ISSN (Online): 2455-7838
SJIF Impact Factor (2015): 3.476

EPRA International Journal of

Research & Development

(IJRD)

Volume:1, Issue:9,November 2016

Published By :
EPRA Journals

SJIF Impact Factor: 3.476 ISSN: 2455-7838(Online)
EPRA International Journal of Research and Development (IJRD)
Volume: 1 | Issue : 9 | November | 2016

PERFORMANCE AND THERMAL ANALYSIS OF DIESEL ENGINE USING DIESEL AND ALCOHOL MIXTURE

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ABSTRACT

Alcohol is a renewable fuel and abundant raw material is available for its production. It can be easily manufactured at reasonable cost. Alcohol has low carbon/hydrogen ratio. Hence the smoke level is low. The high latent heat of vaporization of alcohol increases the volumetric efficiency and hence the power output. The cooling effect of the alcohol reduces the NOx emissions as well as the thermal stresses. Thus alcohols are cleaner running fuels than diesels. However alcohol has problem like knocking because of its long ignition delay and wear of material due to poor lubrication.

A single cylinder, naturally aspirated, direct injection diesel engine (4.4kw at 1500 rpm) was selected for this present experimental study. Alcohol- diesel fuel is supplied by direct injection. The effect of alcohols with different fractions (3%,5%,7%,10%) on performance and emission characteristics were studied and compared with neat diesel fuel.

KEYWORDS: *Performance; Thermal Analysis; Diesel Engine; Diesel And Alcohol Mixture;*

1.0 INTRODUCTION

The increased consumption of petroleum-based fuels has lead to the depletion of their resources and an increase in their cost, and the diesel engines have the following disadvantages.

- High level of emission.
- Depleting nature of diesel.

The emission level can be controlled by modifying the engine design and by adopting innovative techniques like combustion chamber modifications, exhaust gas recirculation, post treatment of exhaust gas etc., But the depleting nature of diesel can be met only by going to an Alternative fuel

Also, burning fossil fuels contributed to higher levels of carbon dioxide and other gases in the Earth's atmosphere. To stop the increase of these gases, we must first stop burning fossil fuels. The petroleum fuel resources are decreasing fast rate. Combustion of petroleum fuels causes environmental pollution. Larger amount is spent on import of crude oil to meet our diesel requirement. These factors have focused the attention of researchers for clean burning renewable alternative fuel.

Various alternative fuels, which can be used in diesel engines, are alcohols, CNG, LPG, vegetable oils, biogas and producer gas. These LPG, CNG, producer gas and biogas requires storage tasks and pressure regulators. This leads to added weight and cost. Vegetable oils are to be used for edible purpose.

Motor vehicles contribute signicantly to green house gases but nevertheless the rise and rise of petrol, diesel and kerosene vehicles continues at an alarming rate. Not only do vehicles contribute net carbon gases, mainly CO and CO2, into the atmosphere, which contribute to global warming and climate change but the products of combustion also produces additional local pollution. Locally the emission of nitrogen oxides, sulpher and carbon particulates (soot) can be very detrimental to health. The apparently illogical passion to burn fossil fuels this way stems from three main factors: consumer demand, supplier economics and national interests. These driving forces are fundamentally underpinned by the fact that petroleum products (from oil and gas) are, for the time beling, readily available and cheap at source.

What are alcohols?

Alcohols are compounds in which one or more hydrogen atoms in an alkane have been replaced by an -OH group.

The different kinds of alcohols:-

Alcohols fall into different classes depending on how the -OH group is positioned on the chain of carbon atoms. There are some chemical differences between the various types.

Primary alcohols:-

In a primary alcohol, the carbon which carries the -OH group is only attached to one alkyl group.

Notice that it doesn't matter how complicated the attached alkyl group is. In each case there is only ***one linkage*** to an alkyl group from the CH_2 group holding the -OH group.

There is an exception to this. Methanol, CH_3OH, is counted as a primary alcohol even though there are ***no*** alkyl groups attached to the carbon with the -OH group on it.

Secondary alcohols:-

In a secondary alcohol, the carbon with the -OH group attached is joined directly to ***two*** alkyl groups, which may be the same or different.

Tertiary alcohols

In a tertiary (3°) alcohol, the carbon atom holding the -OH group is attached directly to ***three*** alkyl groups, which may be any combination of same or different.

Physical properties of alcohols:-

Boiling Points:-

The chart shows the boiling points of some simple primary alcohols with up to 4 carbon atoms.
They are:

CH_3OH	CH_3CH_2OH	$CH_3CH_2CH_2OH$	$CH_3CH_2CH_2CH_2OH$
methanol	ethanol	propan-1-ol	butan-1-ol

They are compared with the equivalent alkane (methane to butane) with the same number of carbon atoms.
Notice that:

- The boiling point of an alcohol is always much higher than that of the alkane with the same number of carbon atoms.
- The boiling points of the alcohols increase as the number of carbon atoms increases.

The patterns in boiling point reflect the patterns in intermolecular attractions.

Hydrogen bonding:-

Hydrogen bonding occurs between molecules where you have a hydrogen atom attached to one of the very electronegative elements - fluorine, oxygen or nitrogen.

In the case of alcohols, there are hydrogen bonds set up between the slightly positive hydrogen atoms and lone pairs on oxygen's in other molecules.

The hydrogen atoms are slightly positive because the bonding electrons are pulled away from them towards the very electronegative oxygen atoms.

Solubility of alcohols in water:-

The small alcohols are completely soluble in water. Whatever proportions you mix them in, you will get a single solution.

However, solubility falls as the length of the hydrocarbon chain in the alcohol increases. Once you get to four carbons and beyond, the fall in solubility is noticeable, and you may well end up with two layers in your test tube.

The solubility of the small alcohols in water:-

Consider ethanol as a typical small alcohol. In both pure water and pure ethanol the main intermolecular attractions are hydrogen bonds.

Table .1 properties of alcohol and petroleum fuels

Property	Ethanol	Butanol	IPA	Diesel
Specific gravity	0.79	0.81	0.789	0.82-0.85
Latent heat of vaporization KJ/Kg	900	828	795	600
Stoichiometric A/F ratio	9.00	21.00	10.3	14.6
calorific value KJ/Kg	42290	33100	30900	43500
Density	753	810	786	860

The primary fuel alcohols are Ethanol, Butanol, Isopropyl, Methanol etc., lower calorific value alcohol fuels generally have a lower energy density than gasoline, this is a major consideration in the design of neat alcohol vehicles. There are various approaches for part Substitution of diesel like blends, emulsion, dual injection and alcohol fumigation. alcohol -blending approach has been selected for this present work.

2.0 EXPERIMENTAL SETUP

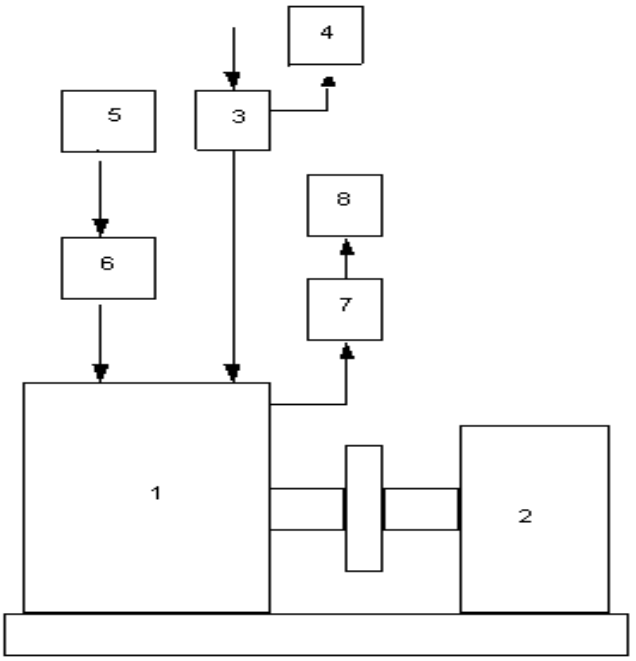

Fig.1 Layout of Experimental Setup

1. Diesel Engine
2. Electrical Dynamometer
3. Air Box
4. U- Tube Manometer
5. Fuel Tank
6. Fuel Measurement tank
7. Exhaust Gas Analyzer
8. AVL Smoke Meter

3.0 TEST PROCEDURE

1. The engine was started in neat diesel mode at no load condition.
2. The engine speed, time for 10 cc diesel consumption, exhaust temperature and smoke meter values were noted.
3. The above step was repeated for 25%, 50%, 75% load, full load conditions.
4. The alcohol-diesel fuel substitutions are enter into the fuel tank, substitution percentages are 3%, 5%, 7%, 10%.
5. First enter the ethanol blended fuel of 3%
6. The engine speed, time for 10cc diesel consumption, exhausts temperature and smoke meter values were noted.
7. The process was repeated at 25%, 50% and so on.
8. The similar procedure was followed for 5%, 7%, and 10% alcohol-diesel blends, like ethanol-diesel, butanol-diesel.isopropyl alcohol-diesel.
9. 9.All the observations for the various percentages of substitutions and for the various loads were tabulated and the efficiency obtained in each case was calculated.
10. 10.The values of efficiency, exhaust temperature, total fuel consumption and filter smoke number, emissions were compared for alcohol-diesel fuels, 3%, 5%, 7% and 10% substitution of diesel conditions

4.0 RESULTS AND DISCUSSION

Brake Thermal Efficiency as Function of percentage of alcohol

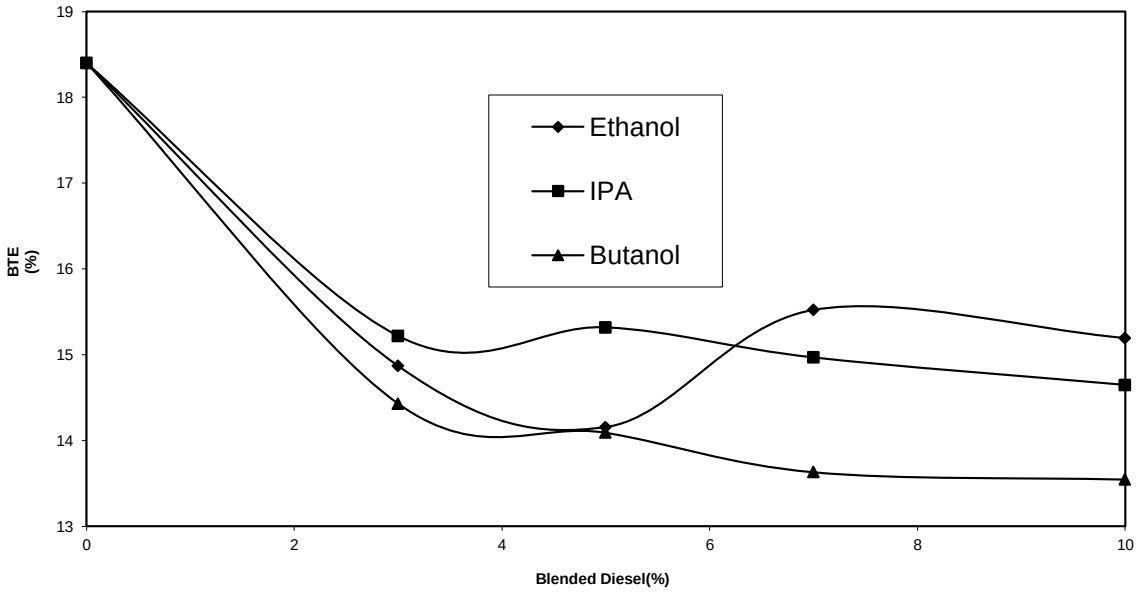

Fig.2. BTE Vs % of alcohol (50% load)HC Emission as Function of percentage of alcohol

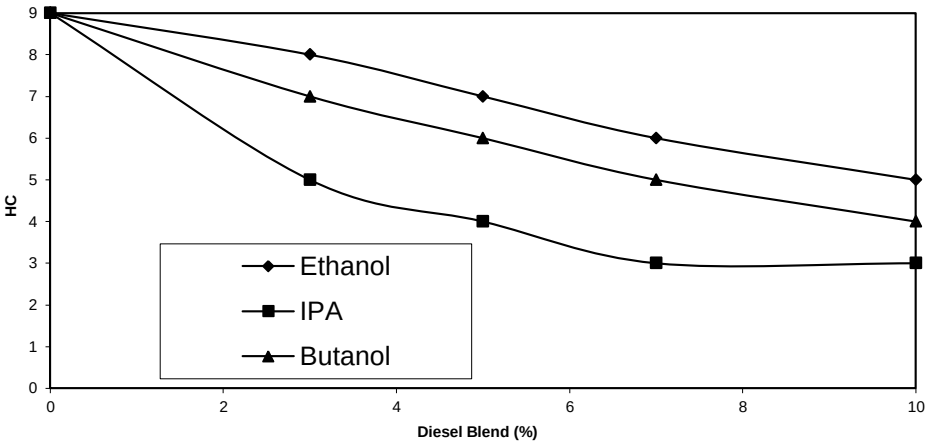

Fig .3 UBHC Vs % of alcohol (0% load)

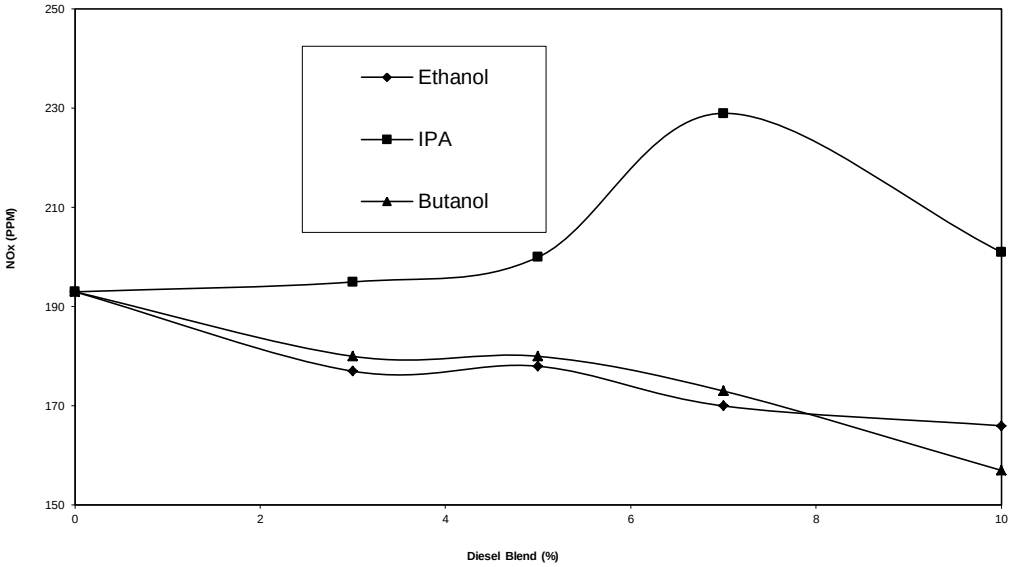

Fig.4 NOx Vs % of alcohol (50% load)

5.0 CONCLUSIONS

The brake thermal efficiency increases with substitution of diesel with alcohols, the increase being larger at larger substitutions. The exhaust soot density is reduced, this decreases the environmental pollution. The unburnt hydrocarbon decreases with the increase in addition of alcohols in diesel.

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