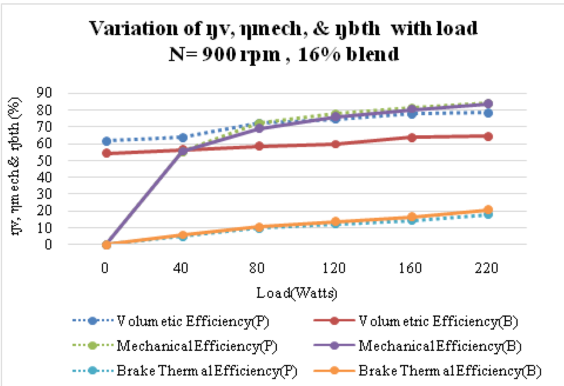

Fig 4.9Efficiencies (η_v, η_{mech}, &η_{bth}) v/s load

The above graph shows the comparison between petrol and petrol blended ethanol (E16%). As compared to petrol the volumetric efficiency of the blend has reduced by 7.31% at no load to 13.64% at full load. Mechanical efficiency initially remains zero at no load and increases as the load increases to 83.8%, but when compared to petrol as the load on engine increases mechanical efficiency gets reduced slightly throughout all the loads. Brake thermal efficiency initially remains zero at no load, but gradually increases as the load on engine increases compared to that of petrol by 2.88% at full load.

Fig 4.10 shows the Variation of SFC with load at 900 rpm, in 16% blend.

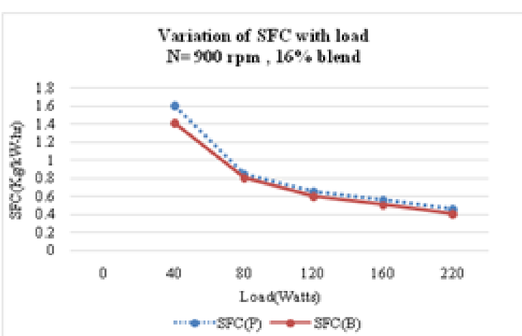

Fig 4.10 SFC v/s load

The above graph shows the comparison of specific fuel consumption between petrol and blend (E16%). The specific fuel consumption as compared has reduced by 0.194 kg/kW-hr to 0.05 kg/kW-hr from 40W to full load respectively.

Fig 4.11shows the variations of efficiencies (η_v, η_{mech}, &η_{bth}) with load at 900 rpm, in 20% blend.

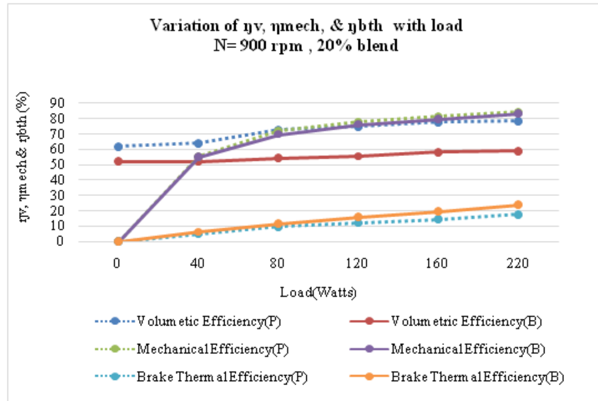

Fig 4.11Efficiencies (η_v, η_{mech}, &η_{bth}) v/s load

The above graph shows the comparison between petrol and petrol blended ethanol (E20%). As compared to petrol the volumetric efficiency of the blend has reduced by 9.6% at no load to 19.6% at full load. Mechanical efficiency initially remains zero at no load and increases as the load increases to 83.34%, but when compared to petrol as the load on engine increases mechanical efficiency gets reduced slightly throughout all the loads. Brake thermal efficiency initially remains zero at no load, but gradually increases as the load on engine increases compared to that of petrol by 5.92% at full load.

Fig 4.12 shows the Variation of SFC with load at 900 rpm, in 20% blend.

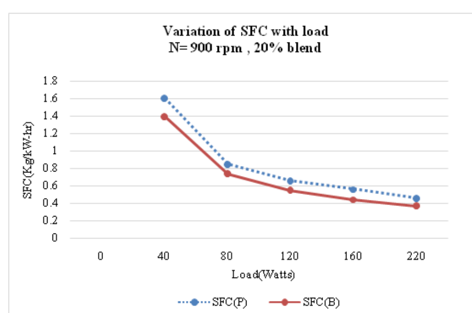

Fig 4.12 SFC v/s load

The above graph shows the comparison between the rate of specific fuel consumption of petrol and blend (E20%). The specific fuel consumption as compared has reduced by 0.215kg/kW-hr to 0.092kg/kW-hr from 40W to full load respectively.

Fig 4.13shows the variations of efficiencies (η_v, η_{mech}, &η_{bth}) with load at 900 rpm, in 24% blend.

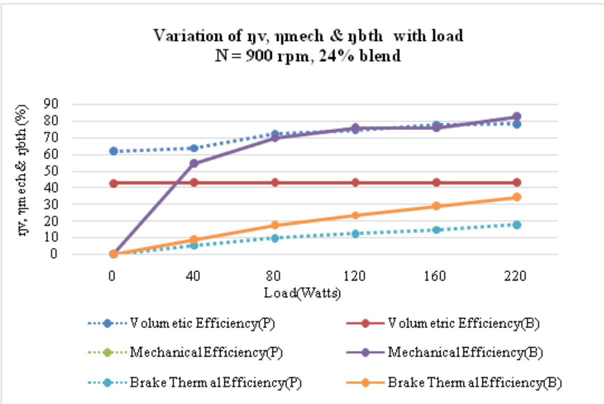

Fig 4.13Efficiencies (η_v, η_{mech}, &η_{bth}) v/s load

The above graph shows the comparison between petrol and petrol blended ethanol (E24%). As compared to petrol the volumetric efficiency of the blend has reduced by 19.1% at no load to 35.4% at full load. Mechanical efficiency initially remains zero at no load and increases as the load increases to 82.7%, but when compared to petrol as the load on engine increases mechanical efficiency gets reduced slightly throughout all the loads. Brake thermal efficiency initially remains zero at no load, but increases suddenly as the load on engine increases compared to that of petrol by 16.24% at full load.

Fig 4.14 shows the Variation of SFC with load at 900 rpm, in 24% blend.

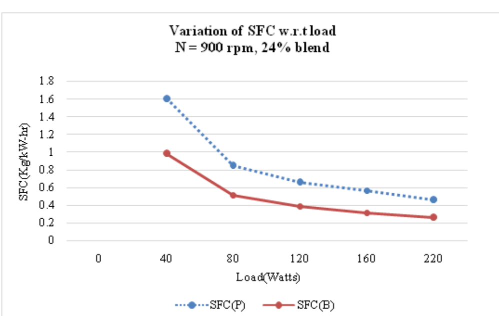

Fig 4.14 SFC v/s load

The above graph shows the comparison of specific fuel consumption between petrol and blend (E24%). The specific fuel consumption as compared has reduced by 0.624kg/kW-hr to 0.198kg/kW-hr from 40W to full load respectively. This graph shows that E24% has the best rate of specific fuel consumption compared to any other blends.

Fig 4.15shows the variations of efficiencies (η_v, η_{mech}, &η_{bth}) with load at 900 rpm, in 28% blend.

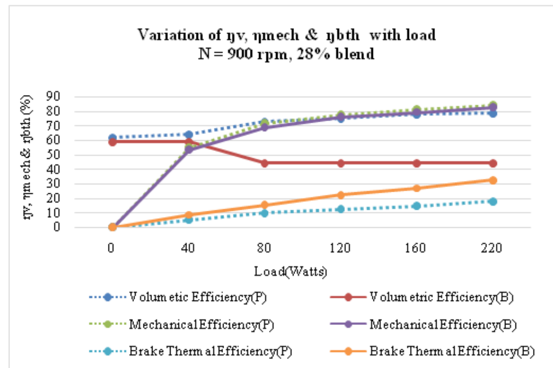

Fig 4.15Efficiencies (η_v, η_{mech}, &η_{bth}) v/s load

The above graph shows the comparison between petrol and petrol blended ethanol (E28%). As compared to petrol the volumetric efficiency of the blend has reduced by 2.9% at no load to 34.2% at full load. Mechanical efficiency initially remains zero at no load and increases as the load increases to 82.8%, but when compared to petrol as the load on engine increases mechanical efficiency gets reduced slightly throughout all the loads. Brake thermal efficiency initially remains zero at no load, but increases as the load on engine increases compared to that of petrol by 14.79% at full load.

Fig 4.16 shows the Variation of SFC with load at 900 rpm, in 28% blend.

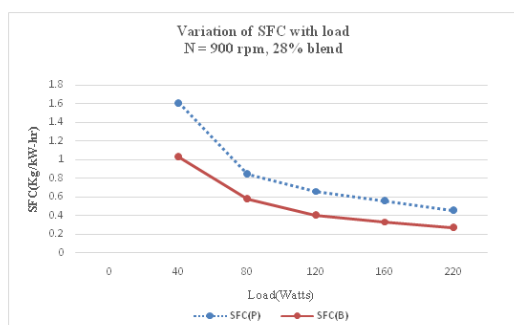

Fig 4.16 SFC v/s load

The above graph shows the comparison between the rate of specific fuel consumption of petrol and blend (E28%). The specific fuel consumption as compared has reduced by 0.577kg/kW-hr to 0.183 kg/kW-hr from 40W to full load respectively.

Fig 4.17shows the variations of efficiencies (η_v, η_{mech}, &η_{bth}) with load at 900 rpm, in 32% blend.

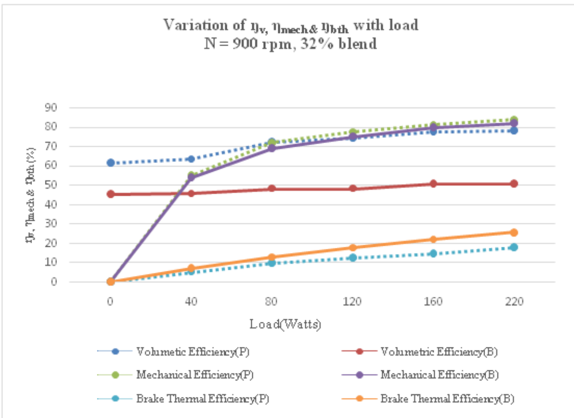

Fig 4.17Efficiencies (η_v, η_{mech}, &η_{bth}) v/s load

The above graph shows the comparison between petrol and petrol blended ethanol (E32%). As compared to petrol the volumetric efficiency of the blend has reduced by 16.3% at no load to 27.5% at full load. Mechanical efficiency initially remains zero at no load and increases as the load increases to 82.2%, but when compared to petrol as the load on engine increases mechanical efficiency gets reduced slightly throughout all the loads. Brake thermal efficiency initially remains zero at no load, but increases as the load on engine increases compared to that of petrol by 7.79% at full load.

Fig 4.18 shows the Variation of SFC with load at 900 rpm, in 32% blend.

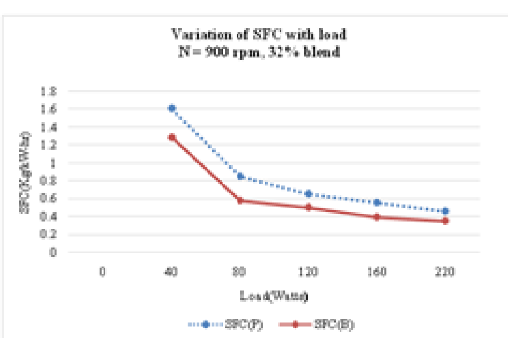

Fig 4.18 SFC v/s load

The above graph shows the comparison between the rate of specific fuel consumption of petrol and blend (E32%). The specific fuel consumption as compared has reduced by 0.318kg/kW-hr to 0.103kg/kW-hr from 40W to full load respectively.

The following are the consolidated graphs as given in fig 4.19, 4.20, and 4.21 respectively, for η_v, η_{mech} &$\eta_{bth}$for various loads at various ethanol blends.

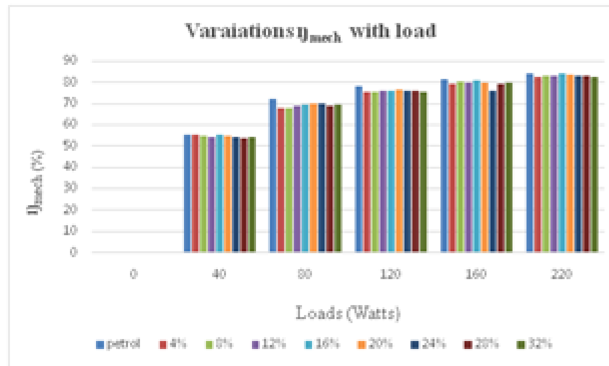

Fig 4.19 variation of $\eta_{mech}$with load for various blends

The fig 6.19 shows comparison of mechanical efficiency among different blends of ethanol and petrol at various loads. The bar graph shows that mechanical efficiency is higher for petrol at all loads, but comparing among all the different blends E16% has better mechanical efficiency.

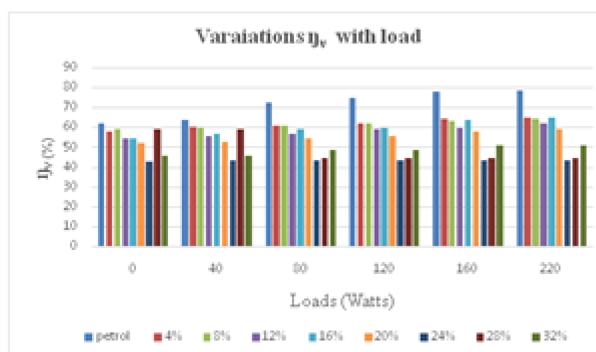

Fig 4.20 variation of η_v with load for various blends

The fig 6.20 shows comparison of volumetric efficiency among different blends of ethanol and petrol at various loads. The graph shows that volumetric efficiency of engine increases as load increases in petrol. Both in blends E4% and E8% the volumetric efficiency decreases as compared to petrol, but compared to all other blend percentages has better volumetric efficiency. After E20% the volumetric efficiency of the engine gets reduced significantly. The volumetric efficiency at E24% has remained constant for all loads. Blends E28% and E32% are not providing better volumetric efficiency as compared to E4% and E8%.

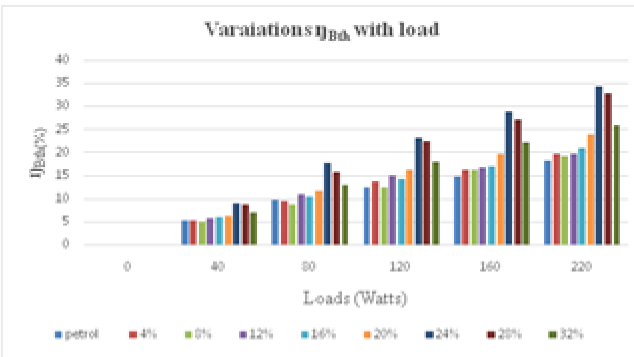

Fig 6.21 variation of $\eta_{Bth}$with load for various blends

The above bar graph shows the comparison of η_{Bth}among different blends of ethanol and petrol at various loads. As seen from the graph above E24% has better brake thermal efficiency compared to all other blends as well as petrol.

Fig 6.22 shows the variation of $\eta_{v,}$ η_{mech} &$\eta_{bth}$with various percentage of ethanol blends at rated load conditions.

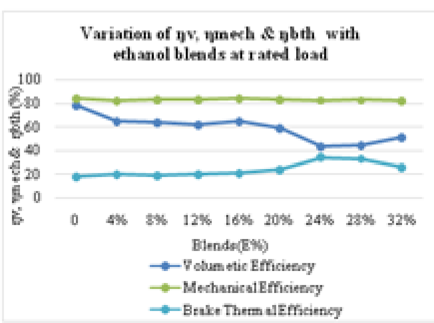

Fig 6.22 variation ofη_v, η_{mech} &$\eta_{bth}$with ethanol blends at rated load

The above graph shows that the best blend for obtaining the better brake thermal efficiency is E24%. E4% and E8% provides better volumetric efficiency compared to other blends. E16% gives better mechanical efficiency compared to other blends.

Fig 4.23 shows the variation of SFCwith various percentage of ethanol blends at rated load conditions.

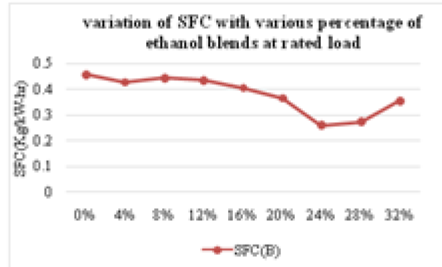

Fig 4.23 variation of SFC with ethanol blends at rated load

By observing the above graph E24% has the least SFC value as compared to other blends, but once the blend percentage crosses E24% the SFC value again starts to increase gradually.

5. CONCLUSIONS

As the load increases, brake thermal efficiency and mechanical efficiency increases at 4%, 8%, 12%, 16%, 20%, 24%, 28%, and 32% of ethanol blends. As the load increases, volumetric efficiency slightly increases at 4%, 8%, 12%, 16%, 20%, 24%, 28%, and 32%, of ethanol blends. As the load increases, SFC decreases at 4%, 8%, 12%, 16%, 20%, 24%, 28%, and 32%, of ethanol blends. Brake thermal efficiency increases for the selected blends, as compared to petrol. Mechanical efficiency does not show much increment for the selected blends, as compared to petrol. In this work, volumetric efficiency decreases for the selected blends, as compared to petrol. SFC decreases for selected blends, as compared to petrol. At the rated load condition, volumetric efficiency is maximum (65%) at 4% blend. At the rated load condition, mechanical efficiency is maximum (83%) at 16% blend. At the rated load condition, brake thermal efficiency is maximum (34.6%) at 24% blend. At the rated load condition SFC is minimum (0.26 kg/kW-hr) at 24% blend. The overall effect on the engine with various blends is negligible.

6. SCOPE OF FUTURE WORK

Performance study of the engine at overloaded conditions and exhaust emission study at various load conditions.

REFERENCES

1. YAO Li-hong, GAO Yan, LI Wen-bin, Wu Jiang School of Technology, Beijing Forestry University, Beijing, 100083, China(2010).
2. R. Jensrakoo, S. Wongsa, D. Koolpiruck, Y. Laoonual Department of Mechanical Engineering King Mongkut's University of Technology Thonburi,Bangkok,Thailand 10140(2014).
3. Chandrakant B. Kothari Ph. D. Research Scholar, Mech. Agnihotri School of Technology Wada, Maharashtra, India. Dr.SuhasKongre, Head of Mech. Engineering Department. A. S. Polytechnic Wada, Maharashtra, India. Dr. D. V. Bhope Professor in Department of Mechanical Engineering. R. G. College of Engineering, Research & Technology Chandrapur, Maharashtra, India (2016).
4. D.Balaji, Anna University- Coimbatore, J.Venkatesan Department of Mechanical Engineering, Sri Venkateswara College Engineering, Dr.P.Govindarajan, Sona College of technology(2010).
5. Kyung-hoAhn, Anna G. Stefanopoulou, Fellow, IEEE, and MrdjanJankovic, Fellow (2010).
6. B.V. Lande Research Scholar, Mechanical Engg. Deptt., BDCOE, Sewagram (India), Dr.SuhasKongre Head of Mechanical Engg. Deptt. A. S. Polytechnic, Wardha. (India)(2016).
7. V. S. Kumbhar, D. G. Mali, P. H. Pandhare& R. M. Mane(2013).
8. FilkertYüksel and BedriYüksel on "The use of ethanol–gasoline blend as a fuel in an SI engine".
9. Mustafa Koç, YakupSekmen, TolgaTopgül, HüseyinSerdarYücesu, on "The effects of ethanol unleaded gasoline blends on engine performance and exhaust emissions in a spark-ignition engine".
10. M. Al-Hasan, in his study on "The effects of ethanol– unleaded gasoline blends on engine performance and exhaust emissions in a spark-ignition engine".
11. M.A. Ceviz and F. Yüksel, in their study on "Effects of ethanol–unleaded gasoline blends on cyclic variability and emissions in an SI engine".