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IMPORTANCE AND ROLE OF ADDITIVES FOR ESTIMATING PERFORMANCE AND EMISSIONS IN C.I ENGINES USING ALCOHOL AS FUELS- A STUDY.

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Abstrcat: Innovative thinking led to find various techniques by which alcohol can be used as fuel in diesel engine, amongst the fuels alternative proposed, the most favourest ones are methanol and ethanol . so far no established method is available to run a normal diesel engine with a compression ratio from 14:1 to 20:1 by using alcohol as fuel.This is because, the properties of diesel engine fuels differs from the properties of diesel fuels . The specific tendency of alcohols to ignite easily from a hot surface makes it suitable to ignite in a diesel engine by different methods .The advantage of this property of alcohols enables to design and construct a new type of engine called surface ignition engine.

In this work it is tried to bring out the advantages of additives to alcohol fuel on the performance of CI Engines. The Additives such as n-butanol,hexanol, 1-octylamino-3octyloxy-2propanol&N-octyl nitramine had been mixed with the blends of diesel & ethy alcohol and experiments are carried out.the present research work is proposed to carry out the experimental investigation on a ceramic hot surface ignition engine by adding Ethylnitrate,Butylnitrate,Diisipropylether and Dimethylether as additives to ethanol/methanol as a fuel with an objective to find the best one interms of performance ,emission and combustion parameters.

Key Words: Additives, Alcohol fuels, ceramic hot surface ignition, performance,emissions, design and construction of new engine.

I.INTRODUCTION TO FUEL ADDITIVES

Fuel additives have been one of the most prolific innovations of liquid engineering as well as material science giving natural fuel sources and additional properties which help us drive that little extra out of them. Whether it's an additive to alter a fuels burn rate, increase surface area ,prevent corrosive effects or simply color, innovators have developed a range of additives over the years which give these fuels an added property which serves a pressing need from consumers.

While fuel additives are largely associated with additives to gasoline and oil based fuels in the interest of environmental protection ,curbing emissions and increasing mileage, the innovation around additives has a broader impact of being able to change ,alter or enhance specific attributes of a fuel whether liquid ,solid or gas .Additives have been developed to increase combustion rates, as anti oxidants, to effect burn rates ,to enable fuels to work under extreme temperatures, reduce harmful emissions and more. Over the years various hybrid compounds and blends have been engineered to create better fuels for industries commercial use and end consumers alike.

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II.TYPES OF FUEL ADDITIVES:

The types of additives include oxygenates, ethers, antioxidants (stabilizers), antiknock agents, fuel dyes, metal deactivators, corrosion inhibitors and some that can't be categorized.
Oxygenates – are fuels infused with oxygen. They are used to reduce the carbon monoxide emissions creating when burning fuel. Oxygenates can be based on either alcohol or ethers.
Eg(1).Alcohol – methanol, ethanol, isopropyl alcohol, n-butanol, and gasoline grade t-butanol

Ethers – methyl tert-butyl ether, ethyl tertiary butyl ether, diisopropylether, tertiary amyl methyl ether, tertiary hexyl methyl ether.
Antioxidants –Some antioxidants are used as a stabilizer in fuel to prevent oxidation. Examples of some antioxidants used are:
• Butylated hydroxytoluene
• 2,4-Dimethyl-6-tert-butylphenol
Di-tert-butylphenol- Phenylene diamine, Ethylene diamine

Antiknock agents – is a gasoline additive that works to reduce engine knocking while trying to increase the octane rating of the fuel. The mixture of air and gas in a traditional car engine has a problem with igniting too early and when it does, it causes a knocking noise.
Some of the antiknock agents are: Tetra-ethyl lead, Methylcyclopentadienyl manganese tricarbonyl, Ferrocene, Iron pentacarbonyl, Toluene, Isooctane
Metal deactivators – are fuel additives and lubricant additives that are used to stabilize the fuel. It works by deactivating metal ions. Metal deactivators inhibit the formation of gummy residues. An example of a metal deactivator that is often used for gasoline is N,N'-disalicylidene-1,2- propanediamine. This compound has been approved for both military and commercial use.
Corrosion inhibitors – these chemical compounds slow down metal corrosion. A good corrosion inhibitor will give 95% inhibition in certain circumstances. Examples of some corrosion inhibitors are sodium nitrite hexamine, and phenylenediamine.
Others –there are several other fuel additives that don't fall into the same categories as the above. Some of these are:
•Acetone – this is a vaporization additive. It is used, together with methanol, to improve vaporization when the engine starts up.
• Nitromethane – is used to up the engine power – commonly referred to as 'nitro'.
• Ferrous picrate is used to improve combustion and increase mileage.
• Ferox- this is a catalyst additive used to :increase fuel efficiency, clean the engine, extend the life of the engine, Lower emissions.

III.RESEARCH STUDIES

A-An experimental study by R. Rama Udaya Marthanda et.al., had been carried on 4-stroke C.I Engine with different blends of Ethyl Alcohol & disel with n-butanol as an additive. In this study a different speed stationary four stroke surface ignition ceramic heater CI engine is selected for the experiment.The details of experimental setup are as follows:
Engine type 4-stroke single cylinder engine
Make Kirloskar
Power 10.0KW
Bore x Stroke(mm) 102x110
Cub ic Capacity(cc) 898
Compression ratio n 18:1
Colling system Water cooled
Lubrication system Force feed
Attachment Ceramic heater(12 V,DC)
RESULTS AND DISCUSSIONS: The experimental tests were carried out on the surface ignition ceramic heater four stroke CI engine using pure diesel and ethanol- diesel blends with n-butanol additive at different speeds. The relevant parameters such as engine torque and fuel consumption of the engine were recorded and the brake

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specific fuel consumption, brake thermal efficiency were also calculated at 1250 rpm and 1500 rpm. The engine emissions of CO, unburned HC and NOx were analyzed using the exhaust gas analyzer The results were obtained by data acquisition system and are shown as follows. The ratio of ethanol- diesel blends gives various fuel consumption according to the percentage of ethanol present in the diesel fuel. If more ethanol is added with diesel, gives more fuel consumption[1].

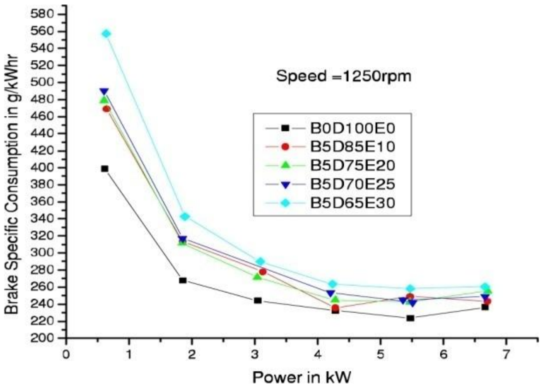

Fig 1

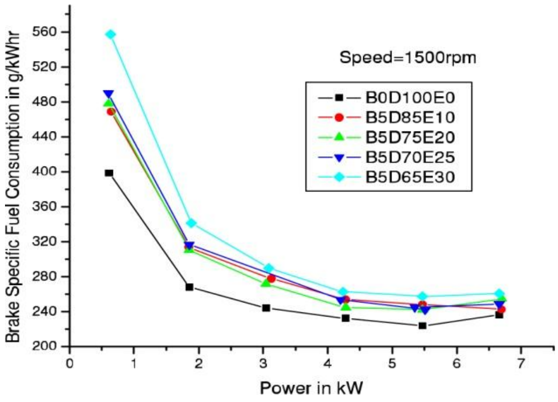

Fig 2

Figures 1 and 2 show the BSFC of the engine. When the engine runs at 1250 rpm on different engine loads, for the blends of B5D65E30, the BSFC is increased by 4% for the blends of B5D85E10 BSFC is decreased by 1.2% for maximum engine load and the blends of B5D75E20 BSFC is average by 2.5% up and down. The results show the trends of the increase of fuel consumption with the increase percentage of ethanol in the blends[2].When the engine runs at 1500 rpm , for the blends of B5D65E30, the BSFC is increased at all engine load conditions.The blends B5D70E25 give 3.25% less BSFC next to pure diesel fuel. However BSFC is high at minimum power for all fuel ratios. This increase of fuel consumption is due to the lower heating value of ethanol than that of pure diesel[3].

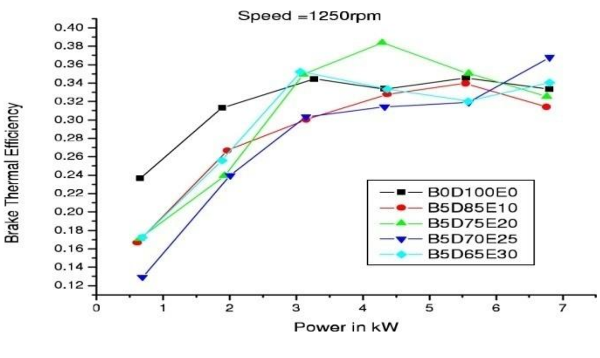

Fig 3

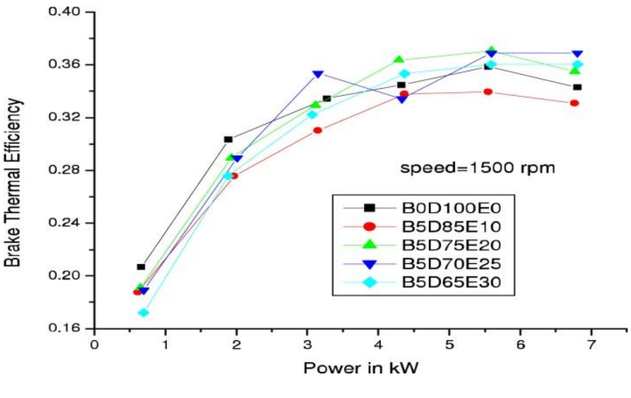

Fig 4

Figures 3 and 4 show the results of the break thermal efficiency(BTE) of the engine.When the engine runs at the speed of 1250 rpm for the blends of B5D70E25 the BTE is increased by 2.5%, and at average load BTE is increased for the blends of B5D65E30 by 3.4%. These results show the difference of the break thermal efficiencies between the blends and diesel are relatively small at 1500rpm.When the engine runs at the speed of 1500 rpm the break thermal efficiency is increased for the blends of B5D75E20 and B5D70E25 by 5% at high load and 2.5% at low load.The exhaust emissions are measured in terms of Corbon Monoxide (CO),Hydrocarbons(HC) and Oxides of Nitrogen (NOx) emissions. The results for diesel fuel as well as ethanol-diesel blends are given below. The oxygen content of the blended fuels would help to increase the oxygen to fuel ratio in the fuel at rich regions. The resulting more complete combustion leads to reduction of CO in the exhaust. If the percentage of ethanol in the blends increased, NOx emission is reduced. This is because of the air-fuel ratio in

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the case of ethanol-diesel blends, is lower as compared to diesel alone. The latent heat of vaporization of ethanol lowers at same temperature resulting in lower NOx emissions.

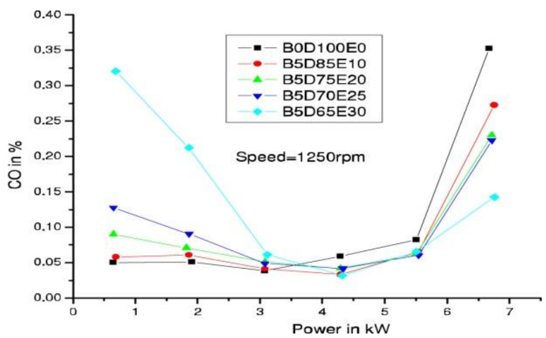

Fig 5

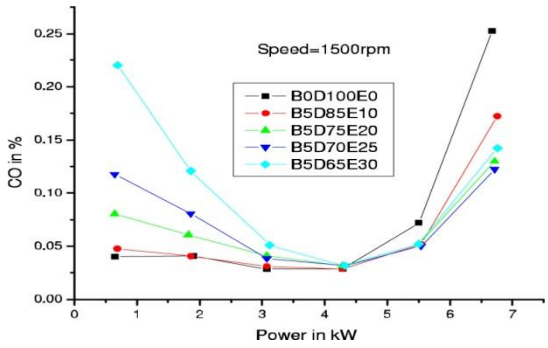

Fig 6

Figures 5 and 6 show the CO emissions of the engine. The CO emissions from the engine fuelled by the blends are higher than those fuelled by pure diesel at minimum loads. The higher percentage of the ethanol gives more CO emissions upto half load. For higher engine loads which are above half load , the CO emissions became lower than that fuelled by diesel for all the blends for all speeds by 0.01% to 0.07%. Upto half load the varition of CO emissions between pure diesel and B5D85E10 is only 0.05% for the speed of 1500rpm. At average load CO emission is same for 1500rpm and 0.01% to 0.02% different for 1250rpm. The percentage of ethanol in the blends increased the percentage of CO emission reduced. The emission reduced with the use of 10%, 20%, 25% and 30% ethanol-diesel blends as compared to diesel alone[4]. This is due to the concept that ethanol has less carbon than diesel. The same fuel dispersion pattern as for diesel, the oxygen content of the blended fuels would help to increase the oxygen in fuel ratio in the fuel rich regions. This results in more complete combustion which leads to reduced CO in the exhaust smoke by ceramic heater engine. The reduction of CO emissions at full load is due to the more complete combustion. The phenomenon is due to the oxygen element contained in ethanol. When the engine working above its half load, the temperature in the cylinder is high, which makes the chemical reaction of fuel with oxygen easier and the combustion becomes more complete for two different speeds.

The level of unburned hydro carbons (HC) in exhaust gases is generally specified in terms of the total hydro carbon concentration expressed in parts per million(ppm) carbon atoms[5].

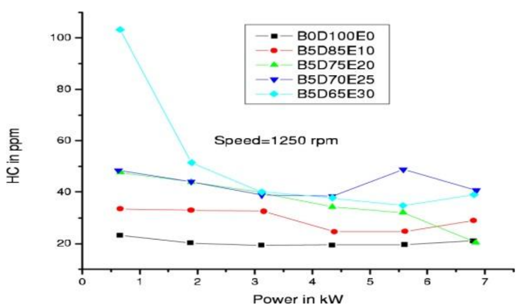

Fig 7

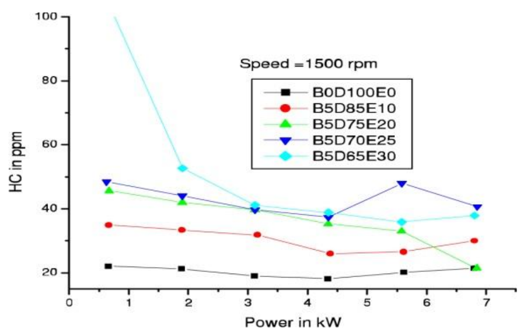

Fig 8

Figures 7 and 8 show the HC emissions of the engine. More percentage of ethanol gives more HC emissions for all speeds. For the blends of B5D85E10 the HC is reduced by 5 to10ppm from pure diesel at1250rpm and

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7 to 12.5ppm at 1500rpm. This is due to the high temperature in the ceramic heater engine cylinder to make the fuel be easier to react with oxygen when the engine runs on the top load and high speed. Figure 9 shows that the results of unburned HC emissions[6] from the engine for the blended fuels are all higher when the engine runs at the speed of 1500rpm.

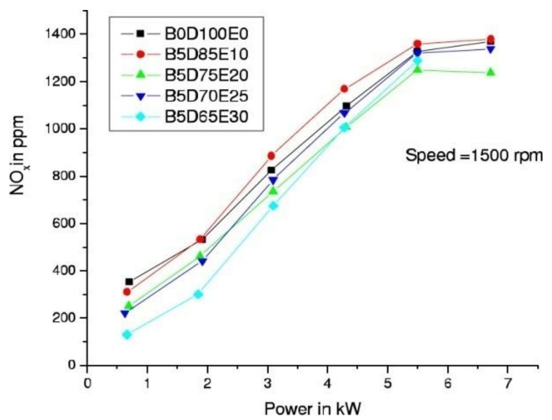

Fig 9

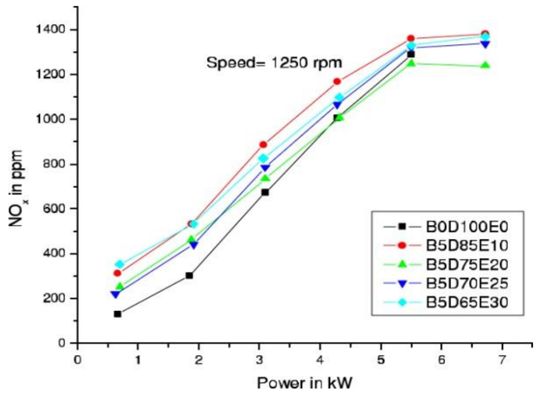

Fig 10

Figures 9 and 10 show the NOx emissions of the engine. When the engine runs at the speed of 1250 rpm NOx emission is minimum for pure diesel and more for1500rpm. The NOx emission is more for the blends of B5D85E10 at 1500rpm by 20%. The blends B5D70E25 give average NOx for all working conditions. The NOx emissions from the enigne are higher than those of diesel. NOx emissions are increased for all blends and speeds when the load is incerased. For low load NOx is minimum due to the fuel air mixture with spread in composition about stoichiometric burns.During the mixing controlled combustion phase the burning mixture is likely to be closer to stoichiometric by the help of ceramic heater. When the engine runs at 1500rpm the NOx is reduced by 40% for the blends of B5D75E20. This is because the air-fuel ratio in the case of ethanol-diesel blends is lower as compared to diesel alone. The latent heat of vaporization of ethanol is minimum for the same temperature in minimum NOx emissions[7].

From this experimental study,it can be observed that,the tested blends were from 10% to 30% of ethanol by volume and also with 5% of the additive of n-butanol.The engine was operated with each blend at different power and different speeds of 1250 rpm and 1500 rpm.Further it may be observed from the Experiment that the n-butanol was a good additive for mixing diesel with ethanol blends.

B-A study was carried out by A.P sathiyagnanam etal ,on DI diesel engine in which hexanol was added in ethanol – diesel .

Specification of test engine:

Type	Vertical, water cooled, four stroke
Number of cylinder	One
Bore& stroke length	87.5mm ,110mm
Compression ratio	17.5:1
Maximum power	5.2 Kw
Speed	1500 rpm
Injection timing	23^0 before TDC
Injection Pressure	220kgf/cm^2

In this study five kinds of fuels were prepared: diesel (D0) as the baseline fuel, 20% ethanol blending with 10% hexanol and 70% diesel (denoted as D 20E), 25% ethanol blending with 10% hexanol and 65% diesel (denoted as D

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25E), 35% ethanol blending with 10% hexanol and 55% diesel (denoted as D 35E) and 45% ethanol blending with 10% hexanol and 45% diesel (denoted as D 45E). Properties of the blend fuels are listed in the table 2. Increasing the ethanol percentage in blend fuels also increases the oxygen content of the fuel and decreases the heat value of the fuel.
The performance and emission characteristics of the test engine were evaluated for the blended ethanol with diesel. The engine started without any problem and it was running smooth, but there was an increase in engine noise when 50% or more of ethanol was blended to diesel. Hence the blending was restricted [8].

performance*:* The variation of brake thermal efficiency against brake power of the engine is shown in figure 11. It was observed the brake thermal efficiency increases with increasing brake power. Among the blends the D 25E concentration shows higher thermal efficiency than other blends. Regarding the brake thermal efficiency for the blends there is no appreciable changes up to part load and beyond that there is slight increased in thermal efficiency than that of diesel were noticed. The presence of oxygen concentration aids improvement in combustion especially diffusion combustion that contributes higher thermal efficiency. The increase in brake thermal efficiency for D 25E is 1.89% when compared to other concentrations.

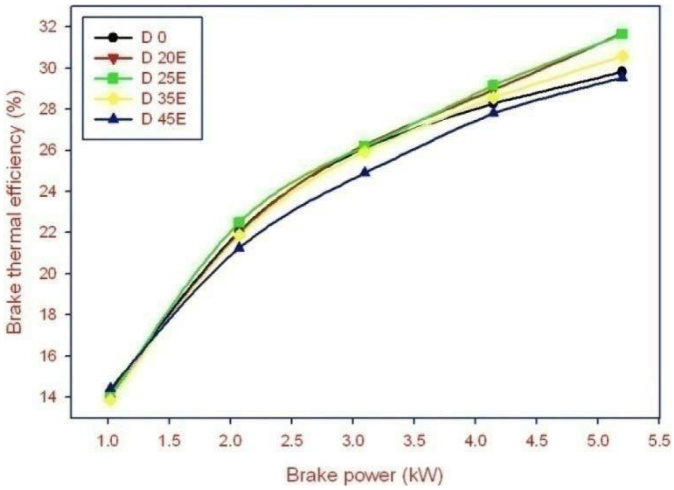

Fig.11

Emission*:* The variation of smoke density with brake power of the engine for D0, D 20E, D 25E, D 35E and D 45E by volume of concentrations are shown in figure 12. It is seen from graph up to 70% of load smoke level increases after that gradually decrease for all the concentrations. It was observed that the smoke density of all the blends is lower than that of diesel at maximum load. The smoke density is lower for D 35E compared to other concentrations. The maximum smoke density recorded for the diesel was 73 HSU and 45.3 HSU for D 35E at maximum brake power. Because of the oxygen enrichment contained by D 35E improves fuel evaporation during diffusion combustion which subsequently reduces the smoke density [9].

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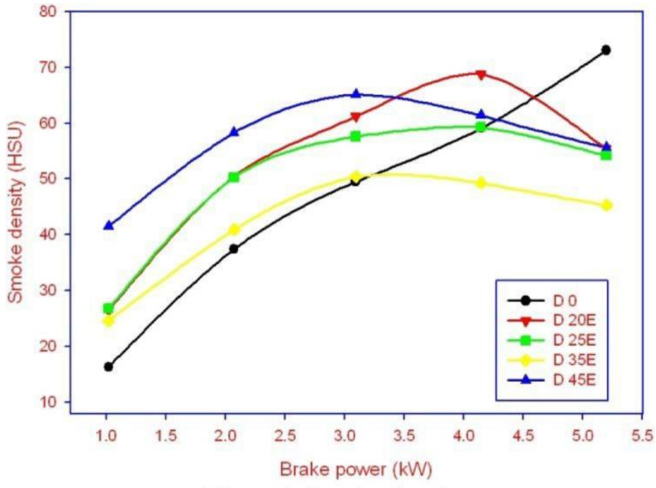

Fig 12

Figure 13. shows NOx emission with different blends of ethanol. It can be seen that NOx emission increases with addition of ethanol blends than diesel. However the blends marginally increase the NOx emission in the entire range of test conditions. All concentrations are increasing the NOx emission due to high temperature prompted by combustion and oxygen enrichment. It is clearly evident from the heat release results graph [10].

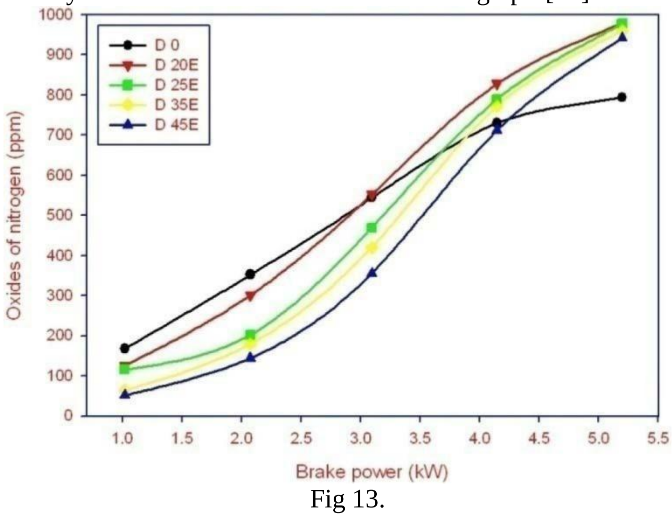

Fig 13.

Figure 14 give the HC emission with different ethanol and hexanol additions. It is observed that HC emission for hexanol blend slightly higher than neat diesel fuel. This is due to higher heat of evaporation ethanol that caused slower evaporating it leads to increase the HC emission[11].

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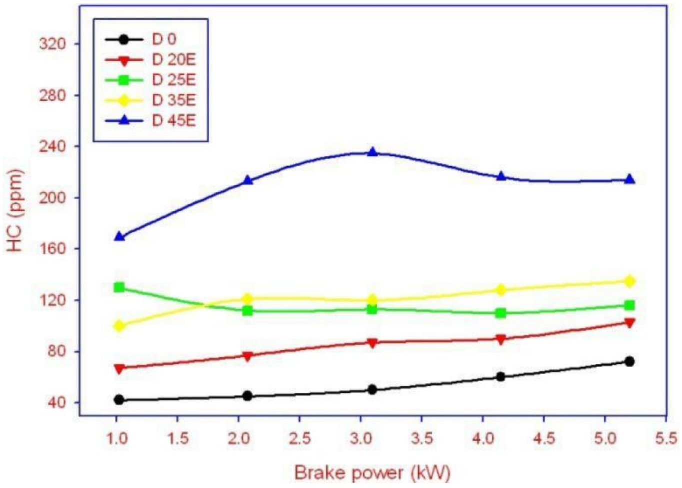


Fig 14.

From these experimental investigations the following conclusions are arrived at:

From the experimental procedure the best ethanol blend could be identified based on the performance, emission and combustion characteristics by conducting the load test on the DI diesel engine. Among the four blends, the D 20E shows higher brake thermal efficiency than the other blends and diesel. The brake thermal efficiency improves by 1.89%.The D 35E concentration shows better smoke reduction than the other blends and diesel. The smoke density is reduced by 45.3 HSU than the diesel at maximum brake power. All the blends slightly increase the NOx beyond 75% load than that if diesel. The cylinder pressure is higher for all the blends. But D 20E concentration show significant increase in the cylinder pressure. Heat release rate for all the blends is higher than that of diesel. In the D 25E concentration shows maximum heat release rate.

C-Two organic additives(1-octylamino-3octyloxy-2propanol&N-octyl nitramine) were selected for different physical –chemical parameters to study the behavior of a diesel ethanol mixture by P.Satge de caro et.al.,

In this study,they performed tests on an engine whose specifications are given below:

Direct injection (DI) Engine*:* The test engine was an air –cooled single cylinder HATZ (667 cm3).The 1D80 model presence 100x85mm2 as borexstroke with a compression of 18:1. The Bosch 4-holes nozzles type 150s1146 was set at 265 bars.

No significant differences between the fuels were apparent for the levels of NOx recorded. Examination of the CO levels did not reveal any notable differences between diesel fuel and diesel containing 10% ethanol. But, thanks to additive, the CO level is reduced particularly at no load, which is interesting for urban vehicles.

Moreover, the 1-octylamino-3octyloxy-2propanol&N-octyl nitramine additives play a role in reducing HC contents but do not bring them to the level of diesel fuel (Fig.15).

Finally, the introduction of 10% absolute ethanol into this directs injection engine led to a slight drop in maximum power, but had no effect on the gases emitted, accepted an HC increase.

Introducing an additive makes up the cetane number, reduces the increase in HC and leads to a decrease of CO up to 20% in relation to diesel fuel alone.

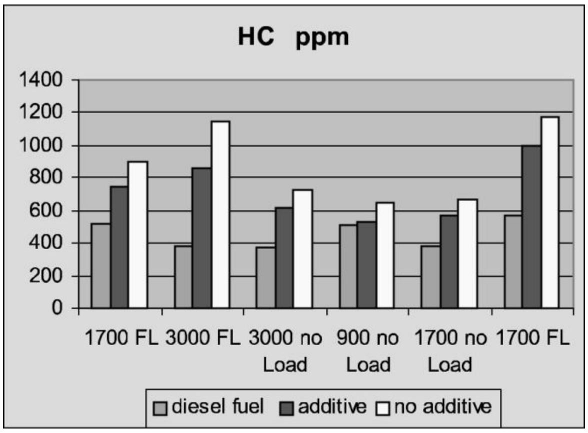
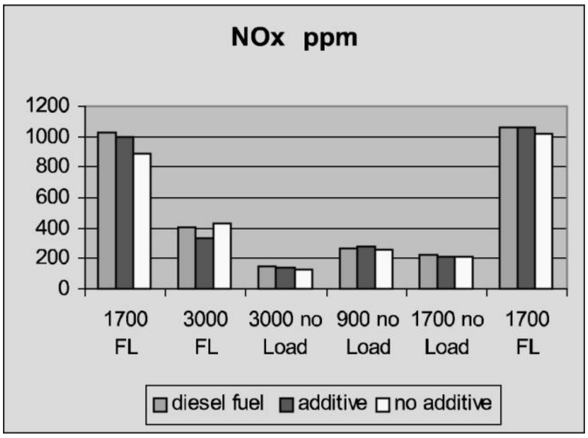


Fig.15(a)



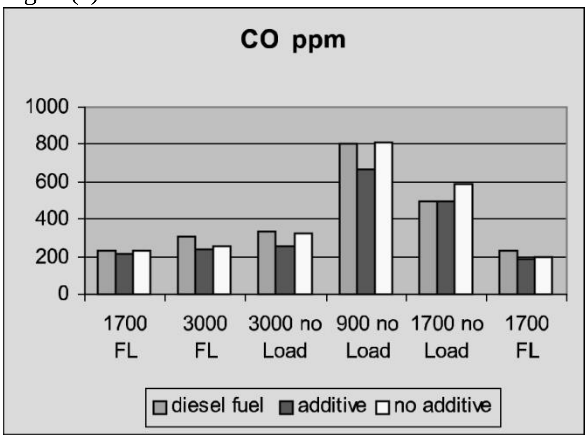


Fig 15(b).

Fig 15(c).

It may be observed from this studythat the two added additives have favourable effects on the physic-chemical properties of the mixture of the diesel & ethanol[12].

IV.CONCLUSIONS

The authors of the work are trying to carryout an experimental investigation on 4-stroke,single cylinder,ceramic hot surface ignition CI engine with alcohol fuels by adding certain additives such as Ethylnitrate,Butylnitrate,Diisipropylether and Dimethylether.In this regard the authors carried out a research on previous works and make certain concusions on the concerned work.

It has been observed from the above studies that alcohols can be used successfully in combination with diesel by adding certain additives .the authors are trying to perform experiments on 4-stroke single cylinder CI engine inorder to estimate the performance using alcohol as a fuel alone along with the above mentioned additives. Further it can be observed that this work is too worthy of its kind after reviewing the precious works.

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