International Journal of Enhanced Research in Science, Technology & Engineering
ISSN: 2319-7463, Vol. 12 Issue 4, April-2023, Impact Factor: 7.957

The Effect of Pine Oil As an Emulsifier on Gasoline-Alcohol Blends in Multipoint Fuel Injection Si Engine

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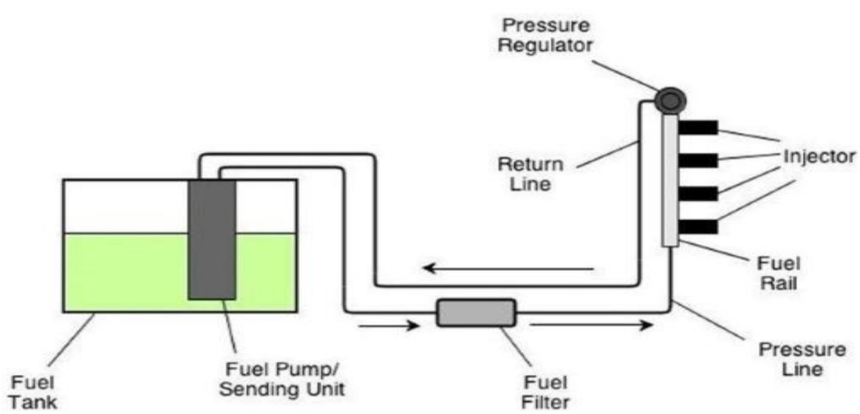
ABSTRACT

In this paper Alcohols such as ethanol, is opropanol are used due to its characteristics to use in the blends of gasoline. Usage of alcohol as fuel for SI engine has some advantages when compared with gasoline. Ethanol and isopropanol have better anti knocking characteristics than gasoline. Alcohol burns with lower flame temperature decreases the peak temperature inside the cylinder. So that NOx emission and heat loss are lower. This paper presents study of the investigations on the effect of emulsifier on gasoline-alcohol blends in a twin cylinder multi-point fuel injection (MPFI) SI engine. The experimental study reveal that use of gasoline- alcohol blends with pine oil in SI engine, brake thermal efficiency(BTE) and nitrogen oxides (NO_x) emissions increased while carbon monoxide(CO) and hydrocarbons(HC) emissions decreased. Also found that specific fuel consumption decreased.

INTRODUCTION

The main drawback of carburetor is the improper mixing of air fuel ratio, which leads to incomplete combustion which results in the increase of emission from exhaust. To overcome this situation the multi-point fuel injection system is used for proper proportion of air fuel mixture to the engine by electrically injecting fuel in accordance to different driving situations. The alternative fuel which is used as substitute of petroleum must be produced from renewable sources. The alcohol gives answer to the problem. Ethanol, methanol, propanol, are the fuels which are suitable for SI engine.



(MPFI)

Fig :1 Multi point fuel injection

Fig 1. shows multi point fuel injection system. It is a system which injects the fuel in the cylinder individually based on the command from electronic control unit. It results in not only in higher out put but also quick response in throttling process.

MAJOR COMPONENTS OF MPFI SYSTEM:

1.Fuel delivery system
2.Air intake
3.Electronic control unit (ECU)
4.Emissions control system

ALCOHALS BLENDED GASOLINE FOR S.I ENGINE:

The exhaust emissions which comes out of exhaust pipe after expansion stroke is depend on air /fuel ratio, drying condition and also the content of oxygen in additives. To reduce the CO, NOx, HC emissions the gasoline must be blended with fuel containing oxygenates. Methyl tertiary- butyl ether (MTBE) is one the fuel which contains oxygenates,

LITERATURE REVIEW

1. Elfaskhany [1] on conducting investigation on acetone gasoline blend have founded that addition of acetone can reduce the CO2,CO and HC emissions.
2. Topgul [2] have tested on methyl butyl ester -gasoline blend and founded that CO emissions are reduced while NO emissions are increased. Though there is a lot of information regarding alternative fuel such as alcohol group, methyl group, ethyl group but very less research paper are available on IPA.
3. M. al Hassan [3] conducted experiment on the effect of unleaded gasoline ethanol on spark ignition engine and exhaust emissions and performance were tested. The result shows that unleaded gasoline ethanol blend increases the torque, thermal efficiency and brake power and decreases in BSFC and air fuel ratio.
4. NR Silva et.al [4] experimented cold start derivability characteristic of methyl -t- butyl ether blend fuel vehicle. In this investigation different conc of (MTBE) of ethanol were tested. The result shows that satisfactory in derivability characteristic for tested condition, the researcher emphasized that the cold start problem for decreased by utilizing MTBE ethanol blend.
5. Wei-dong et.al [5] conducted experiment on engine performance and pollutant emissions of an spark ignition engine using ethanol blended fuel. Result shows that NO_x emission depend on operating conditions of engine rather than ethanol content.
6. Bang-Quan he.et.al [6] investigated the effect of ethanol blended gasoline fuel on catalyst conversion efficiencies and emissions were investigated. It is found that 30% ethanol by volume can drastically reduced total hydro carbons (THC) at operating conditions tail pipe emissions have close relation between THC, CO, NO_x more over blended fuel can decrease BSFC.
7. Fikret yquskel.et.al [7] investigated the use of ethanol gasoline as fuel and have founded that HC, CO emissions would be reduced approximately by 80% to 50% respectively.
8. Agarwal et al. [8] conducted experiment on methanol gasoline blend on multi cylinder spark ignition engine and he founded that the use of methanol as a substitute in gasoline blend, results in improvement of BTE,NO, CO and slight irregularities in hydrocarbon.
9. Scifter et al. [9] investigated for constant mass fuel rate using ethanol gasoline blend and revealed that decrease in hydrocarbon and carbon monoxide but increase in Nitrous oxide.
10. Keskin et al. [10] after conducting experiment at load condition and concluded that with increase in iso propanol (IPA) blends hydrocarbon , carbon monoxide ,carbon dioxide are decreased and NO emissions are increased. It is founded that alcohol is also suitable for diesel proved by [9-13].when they conducted investigation on isobutonol, n- pentanol, n-hexanol as a substitute diesel blend in C.I engine.

MATERIALS AND METHODS

In this investigation, the effect of pine oil as an emulsifier on gasoline alcohol blends in MPFI SI engine is studied. The alcohols used in this experiment are Ethanol(E) and Isopropanol (IPA). Pine oil, which is extracted from pine tree leaves by water distillation process or home-made process is considered. The emulsifier is added to the fuel to improve the operation of the engine to reduce emissions. Table 2 compares the properties of gasoline, ethanol and isopropanol.

Blends with their specifications

Gasoline -pine oil blends (P20):

gasoline 80% +pine oil 20%

Gasoline-ethanol-pine oil blends:

i) gasoline 75% + ethanol 5%+pine oil 20% -E5
ii) gasoline 70% + ethanol 10%+ pine oil 20% -E10

iii) gasoline 65% + ethanol 15%+pine oil 20% -E15

Gasoline-isopropanol--pine oil blends:

i) gasoline 75% + isopropanol 5%+pine oil 20% -IPA5
ii) gasoline 70% + isopropanol 10%+pine oil 20% -IPA10
iii) gasoline 65% + isopropanol 15% +pine oil 20% - IPA15

As shown in table 3, The P20 has the highest gross calorific value when compared with other pine oil percentages (i.e. P10, P30, P40), and also the acidity increases after P20.

Table 1Test engine specifications

Parameter	Value
No. of cylinders	2
Displacement	624 cc
Bore	73.5 mm
Stroke	73.5 mm
Compression ratio	9.5:1
Maximum output	25.74 kW
Maximum torque	48 N-m
Speed	2500 rpm
Orifice diameter	20 mm

Table 2 Properties of gasoline, ethanol and isopropanol

Properties	Gasoline	Ethanol	Isopropanol
Density kg/m^3	736	789	786
Calorific value kJ/kg	45800	29700	30400
Latent heat of vaporization kJ/kg	349	904	758
Octane number	99	106	112
Chemical formula	C_5-C_{12}	C_2H_2OH	C_3H_7OH

Table 3 Properties of gasoline and pine oil

Properties	Gasoline	P10	P20	P30	P40
Specific gravity	0.71	0.7522	0.7603	0.7768	0.8014
Density, gm/cc	0.70	0.7514	0.7598	0.7759	0.7840
Lower calorific value, kJ/kg	45524	45536	45599	44452	44088

Acidity as mg of KOH/gm	0.023	0.050	0.076	0.13	0.15

EXPERIMENTAL SETUP AND METHODOLOGY

The tests were performed on two cylinder four stroke multi point fuel injection SI engine. The engine is connected to an eddy current dynamometer for loading purpose. Exhaust gas emissions such as CO, HC, and NO_x are measured by using AVL DI gas analyser. Table 3.1 shows the test engine specifications.

EXPERIMENTAL METHODOLOGY

The experiments were performed at different loads varying from 0% to 100% in steps of 20% with a constant speed of 2500 rpm. The first set of experiments were conducted with pure gasoline at various loads. The same procedure was repeated for other three sets of fuel samples, i.e., for gasoline with pine oil 20%, blends of gasoline-ethanol-pine oil (E5,E10 and E15) and blends of gasoline- isopropanol-pine oil (IPA5, IPA10 and IPA15). For each experiment the engine was allowed to reach a stable condition and then measurement were recorded. The exhaust temperature measured by K-type thermocouple was monitored to ensure that the engine was running in a stable condition. The exhaust gas is measurement is measured by using extension pipe to exhaust pipe, where it is remained until steady state values were obtained on the AVL digas analyser screen. After conducting all tests, the values were retrieved and graphs were plotted.

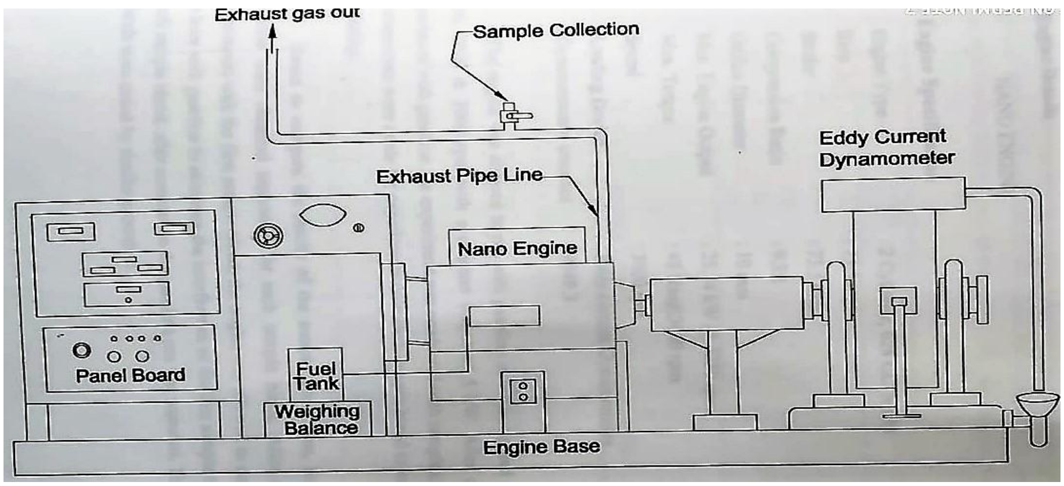


Fig: 2 Block diagram

Fig : 3 Experimental set-up

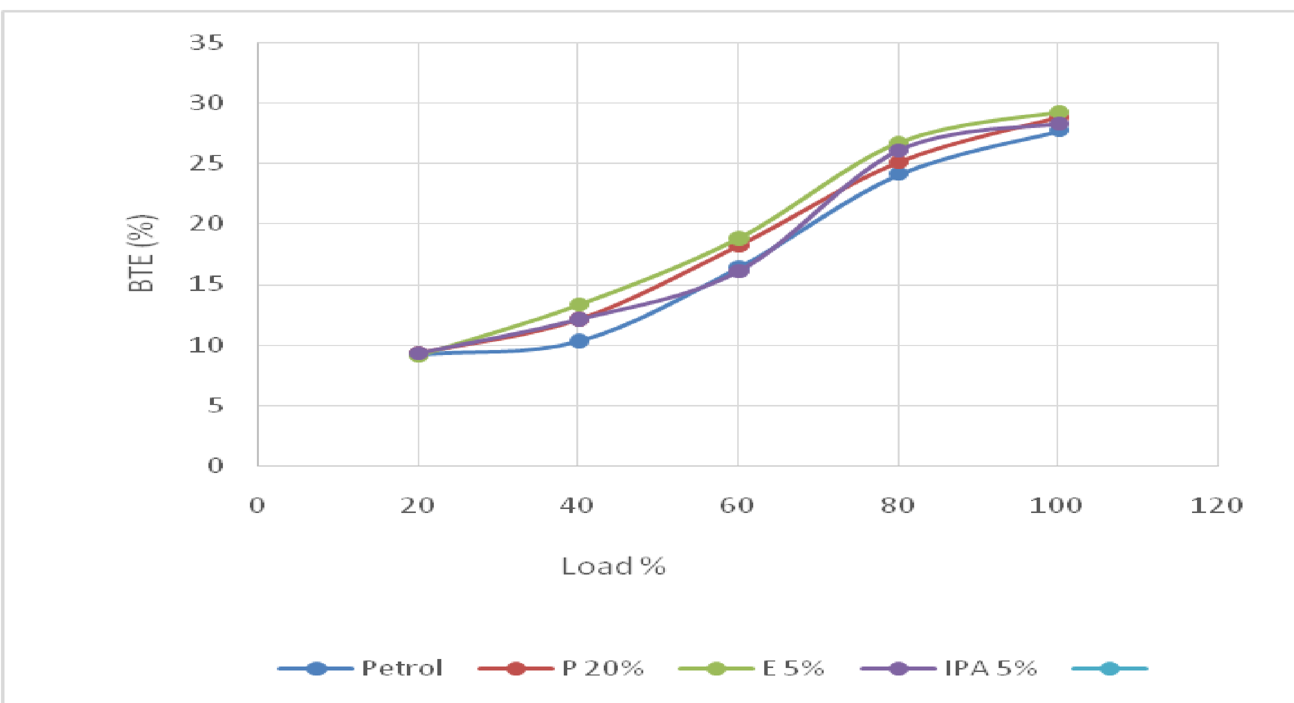
Fig : 4Avl di gas analyser

RESULT AND DISCUSSIONS

The results of the experimental investigations conducted on gasoline-alcohol blends are presented in this section. Performance characteristics considered are BTE and BSFC while emission characteristics are CO,HC and NO_x.

PERFORMANCE CHARACTERISTICS:

Brake thermal efficiency.



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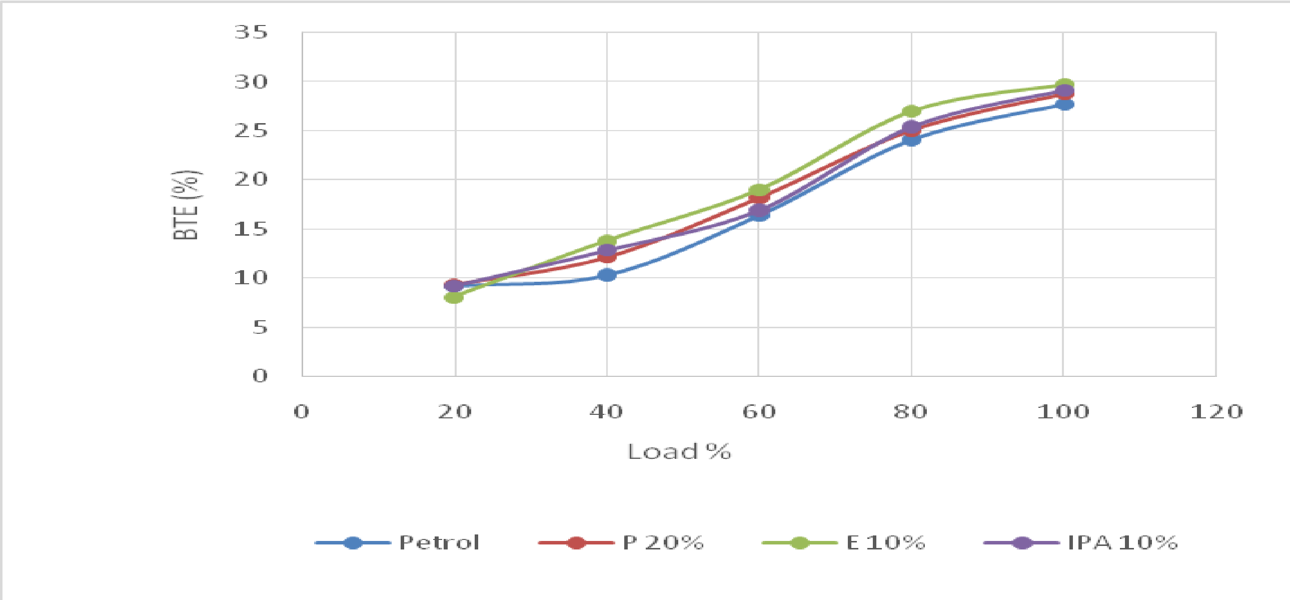

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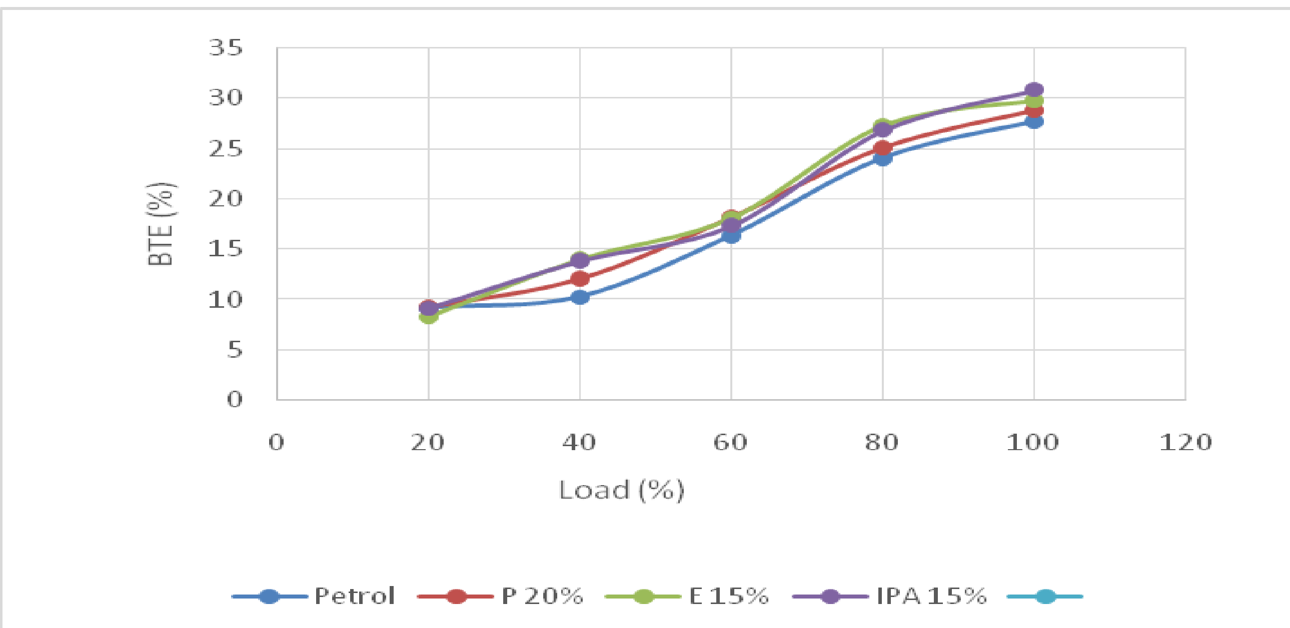


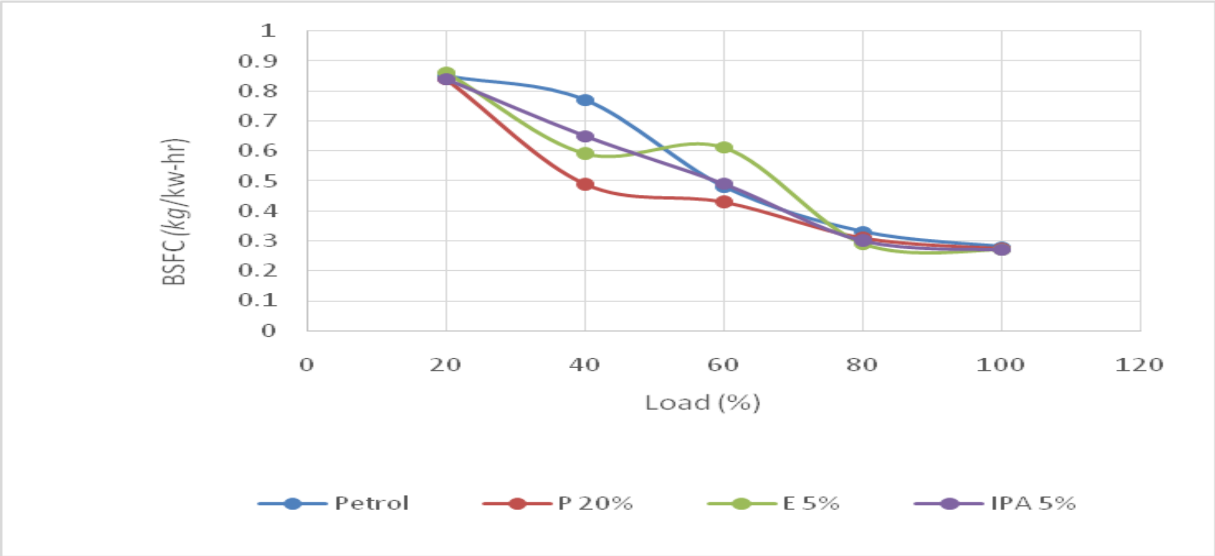
(C)

Fig : 5 Variation in BTE with load

Brake Thermal Efficiency (BTE) is the capacity of an engine to convert the chemical energy into useful work. Figure 5.1.(a)(b)&(c) show the variation of BTE with load for various fuels considered i.e. for gasoline with pine oil 20%, blends of gasoline-ethanol-pine oil (E5,E10 and E15) and blends of gasoline- isopropanol-pine oil (IPA5, IPA10 and IPA15). It was observed that with increase in the concentration of alcohol blends and load, BTE gradually increased. This is because of reduction in heat loss and increase in power with increase in load.

It is also found that IPA15 gave higher thermal efficiency than gasoline for full load condition. The improvement in brake thermal efficiency with IPA15 blend is 11.20%at 100% load, when compared with gasoline at same load.

Brake specific fuel consumption:



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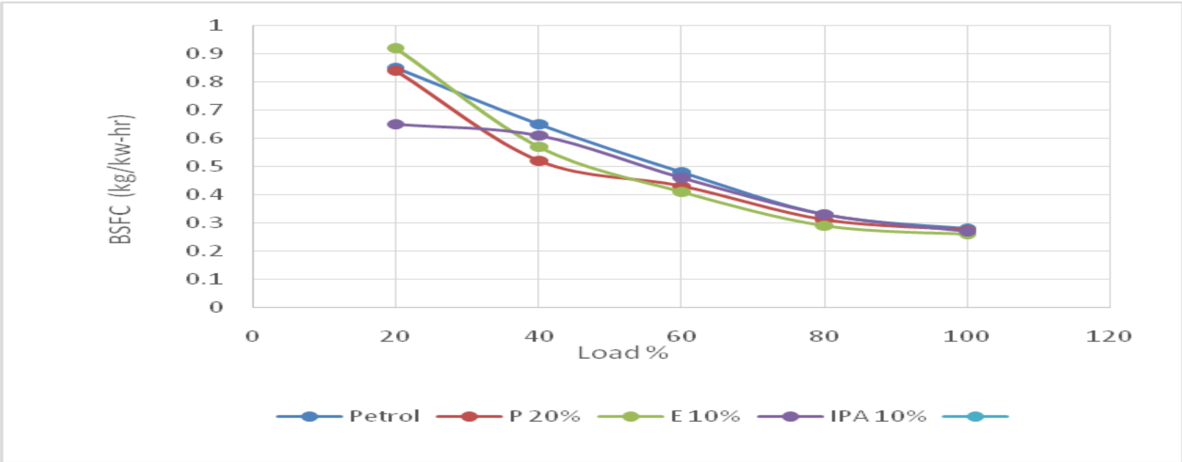

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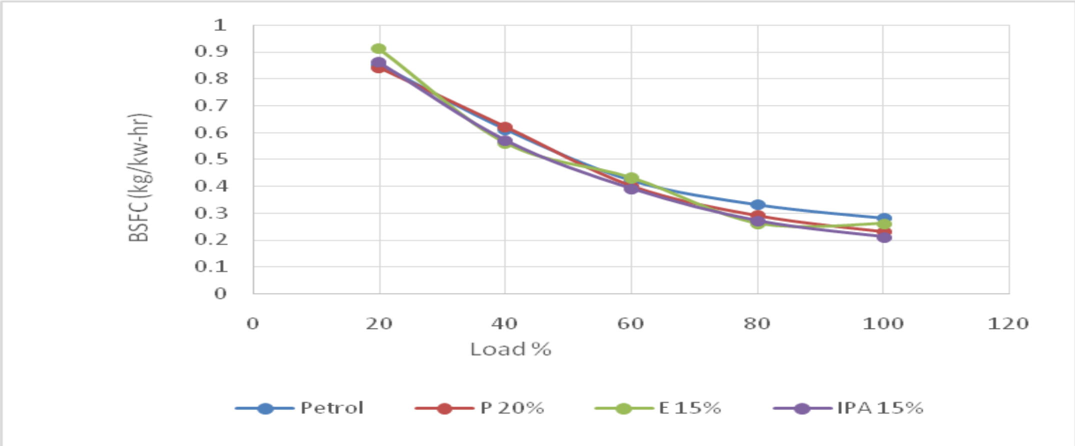


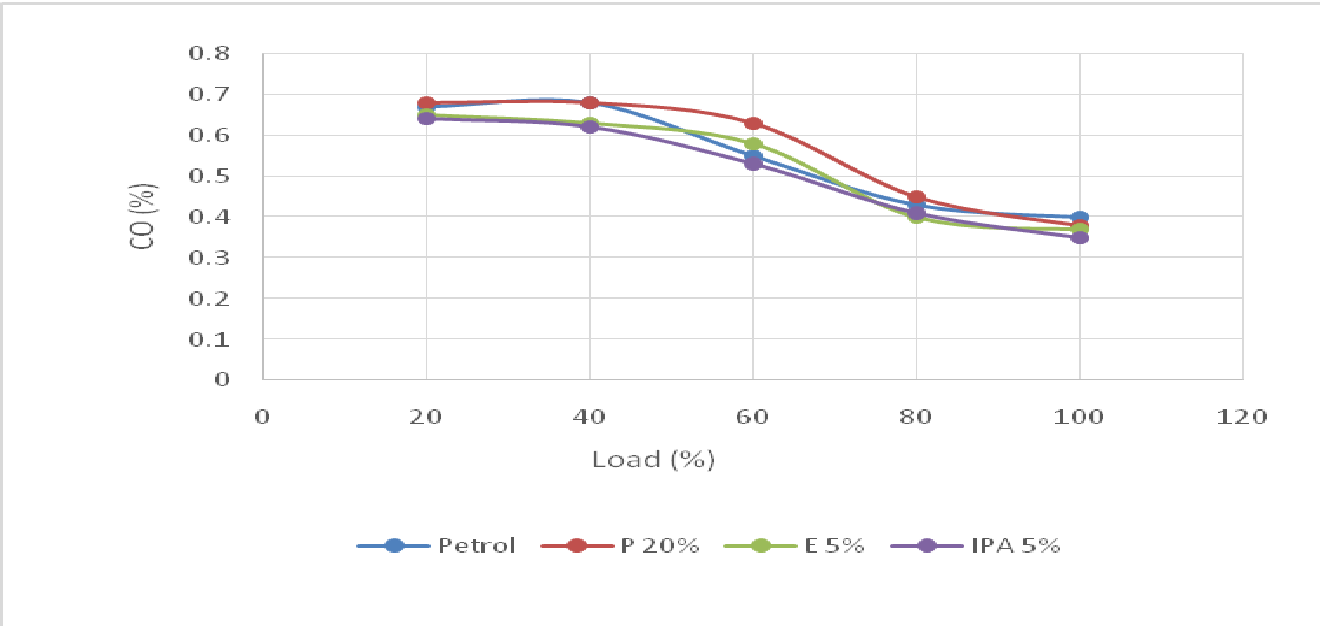
(c)

Fig: 6 Variation in BSFC with load

Brake specific fuel consumption is a parameter that reflects the efficiency of a combustion engine which burns fuel and produces rotational power. As shown in Figure 5.2(a)(b)&(c) the variation of BSFCwith load for various fuelsconsidered. It was observed that BSFC decreases with respect to load in all blends. This is due to the percentage increase in fuel required to operate the engine is less than the percent increase in brake power due to relatively less portion of heat loss at higher loads. It is found that IPA15 gave maximum reduction in BSFC, i.e., up to 25% as compared to that of gasoline.

EMISSIONS CHARACTERISTICS

Carbon monoxide (CO) emissions:



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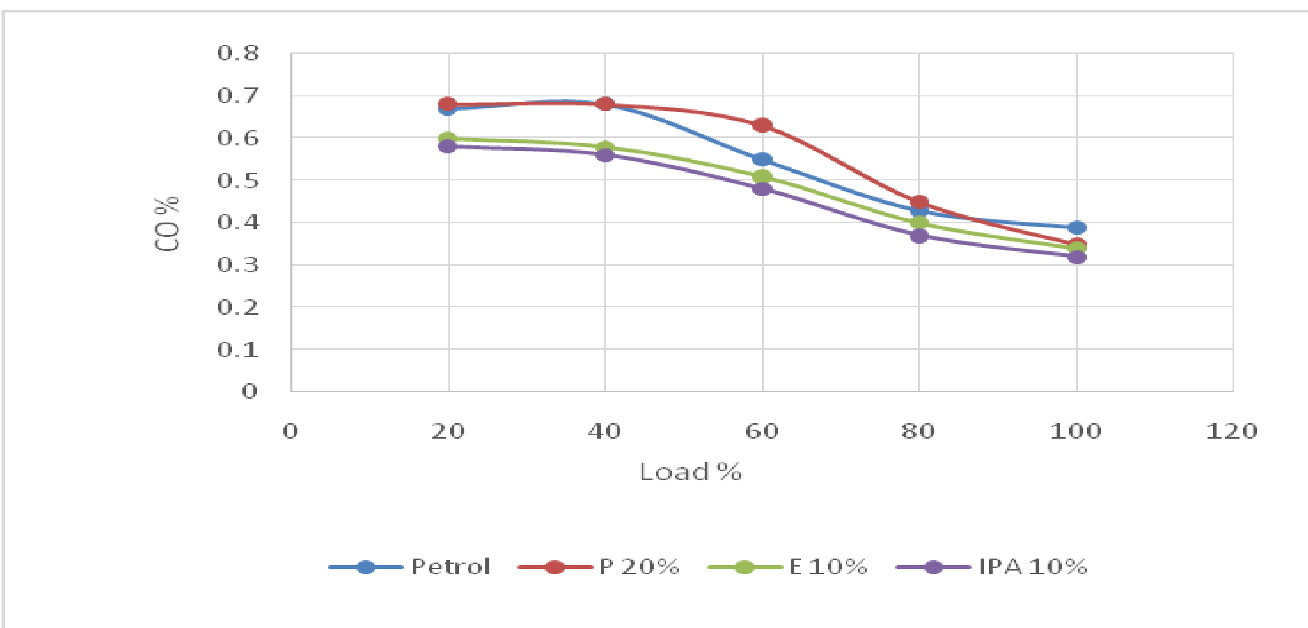

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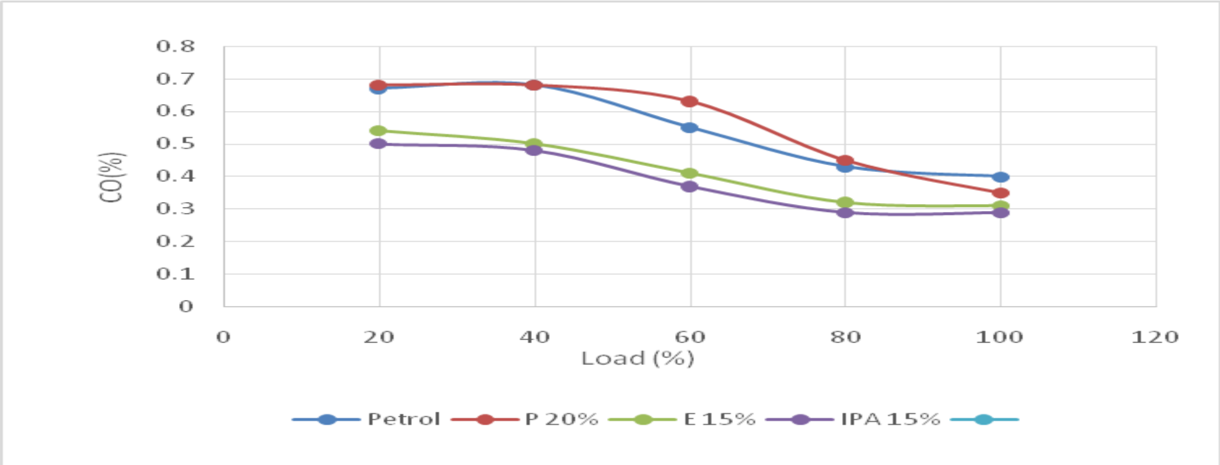
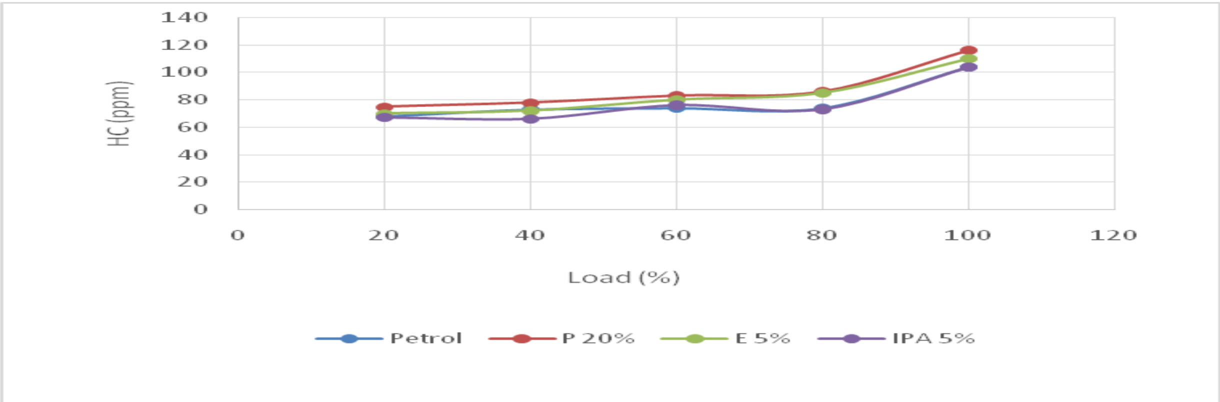


(c)

FIG: 7 Variation in CO with load

The formation of carbon monoxide indicates loss of power due to deficiency of oxygen in combustion chamber and hence incomplete combustion takes place which results in CO formation. Figure 5.3.(a)(b)&(c) show the variation of CO emissions with load for various fuels considered. It was observed that CO emissions decreases in all blends with respect load, this is due to the lesser heat of evaporation of alcohols and higher oxygen content. It is found that IPA15 presents highest decrease in CO that is 27.5% , when compared with gasoline.

Hydrocarbon *(HC) emissions*



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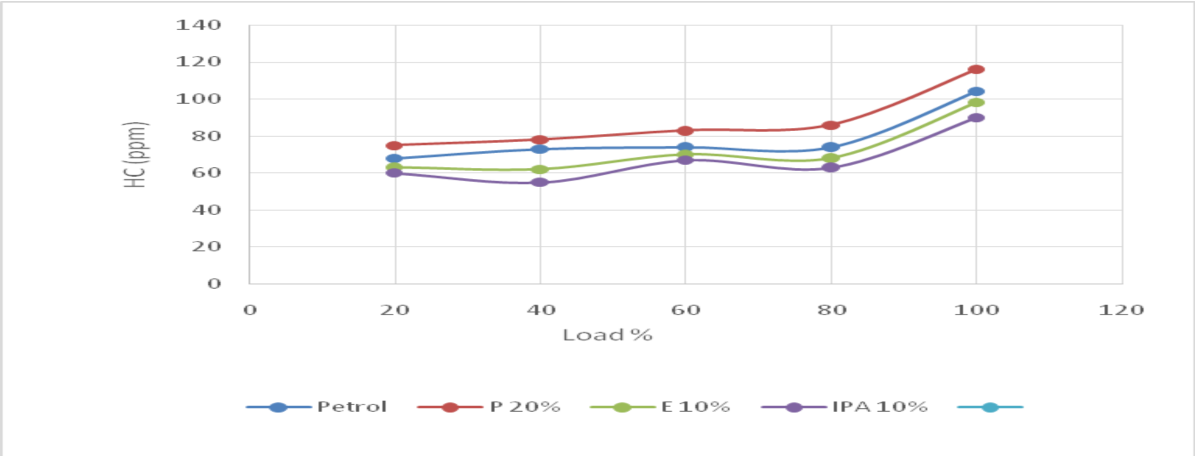

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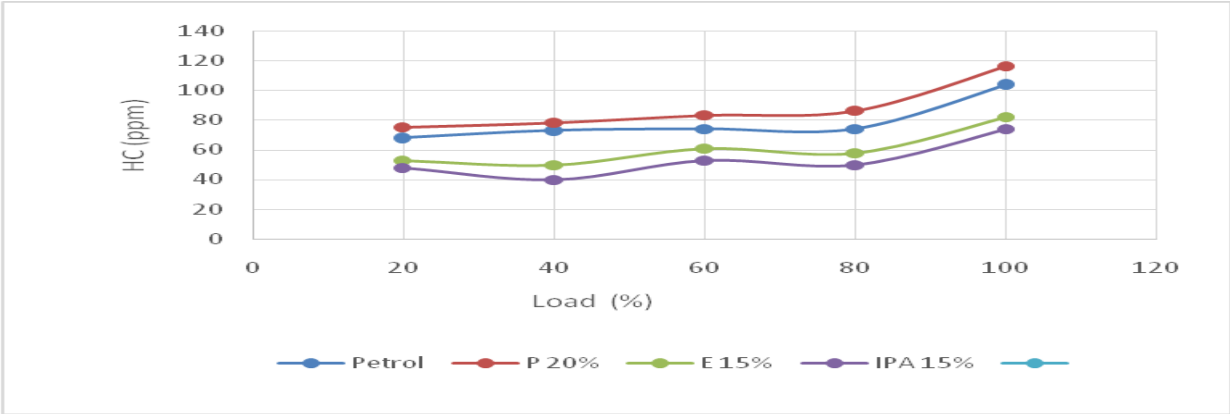
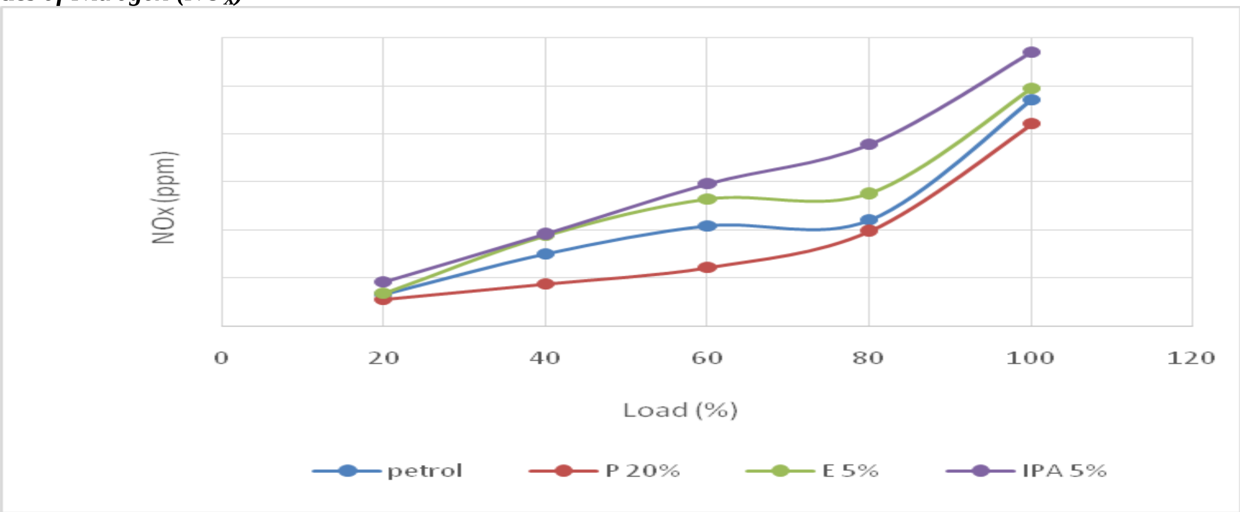


(c)

Fig: 8 Variation in HC with load

The unburnt hydrocarbons are formed as a consequence of incomplete combustion. The volatile organic compound present in these hydrocarbon mixes with sulphur dioxide and nitrogen dioxide to form smog. Even minor exposure to smog causes severe health problems. Figure 5.4(a)(b)&(c) show the variation of HC emissions with load for various fuels considered. It was observed that when the proportion of oxygen increases in the fuel blend, the emission level of hydrocarbons decreases. It is also found that IPA15 gives higher reduction in HC emissions up to 28.8% ,when it is compared with actual gasoline.

Oxides *of Nitrogen (NO_X)*



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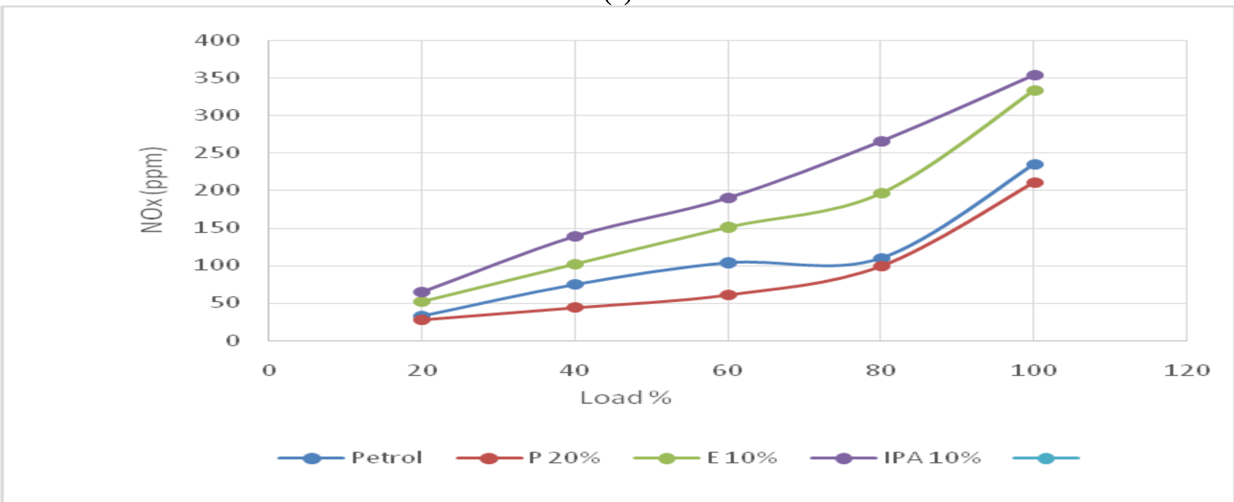

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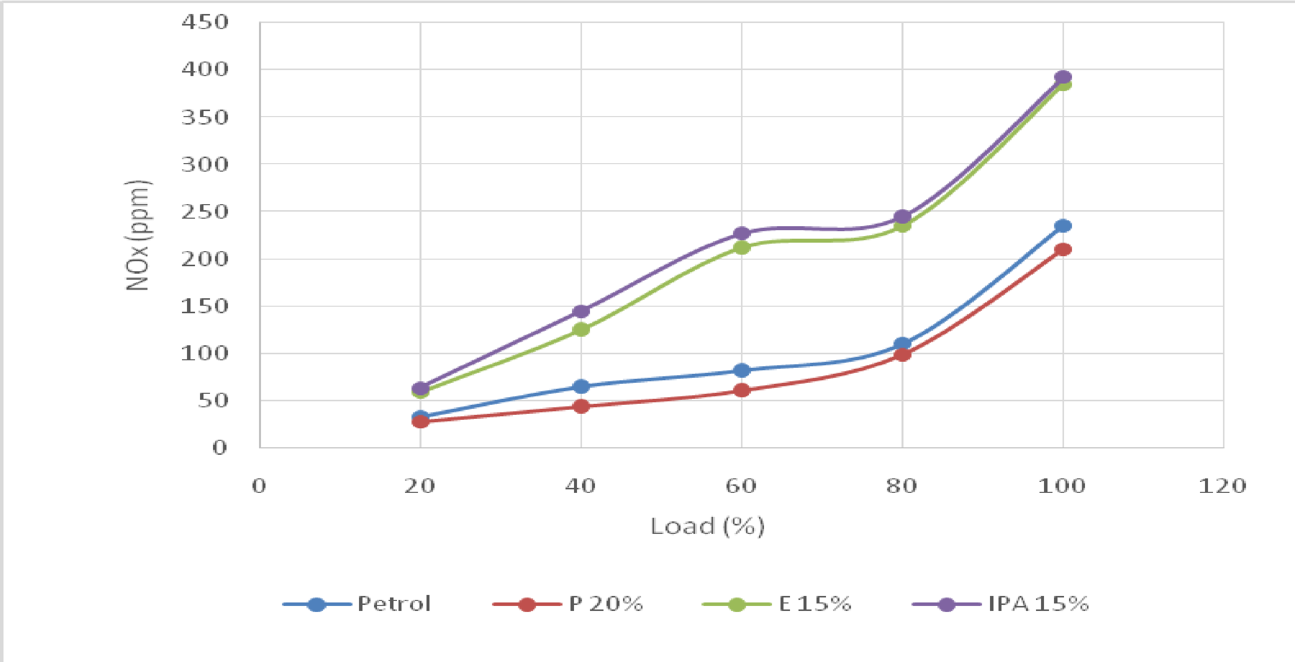

(c)

Fig: 9 Variation in NO_X with load

Major contribution to NOx emission include high temperature and presence of oxygen during combustion. Figure 5.5(a)(b)&(c) show the variation of NO_x emissions with load for various fuels considered. It was observed that NO_x emissions increase by 21.2% with IPA15 when compared with gasoline. This is due to presence of high oxygen content in the blend containing alcohol.

CONCLUSIONS

The performance and emission characteristics of ethanol and isopropanol with pine oil as an emulsifier have been investigated. The conclusions from this investigation are follows:

1.The addition of an emulsifier in quantity of 20% with alcohol-gasoline blends increase the brake thermal efficiency of the engine and reduce the specific fuel consumption due to the presence of oxygenates.
2. It can be concluded that better combustion of emulsified fuel with alcohol- gasoline blends lower the carbon monoxide (CO) emissions.
3.Due to higher cetane value of alcohols and emulsified fuel, the unburned hydrocarbon(HC) decreases when compared with gasoline.
4.The oxides of nitrogen (NO_x) emissions increased with the usage of alcohol gasoline blends.
From the above results, it has been concluded that optimum emulsified fuel blend for MPFI engine is gasoline 65% + pine oil 20% + alcohols(ethanol or isopropanol) 15%) that gives better performance and lower emissions.

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