TO STUDY AND ANALYSE THE EFFECT OF BLENDING ALCOHOL ON DIESEL ENGINE PERFORMANCE

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ABSTRACT

The diesel engine (also known as a compression-ignition engine) is an internal combustion engine that uses the heat of compression to initiate ignition and burn the fuel that has been injected into the combustion chamber. In compression ignition or diesel engine combustion process, fuel is injected by the fuel injection system into the engine cylinder towards the end of the compression stroke just before the desire start of combustion. Methanol is a chemical with the formula CH_3OH . Methanol acquired the name "wood alcohol" because it was once produced chiefly as a byproduct of the destructive distillation of wood. Modern methanol is produced in a catalytic industrial process directly from carbon monoxide, carbon dioxide, and hydrogen. In the increasing pressure on crude oil reserves and environmental degradation as an outcome , fuels like methanol may present a sustainable solution as it can be produced from a wide range of carbon . The present investigation evaluates methanol as a diesel engine fuel . Methanol and diesel are blends at room temp. and formulation of micro-emulsion using surfactants has been a prescribed technique for diesel engine application s. In this study, experiments were conducted to examine the effect of using a mixture of diesel and n-pentanol, which is one of the second-generation bio-fuels with comparable properties to diesel fuel, as fuel on the combustion, performance, and gaseous and particulate emissions of a naturally-aspirated, four-cylinder, direct-injection diesel engine. Three n-pentanol fractions in the fuel mixture were selected: 10, 20 and 30% by volume. The effects of ethanol / diesel fuel blends and ethanol fumigation (the addition of ethanol to the intake air manifold) on the performance and emission of a single cylinder diesel engine . the optimum percentage of ethanol that gives shortest emissions and better performance at the same time . it is apparent from the increasing popularity of light – duty diesel engine that alternative fuels , such as alcohols , must be applicable to diesel combustion if they are to contribute significantly as substitute s for petroleum based fuels . Result show that METHANOL: efficiency – reduction , NO_X - Decrease , HC – increase , CO – decrease .ETHANOL :efficiency – reduction , HC – increase , CO – increase .PENTANOL : efficiency – Not affected , HC – decrease , CO – decrease , NO_X – increase

Key Word: Methanol, Ethanol, Pentanol, Blending, Diesel Engine, Efficiency, Emissions.

I. DIESEL ENGINE

The diesel engine (also known as a compression-ignition engine) is an internal combustion engine that uses the heat of compression to initiate ignition and burn the fuel that has been injected into the combustion chamber. This contrasts with spark-ignition engines such as a petrol engine (gasoline engine) or gas engine (using a gaseous fuel as opposed to gasoline), which use a spark plug to ignite an air-fuel mixture. Compression ignition engines have high thermodynamic efficiency therefore they have always been the first choice for heavy duty vehicles. However, future emission regulation poses a challenge for upcoming diesel engine combustion systems. Future emission regulations are becoming more restrictive, forcing engine designers towards lower exhaust emissions and better performance. With this perspective, knowledge of the injection and the combustion processes is currently being considered as a major research objective. Particularly, the analysis is focused on direct injection Diesel engines, where the fuel-air mixing process plays a dominant role on engine performance. Only with a good understanding of these phenomena it will be possible to reduce the emission levels without impairing the engine performance and efficiency. [1]

1.1 Combustion in CI Engines

In compression ignition or diesel engine combustion process, fuel is injected by the fuel injection system into the engine cylinder towards the end of the compression stroke just before the desire start of combustion. The liquid fuel usually injected at high velocity as one or more jets through small nozzles in the injector tip, atomizes into small drops and penetrates into the combustion chamber. The fuel vaporizes and mixes with high temperature, high pressure cylinder air. The cylinder pressure increases as combustion of the fuel air mixer occurs.

The combustion process is neither completely non-premixed (diffusion) nor premixed. On the contrary the initial portion of the fuel being injected is vaporized and forms a premixed mixture, in a period known as ignition delay.

Premixed burning takes place with the instantaneous rise in the flame temperature and consequently, the maximum rate of heat release. It is the burning phase during which although only 20% of total fuel injected is burnt but nearly 50% of NOx are formed tie to the high temperature during this phase. The premixed burning at the end of ignition delay is followed by homogeneous diffusion burning at different location of combustion chamber.

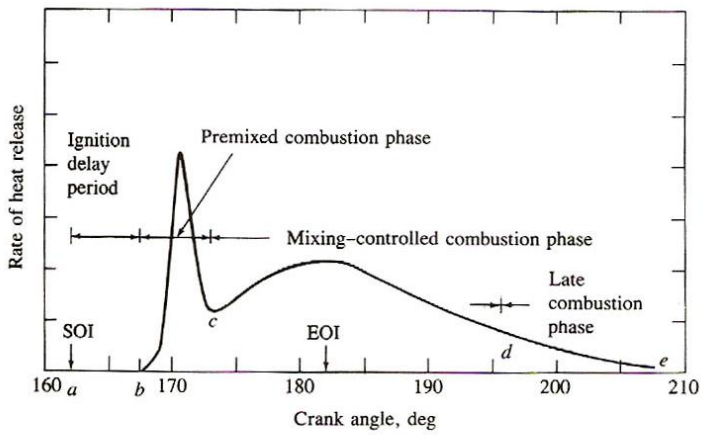


Figure: ROHR Curve for Diesel Engine

This burning phase is followed by heterogeneous diffusion burning during which individual droplets continue to burn and eventually end the combustion process well advance in the exhaust stroke. [2]Methanol, also known as methyl alcohol, wood alcohol, wood naphtha or wood spirits, is a chemical with the formula CH_3OH . Methanol acquired the name "wood alcohol" because it was once produced chiefly as a byproduct of the destructive distillation of wood. Modern methanol is produced in a catalytic industrial process directly from carbon monoxide, carbon dioxide, and hydrogen. Methanol is the simplest alcohol, and is a light, volatile, colorless, flammable liquid with a distinctive odor very similar to that of ethanol (drinking alcohol).[8] However, unlike ethanol, methanol is highly toxic and unfit for consumption. At room temperature, it is a polar liquid, and is used as an antifreeze, solvent, fuel, and as a denaturant for ethanol. It is also used for producing biodiesel via transesterification reaction .Methanol is produced naturally in the anaerobic metabolism of many varieties of bacteria, and is commonly present in small amounts in the environment. As a result, there is a small fraction of methanol vapor in the atmosphere. Over the course of several days, atmospheric methanol is oxidized with the help of sunlight carbon dioxide.

II. ENGINE TEST SETUP

2.1 Specifications

- PRODUCT RESEARCH ENGINE TEST SETUP 1 CYLINDER , 4 STROKE .
- PRODUCT CODE 240 .
- ENGINE TYPE 1-CYLINDER , 4 STROKE,WATER COOLED, STROKE 110MM ,BORE 87.5MM , CAPACITY 661CC.
- DIESEL MODE : 3.5 KW.
- SPEED 1500 R.P.M
- CR : 12:1,18:1.
- INJECTION VARIATION : 0-25 Deg BTDC
- DYNAMOMETER TYPE EDDY CURRENT .WATER COOLED ,WITH LOADING UNIT.
- AIR BOX MS FABRICATED WITH ORIFIC METER AND MANOMETER.
- FUEL TANK CAPACITY 15 lit.
- CALORIMRTER TYPE PIPE IN PIPE.
- PIEZO SENSOR COMBUSTION : RANGE 5000 PSI WITH LOW NOISE CABLE.
- DIESEL LINE : RANGE 5000 PSI WITH LOW NOISE CABLE.
- TEMPRATURE TRANSMITTION TYPE TWO WIRE INPUT RTD ,RANGE 0-100 Deg C
- OUTPUT 4-20 MA AND TYPE TWO WIRE , INPUT THERMOCOUPLE.
- LOAD INDICATOR DIGITAL, RANGE 0-50 KG SUPPLY 230 VAC.
- SOFTWARE ‘ENGINESOFT’ ENGINE PERFORMANCE ANALYSIS SOFTWARE
- OVERALL DIMENSIONS W2000 × D 2500 × H 1500 mm .

PROPERTIES	
MOLECULAR FORMULA	CH_4O
MOLAR MASS	32.04 $g.mol^{-1}$
Appearance	Colorless liquid

Density	0.7918 g·cm^{-3}
Melting point	−97.6 °C (−143.7 °F; 175.6 K)
Boiling point	64.7 °C (148.5 °F; 337.8 K)
Vapor pressure	13.02 kPa (at 20 °C)
Viscosity	5.9×10^{-4} Pa s (at 20 °C)
Flash point	11 °C (52 °F; 284 K)
Autoignition temperature	385 °C (725 °F; 658 K)

2.2 Ethyl alcohol

It is the principal type of alcohol found in alcoholic beverages, produced by the fermentation of sugars by yeasts. It is a neuro toxic psychoactive drug and one of the oldest recreational drugs used by humans. It can cause alcohol intoxication when consumed in sufficient quantity. Ethanol is used as a solvent, an antiseptic, a fuel and the active fluid in modern (post-mercury) thermometers (since it has a low freezing point) . It is a volatile, flammable, colorless liquid with a strong chemical odor. Its structural formula CH 3CH2OH, is often abbreviated as C2H5OH, C2H6O.

PROPERTIES	
MOLECULAR FORMULA	C_2H_6O
MOLAR MASS	46.07 g·mol^{-1}

Density	0.789 g/cm^3 (at 25°C)
Melting point	−114 °C (−173 °F; 159 K)
Boiling point	78.37 °C (173.07 °F; 351.52 K)
Acidity (pK_a)	15.9 (H_2O), 29.8 (DMSO)
Explosive limits	3.3%–19%
Flash point	16 °C (61 °F; 289 K)
Autoignition temperature	365 °C (689 °F; 638 K)

2.3 1-Pentanol

It is an alcohol with five carbon atoms and the molecular formula $C_5H_{12}O$. 1-Pentanol is a colorless liquid with an unpleasant aroma. There are 8 alcohols with this molecular formula (see amyl alcohol). The ester formed from butyric acid and 1-pentanol, pentyl butyrate, smells like apricot. The ester formed from acetic acid and 1-pentanol, amyl acetate (gentle acetate), smells like banana. Pentanol can be prepared by fractional distillation of fossil oil. To reduce the use of fossil fuels, research is underway to discover cost-effective methods of utilizing fermentation to produce Bio-Pentanol. Pentanol can be used as a solvent for coating CDs and DVDs. Another use is a replacement for gasoline.

PROPERTIES	
MOLECULAR FORMULA	$C_5H_{12}O$
MOLAR MASS	88.15 g·mol^{-1}

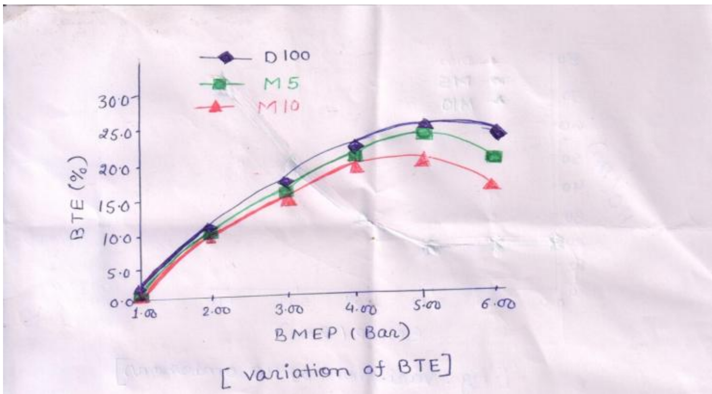
Density	811 g cm^{-3}
Melting point	−78 °C; −109 °F; 195 K
Boiling point	137 °C; 278 °F; 410 K
Solubility in water	22 g l^{-1}
Vapor pressure	200 Pa (at 20 °C)
Flash point	49 °C (120 °F; 322 K)
Autoignition temperature	300 °C (572 °F; 573 K)

III. BLENDING METHANOL

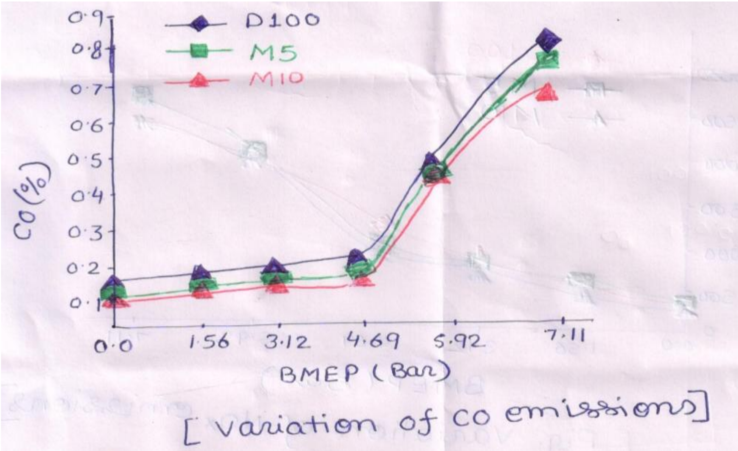
In the increasing pressure on crude oil reserves and environmental degradation as an outcome , fuels like methanol may present a sustainable solution as it can be produced from a wide range of carbon . The present investigation evaluates methanol as a diesel engine fuel . Methanol and diesel are blends at room temp. and formulation of micro- emulsion using surfactants has been a prescribed technique for diesel engine application s. However , preparation of micro – emulsion requires technical expertise . therefore , macro –emulsion using a simple on board stirrer with predetermined rpm is a promising solution .the test fuels were prepared with 6% and 12% (v/v) of methanol in the emulsion and experiment were conducted on a single cylinder diesel engine .Since the inception of industrial revolution in eighteenth century , the search for portable prime movers to run machines for both industrial and transportation purpose became intense . steam engine took a lead role in the beginning , but could not pass the test of time as they were bulky , less efficient and required huge quantity of low energy density solids fuels like coal .In the nineteenth century , diesel engine was invented .since then these engines have become an integral part of modern human civilization and mostly replaced the steam engine which became obsolete. These engine are extensively used world wide for transportation , decentralized power generation , agricultural application and industrial sectors because of their high fuel conversion efficiency , ruggedness and relatively easy operation . these wide fields of global usage of diesel engine lead to ever increasing demand of petroleum fuels .Among the alcohol , methanol has the lowest combustion energy . however , it also has the lowest stoichiometric or chemically correct air –fuel ratio . therefore , an engine burning methanol would produce the max. power a lot of research has been done on the prospect of methanol as an alternative fuel .

3.1 Discussions

BTE indicates the ability of the combustion system to accept the experimental fuel and provides comparable means of assessing how efficiently the energy in the fuel was converted to mechanical output .



Variation of BTE with respect to engine BMEP for various test fuels in fig. result indicated that M5 showed lower BTE at all loads as compared to neat diesel operation . more specially BTE exhibited by M5 was 3.3 % and 10 % lower at 90 % and 100 % loads as compared to the same for diesel baseline .this reduction in thermal efficiency for M5 may be attributed by the fact that despite of being an oxygenated fuel with very low stoichiometric air fuel ratio requirement to burn completely , it has very low calorific value and therefore in an unmodified diesel engine thermal efficiency got reduced .M10 shows further decline in BTE as compared to M5.



CO takes place when the oxygen present during the combustion is insufficient to form CO2(24). Variation of CO emission with respect to engine BMEP for various test fuels is shown in fig.. it was found from the experiment that CO emission reduced with increase in methanol percentage in the test fuel. Full load CO emission exhibited by M5 was found to be 9% less and that of M10 was 18% less than full load neat diesel operation.

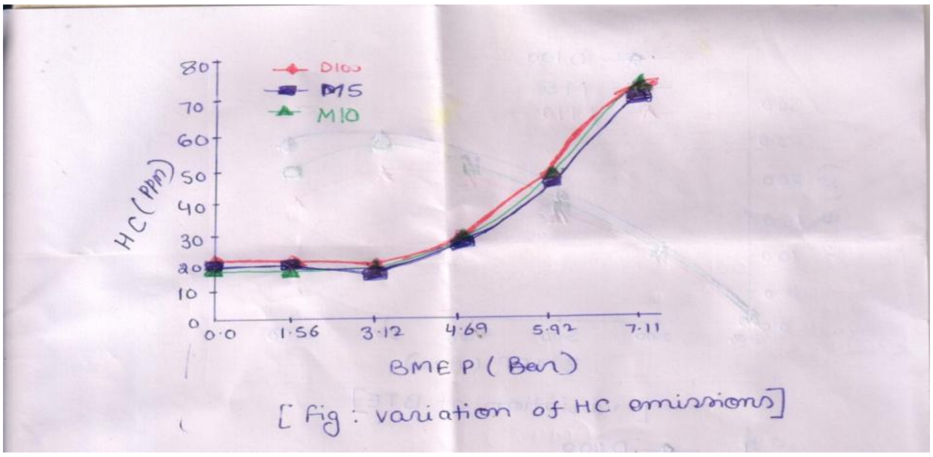
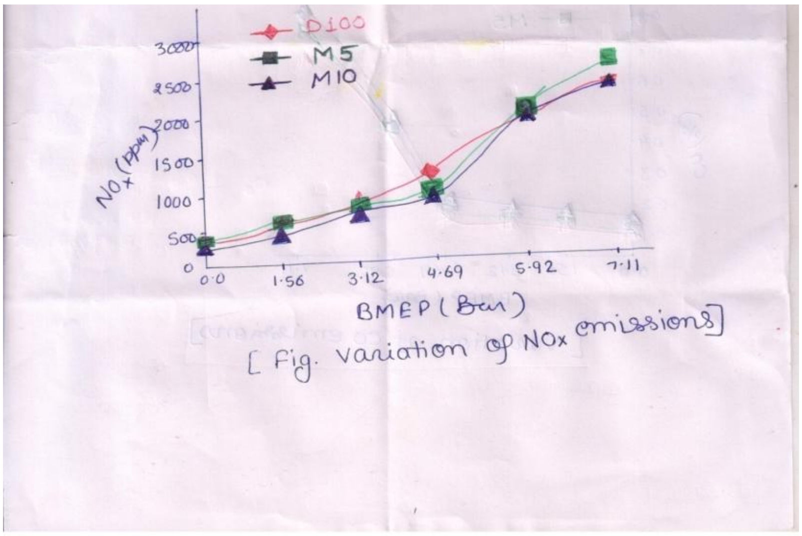


Fig: variation of HC Emissions

Most of the un burnt hydrocarbons are caused by un burnt fuel air mixture; where as the other sources are the engine lubricant and incomplete combustion. Variation of HC emission with respect to engine BMEP for various tests fuels is shown in fig, . When methanol is added diesel it provides more oxygen for the combustion process. Again methanol needs less air for complete burning; hence excess air is made available for the combustion process. Besides methanol molecules are polar and not be absorbed easily by non-polar lubricating oil, hence methanol can lower the possibility of organic compounds in the gaseous state by lubricating oils.



The variation of emission of NOx with respect to engine BMEP is shown in fig,. When methanol is added to the diesel, it provides more oxygen for the combustion process. .Temperature at lower blends. This can be seen from the results. Results showed that full load NOx emission exhibited by M5 was 13% higher than diesel baseline. However, full NOx emission for M10 was very close to diesel baseline confirming the previous results of poor higher load BTE.The variation of engine exhaust smoke with respect to BMEP for various test fuels. It can be clearly found that full load smoke exihibited by M5 and M10 were significantly lower than diesel baseline. Very less stoichmeric air fuel requirements, better atomization and improved combustion have led to reduced smoke with increasing percentage of methanol in the test fuel.

3.2 Pentanol Blends

In this study, experiments were conducted to examine the effect of using a mixture of diesel and n-pentanol, which is one of the second-generation bio-fuels with comparable properties to diesel fuel, as fuel on the combustion, performance, and gaseous and particulate emissions of a naturally-aspirated, four-cylinder, direct-injection diesel engine. Three n-pentanol fractions in the fuel mixture were selected: 10, 20 and 30% by volume.

IV. INTRODUCTION

The increasing use of internal combustion engines has led to the problems of depletion of fossil fuel and increasing stringent regulations on particulate emissions. Different approaches to relief

these problems on diesel engines have been explored, including the use of alternative fuels. Oxygenate bio fuels , such as bio-alcohols, can be produced from a variety of non-food biomass, such as forest wood feedbacks, agricultural residual and marine algae through the biochemical conversion process .Additionally, oxygenated additives have been shown to reduce the particulate emission . Thus bio-alcohols have the potential to be a substitution for the

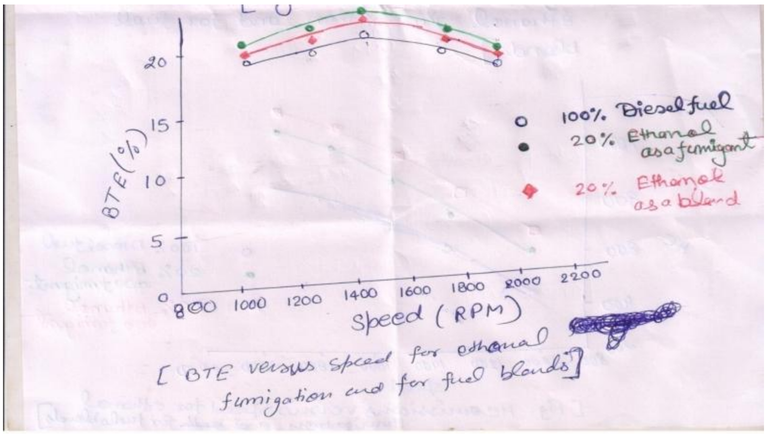
traditional diesel fuel. Among the bio-alcohols, ethanol has been widely studied as additives on both spark-ignition engines and compression-ignition engines

The variations of carbon monoxide (CO) emissions, which are similar with HC emissions. It can be observed that the CO emissions in general decrease with increasing engine load due to the increased in-cylinder gas temperature. Besides, CO emissions exhibit an increasing trend with increasing n-pentanol except at 7.20 bar. Similar increase in CO emissions was reported in the literatures for ethanol/diesel blends and attributed to the higher heat of evaporation of ethanol which reduced the in cylinder gas temperature. However, using cetane number improver, substantial decrease in CO emissions was achieved . Consequently, similar to HC emissions, the lower cetane number of n-pentanol plays a dominate role in the increase of CO emissions. Concerning the CO emissions of neat diesel fuel, it exhibits a slight increase from engine load of 7.30 bar.

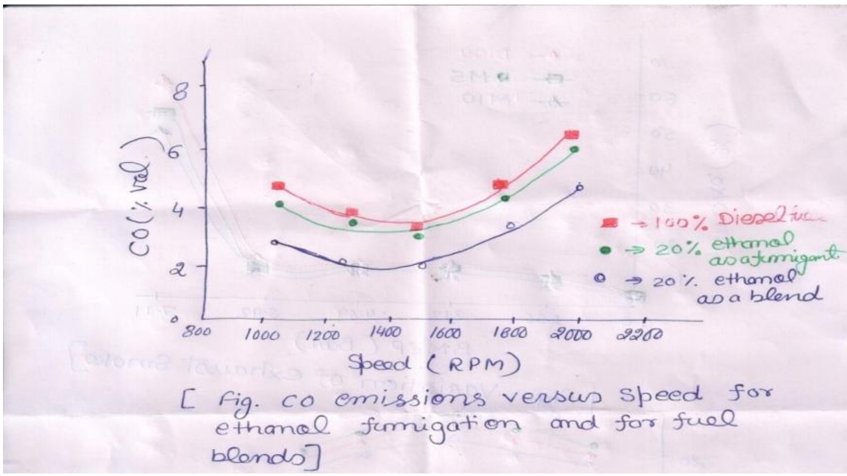
The effect of n-pentanol addition on nitrogen oxides (NOx) emissions is given in . In general, NOx emissions increases with the engine load for all n-pentanol /diesel blends as well as for diesel fuel. in-cylinder gas temperature increases with the increase of engine load, leading to higher NOx emissions. NOx emissions of n-pentanol/diesel blends show no noticeable difference at low engine load. Pentanol /diesel blends and higher percentage of n-pentanol leads to higher NOx emissions at a given engine load. In diesel engine, several factors are related to the NOx formation process for alcohols/diesel blends . First, alcohols, like ethanol, butanol and pentanol have lower cetane number than diesel fuel, which leads to longer ignition delay. Consequently, more blend fuel is injected into the combustion chamber during the ignition delay period, resulting in more fuel being burned in the premixed combustion phase and hence elevating the in-cylinder gas temperature. Second, the oxygen content contained in n-pentanol might assist NOx formation.

4.1 Blending the Ethanol

The effects of ethanol / diesel fuel blends and ethanol fumigation (the addition of ethanol to the intake air manifold) on the performance and emission of a single cylinder diesel engine . the optimum percentage of ethanol that gives shortest emissions and better performance at the same time . it is apparent from the increasing popularity of light – duty diesel engine that alternative fuels , such as alcohols , must be applicable to diesel combustion if they are to contribute significantly as substitute s for petroleum based fuels . however , little attention has been given to the utilization of alcohol fuels in compression ignition engines . although replacing diesel fuel entirely by alcohols is very difficult , an increased interest has emerged for the use of alcohols and particularly lower alcohols (methanol and ethanol) with different amounts and different technique in diesel engines as a dual fuel operation during recent years.



The effect of ethanol substitution on CO and HC production, respectively .The maximum increase in CO and HC emissions was at 20% ethanol for both the fumigation and blends methods. Also, the CO and HC emissions were always higher when using the blended fuels than when the engine operated with fumigation. For 20% ethanol fumigation, the increase in CO emissions was in the range of 21±55% at the speed range used, and for 20% ethanol as a blend with diesel fuel, the increase in CO emissions was in the range of 28±71.5% at the same speed range used. The increase in the CO levels with increasing ethanol substitution is a result of incomplete combustion of the ethanol ±air mixture. Factors causing combustion deterioration (such as high latent heats of vaporization) could be responsible for the increased CO production. Combustion temperatures may have had a significant effect. A thickened quench layer created by the cooling effect of vaporizing alcohol could have played a major role in the increased CO production. Another reason for the increasing CO production is the increase in ignition delay. This could lead to lower temperatures throughout the cycle. This results in combustion of a proportion of the fuel in the expansion stroke, which lowers temperatures and reduces the CO oxidation reaction rate.



The effect of ethanol substitution on HC emissions. For 20% ethanol Fumigation ,the increases in HC emissions were between 20 and 36%, and for 20% ethanol as a blend with diesel fuel, the increases were between 25 and 49% over the entire speed range. The HC emissions tend to increase because of the quench layer of unburned fumigated ethanol present during fumigation. There is no quench layer with diesel fuel injection alone because the combustion is droplet-diffusion controlled and completely surrounded by air.

V. RESULT & CONCLUSION

FUEL	EMISSIONS					EFFICIENCY	IGNITION DELAY
	NOX	CO	HC	Engine smoke	Soot		
METHANOL	Decrease with increase methanol percentage on full load	Reduce with increase methanol percentage on full load	Increase with increase methanol percentage	Reduce with increase methanol percentage	-	Reduction with increase in Methanol percentage on full load.	increase
ETHANOL	-	increase	increase	reduction	Reduction	Decrease at max. speed	increase
PENTANOL	increase	decrease	decrease	-	-	Not affected	increased

VI. LIMITATION

In this research we find out blending of methanol decrease the efficiency as well as increase the Ignition delay and in case of ethanol and pentanol the ignition delay also increases. So we need to improve the composition and blending fuels so find it will also reduce ignition delay .

VII. FUTURE SCOPE

We can also blend the alcohol (methanol , ethanol, pentanol) with petrol and it will be interested to observe the effect of blending alcohol on petrol engine performance and emissions.

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