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Effect of Nox Emissions in a Bio-Fuelled Di Diesel Engine

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ABSTRACT: Biodiesel is associate ventilated diesel oil made up of vegetable oils and animal fats by changing the tri-glyceride fats to esters via varied esterification processes. A number of studies have shown substantial particulate matter (PM) reductions for biodiesel and biodiesel(canola oil) blended with petroleum diesel relative to petroleum diesel. However, most studies also show a significant increase in nitrogen oxides (NOx) emissions. The causes of this increase in NOx and solutions to this problem have been the subjects of research for considerable time. In the Internal Combustion Engine, at high temperature, oxidation of nitrogen takes place and a significant amount of NOx will be formed at the end of combustion. The majority of NOx formed will however decompose at the low temperatures of exhaust. But due to very low reaction rate at the exhaust temperature, a part of NOx formed remains in exhaust. It is fair in excess of the equilibrium composition at that temperature though the formation of NOx freezes at low exhaust temperature. Experimentation in this area with a new approach using Cetane improvers for NOx reduction from biodiesel would increase the basic fuel properties of biodiesel. Perhaps the most practical strategy for NOx reduction in the short term is the use of Cetane improvers. This is because, some additives caused an increase in Particulate emission which may severely limit the marketability of biodiesel, and hence the Cetane enhancers are the choices for experimentation in reducing NOx emissions, and at the same time with the use of some anti-oxidants basic quality of fuel could be enhanced for biodiesels.

Keywords : Nitrogen oxides, Particulate matter, Cetane improvers

I.INTRODUCTION

Renewable fuels continue to be of interest to achieve a sustainable energy economy and reduce the effects of fossil fuel utilization. Use of renewable transportation fuels are expanding, and a national five percent renewable fuel has been proposed in recently considered energy, related legislation. The primary renewable transportation fuels like ethanol is derived from animal fats and vegetable oils. In the latter case, the fatty acid methyl esters from tranesterified animal fats and vegetable oils, referred to as biodiesel, can provide significant reductions in particulate matter,CO and HC emissions but increase in NOx emissions of 2-4% for B20 blends (eg. A blend of 20vol % biodiesel in diesel fuel) and as much as 10% for B100.

Recycled corn-oil delivered biodiesel produced significantly lower NOx than the baseline diesel fuel, while the canola oil delivered biodiesel produced significantly higher NOx than the baseline diesel fuel. Application of pure canola oil as an inexpensive and convenient diesel engines has hardly been promoted attributable to some technical issues associated with its high density, viscosity, poor filtration and low volatility.. Main advantage of canola oil to be used is that is has high oxygen content of the fatty acids and therefore more complete combustion and lower emission of harmful species, such as particulate matter and smoke can be achieved. As other renewable fuels, canola methyl ether is biodegradable, non-toxic and sulphur free and at heavy loads and high gas temperatures, no sulphates are formed.

Biodiesel may be created from more cost effective fats, as well as inedible beef fat, pork fat, duck fat, fish fat and yellow grease. These new materials can be suitable for biodiesel production. Besides, their high cetane range and heating values area unit near that of the diesel oil and their chemical element content create animal fats to have surplus advantage. Animal fats area unit extraordinarily viscous and mainly in solid sort at shut temperature thanks to their high content of saturated fatty acids. The high viscous fuels cause poor atomization of the fuel and cause incomplete combustion. The high viscous fuels cause poor atomization of the fuel and lead to incomplete combustion. Transesterification and emulsification are two solutions that have appeared as effective strategies for victimization animal fats in diesel. The fuels created by these strategies from animal fats and edible fat cut back waste emissions and improve combustion. Animal beef fat and port fat generated bio-diesel offers a large vary of energy, environmental, and economic advantage as explicit by Nelson and schrock.

The choice of edible fat as engine fuel naturally depends upon the native conditions prevailing convenience of a specific edible fat in excess quantity. There area unit numerous oils that area unit being thought of worldwide to be used within the engines, these embrace Karanja oil, Rice bran oil, sunflower oil, Soyabean oil, Rape seed oil, Madhucalatifolia oil, Jatropha oil and etc. From previous studies it is evident that these area unit numerous issues related to edible fat, being employed as fuel in C.I engines. There area unit in the main caused by the high body worth of the edible fat. This higher body is because of free carboxylic acid gift within the oil. This free carboxylic acid because of giant molecular mass and chemical structure of edible fat, that successively results in drawback in pumping, combustion and atomization in C.I engines so it\'s necessary to cut back the free carboxylic acid and body of edible fat to form it appropriate as another fuel for ICE.

In the present work, transesterification method has been taken as a method for conversion of edible fat to bio-diesel. Exhaust gases of associate engine will have upto 2000ppm of oxides of nitrogen. Most of this may be pollutant (NO), with a tiny low quantity of nitrogen di-oxide (NO_2). NOx is very undesirable. Laws to scale back Nox emissions still become additional and additional tight year by year. Released Nox reacts within the atmosphere to create gas and is one in every of the key causes of chemical science smogginess (photochemical smog). Nox is formed principally from gas within the air. Nitrogen can also be found in fuel blends. At warmth and pressure higher levels of Nox is formed and at temperature lower level of Nox is made. Additionally to temperature, the formation of Nox depends on pressure and air-fuel quantitative relation.

The objective of this work is propsed by reduction of Nox level over the exhaust gases with the fuel of Canola blended diesel oil and cetane improver of DEE added for enhancing the pollutant free environment.

II. CETANE NUMBER & IMPROVERS

. The fundamental quantity between the beginning of injection and therefore the initial pressure increase throughout combustion of the fuel. In an exceedingly specific diesel engine, higher cetane fuels can have shorter ignition delay periods than lower Cetane fuels. Diesel engines run well with a CN from 40 to 55. Hence, higher speed diesels operate additional effectively with higher cetane number fuels. There is no performance or emission advantage once the CN is raised past approximately 55; Diethyl ether might prove advantageous as a future diesel oil because it incorporates a high cetane rating .

CETANE IMPROVERS:

Cetane improver is associated with un-branched chemical chain methane series molecule that ignites at low compression, Thus it absolutely was assigned a cetane variety of one hundred, whereas alpha-methyl hydrocarbon was assigned a cetane variety of zero. All different hydrocarbons in diesel oil are unit indexed to cetane on however well they ignite below compression. The cetane variety thus measures however quickly the fuel starts to burn (auto-ignited) below internal-combustion engine conditions.

PROPERTIES OF DEE:

Formula	: $(C_2H_5)_2O$
Density	: 713.40 kg/m³
Boiling point	: 34.6 °C
Molar mass	: 74.12 g/mol
Melting point	: -116.3 °C
IUPAC ID	: Ethoxyethane
Classification	: Ether

DIESEL ENGINE POLLUTANTS:

The pollutants from diesel fuel vehicles are Particulate Matter (PM), smoke, NOx, Sulphur di-oxide, CO and HC. Most pollutants are emitted from the exhaust. Because diesel engines operate at high air-fuel ratios, they tend to have low HC and CO emissions. They have considerably higher PM emissions than gasoline fueled vehicles, however for heavy –duty vehicles CO,HC and NOx emissions in the exhaust also vary with driving modes, engine speed and load.

III. NOx FORMATION MECHANISM

NOx is formed by reaction between oxygen and nitrogen in the combustion chamber dramatically increases with increasing combustion temperature, combustion efficiency and combustion pressure. At high temperature, the following chemical reaction takes place behind the flame:

$$\mathbf{N_2 + O_2 \rightarrow 2NO}$$

Chemical equilibrium calculation show that a significant amount of NOx will be formed at the end of combustion . But due to very low reaction rate at the exhaust temperature a part of NOx formed remains in exhaust. It is fair in excess of the equilibrium composition at that temperature as the formation of NOx freeze at low exhaust temperature. NOx emissions can be reduced by reducing power, lowering the intake air temperature, retarding the injector timing, reducing the coolant temperature and reducing the combustion temperature. These often reduce fuel economy.

NO FORMATION:

Diesel fuels contain more nitrogen. In combustion of neat stoichiometric fuel-air mixtures, the principal reactions governing the formation of NO from molecular nitrogen are

$$\mathbf{O + N2 \rightarrow NO + N}$$
$$\mathbf{N + O\,2 \rightarrow NO + O}$$
$$\mathbf{N + OH \rightarrow NO + H}$$

NO_2 FORMATION:

Chemical equilibrium considerations indicate that for burned gases at typical flame temperatures, NO_2/NO ratios should be negligibly small. A plausible mechanism for the persistence of NO_2 is the following. NO formed in the flame zone can be rapidly converted to NO2 via reactions such as,

$$\mathbf{NO + HO_2 \rightarrow NO_2 + OH}$$
$$\mathbf{NO_2 + O \rightarrow NO + O_2}$$

FORMATION OF CARBONMONOXIDE:

The appearance of carbon monoxide in combustion process is generally a simple result of oxygen insufficiently either on an overall or local basis. In principle the concentration of carbon monoxide contained in exhaust products should correspond to a chemical equilibrium state represented by the water gas equation.

$$\mathbf{H_2O + CO \rightarrow H_2 + CO_2.}$$

At maximum flame temperature this equilibrium yields significant quantities of CO relative to CO_2 even for fuel lean mixture ratios. However, as combustion gases cool from peak flame temperatures to the much lower temperatures characteristic of exhaust products, this equilibrium shifts in a direction favoring oxidation of CO to CO_2 .

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IV. EXPERIMENTAL PROCEDURE

The engine was allowed to run with Biodiesel (solefuel) at various loads for nearly ten minutes to attain the steady state and constant speed conditions. Then the following observations were made.

1. The water flow was maintained constant throughout the experiment.
2. The load, speed and temperature indicators were switched on.
3. The engine was started by cranking after ensuring that there is no load.
4. The engine was allowed to run at the rated speed of 1500 rev/rpm for a period of 15 minutes to reach the steady state.
5. The fuel consumption was measured by a stop watch.
6. The amount of NOx, HC and CO were measured using exhaust gas analyser.
7. The exhaust temperature was measured by using a sensor.
8. Then the load was gradually applied by 20,40,60,80 and 100 % respectively.
9. Each load readings were noted.
10. First, engine was operated different blends of biodiesel like B30, B70 and B100 and the readings were noted.
11. Then the engine was run by B30,B70 ,B100 with adding of 1ml, 3ml and 5ml of DEE.
12. Experiment was conducted using solefuel and solefuel with cetane improver of DEE.
13. From the readings of added DEE, without DEE graph was plotted based on the tabulated readings.

VI. RESULTS AND DISCUSSION

Fig.6.1 Shows that the variation in hydrocarbon emission with load of Blended (B30) solefuel with additive of 0.001%,0.003% and 0.005%DEE. From low load to high load HC emission is increased. At peak load condition the friction power found to be higher than no load condition. At this stage more amount of fuel has been consumed. HC emission is remarkable in the idling and low load because of high heat of vaporization of the fuel. By increasing cetane number and shortening of ignition delay could be expected to reduce the HC emission.

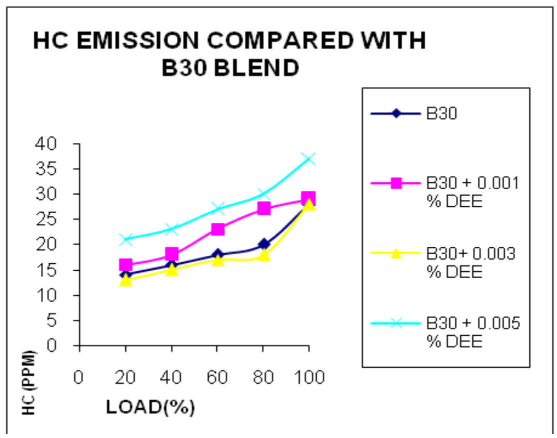

Fig.6.1

Fig.6.2 Shows that the variation in Carbon monoxide emission with load of Blended (B30) sole fuel with additive of 0.001%,0.003% and 0.005% DEE.CO concentration is lower at the idling and low load and it is slightly increased at high load because an increased premixed combustion due to longer ignition delay.

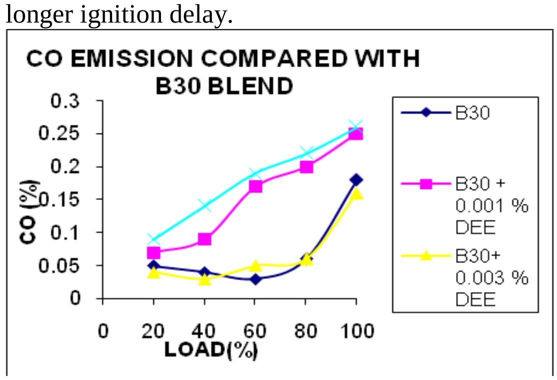

Fig.6.2

In this Fig.6.3expose that the variation in NOx emission with load of Blended (B30) sole fuel with additive of 0.001%,0.003% and 0.005%DEE. An increase in the cetane number is accompanied by a reduction in the ignition delay and it will lead to less mixture being involved in premixed combustion , leads to lower peak cylinder gas temperatures and lower NOx formation rates. On the other hand, with start of combustion at TDC, the premixed combustion period always occurs after TDC, when the gases are expanding. This has the effect of moderating the combustion temperature and the exhaust NOx level.

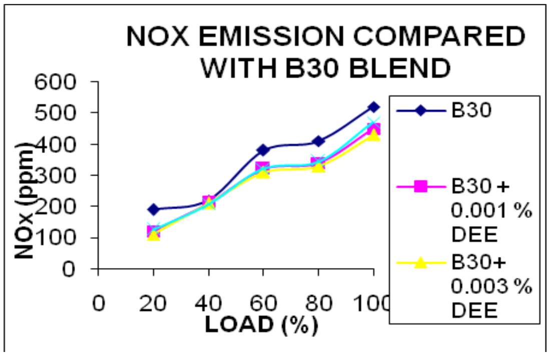

Fig.6.3

Fig.6.4 Shows that the variation in hydrocarbon emission with load of Blended (B70) sole fuel with additive of 0.001%,0.003% and 0.005% DEE. From low load to high load HC emission is increased. Unburnt hydro carbons come under different forms such as vapour, drops of fuel or products of fuel after thermal degradation and HC emissions contribute to the formation of smog.

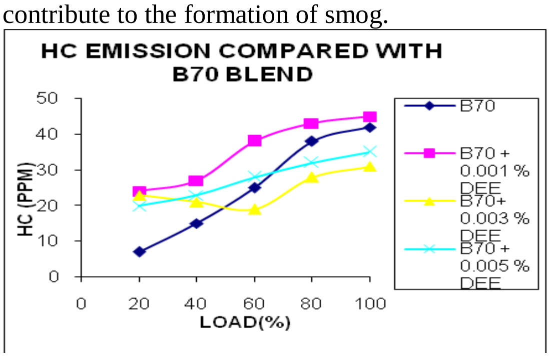

Fig.6.4

Fig.6.5 Shows that the variation in Carbon monoxide emission with load of Blended (B70) sole fuel with additive of 0.001%,0.003% and 0.005% DEE.CO concentration is lower at the idling and low load and it is slightly increased at high load because an increased premixed combustion due to longer ignition delay. Low flame temperature and too rich fuel –air ratio are the major causes of CO emissions from engine. Higher CO emissions results in loss of power in engine.

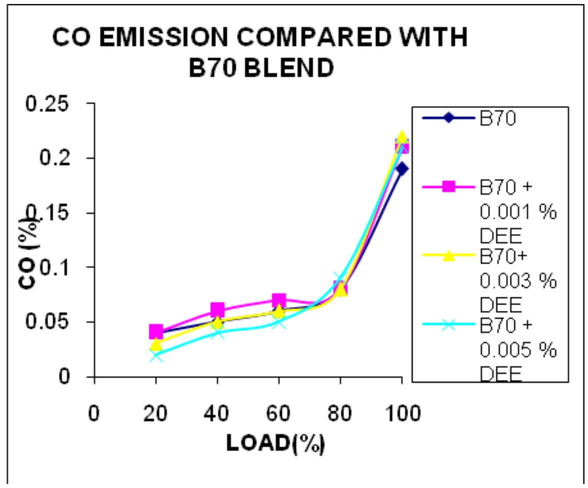

Fig.6.5

In this Fig.6.6 expose that the variation in NOx emission with load of Blended (B70) sole fuel with additive of 0.001%,0.003% and 0.005%DEE. On the other hand, with start of combustion at TDC, the premixed combustion period always occurs after TDC, when the gases are expanding. This has the effect of moderating the combustion temperature and the exhaust NOx level.

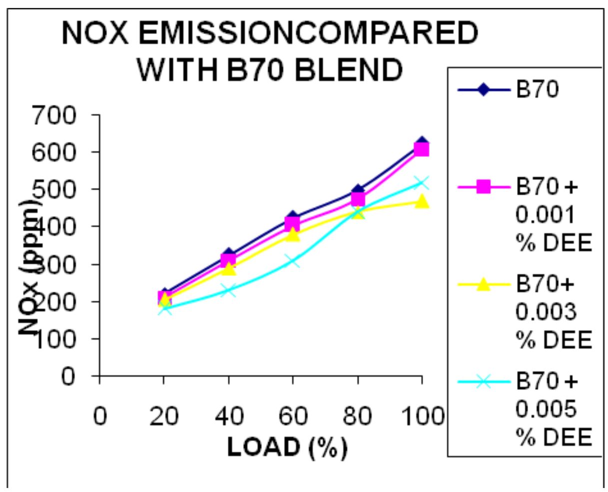

Fig.6.6

Fig.6.7 Shows that the variation in hydrocarbon emission with load of Blended (B100) sole fuel with additive of 0.001%,0.003% and 0.005% DEE. From low load to high load HC emission is increased but average reduction in medium loads

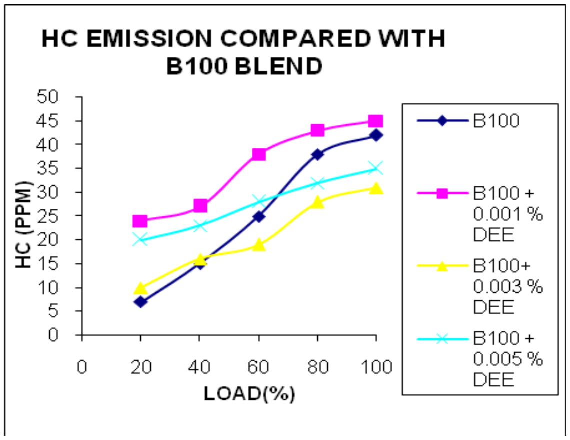

Fig.6.7

Fig.6.8 Shows that the variation in Carbon monoxide emission with load of Blended (B100) sole fuel with additive of 0.001%,0.003% and 0.005% DEE.CO concentration is lower at the idling and low load and it is slightly increased at high load because an increased premixed combustion due to longer ignition delay. Carbon spheres are generated in the combustion chamber in the fuel rich zones where there is not enough oxygen to convert all carbon to CO2.But in 0.003% DEE which lead to low flame temperature and too lean fuel – air ratio are the major causes of reduction of CO emissions from engine.

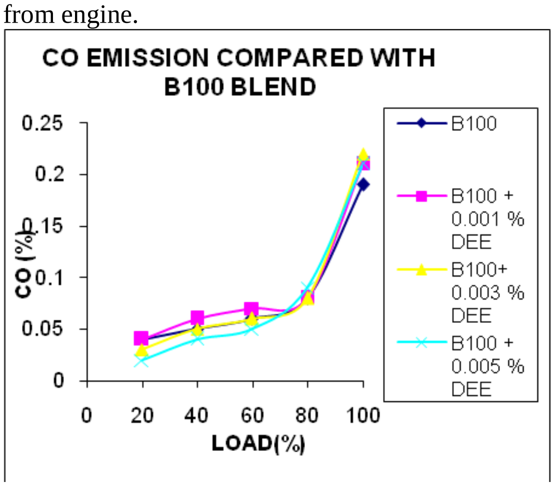

Fig.6.8

In this Fig.6.9 shows that the variation in NOx emission with load of Blended (B100) sole fuel with additive of 0.001%,0.003% and 0.005%DEE. Oxides of Nitrogen depends on pressure and air-fuel ratio. In B100, leads to increase in NOx in 0.005% DEE on because accumulation of fuel in combustion chamber, i.e., increase in air-fuel ratio which lead to increase in temperature of the engine.

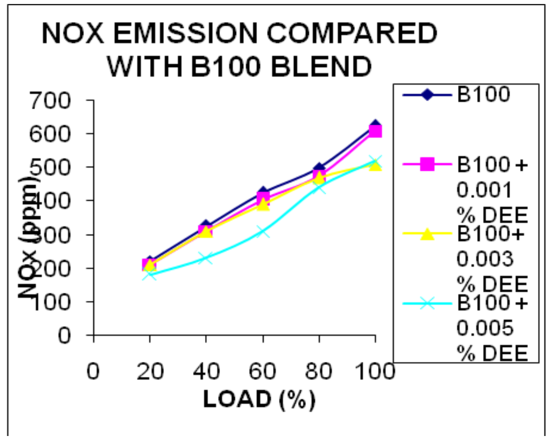

Fig.6.9

V.CONCLUSION

Considering the experimental results, it is possible to draw following conclusions. Most of studies report slight increase in NOx emissions when using biodiesel fuels. B30 blend fuel with 0.003% of Ethylal produces significant reduction in NOx emission when compared to sole diesel fuel, 0.001%, 0.005% of Ethylal. Biodiesel blends of B30, B70, B100 were tested in the engine without Ethylal as an additive. B70 blend without Ethylal as an additive produces significant reduction in NOx emission. Biodiesel blends of B30, B70, B100 were tested in the engine with Ethylal as an additive. Ethylal or DEE used as an additive of 1ml, 3ml, 5ml respectively.

B30 blend with 3ml of DEE produces 8.2% reduction in NOx emission and also significant reduction of HC, CO emissions. B70 blend with 3ml of DEE produces moderate reduction in NOx emission than B30 blends. From the above analysis, B30 blend with 0.003% of DEE or Ethylal is selected as suitable cetane proportion to reduce the NOx emission in canola ester. The variation in the exhaust emissions of a diesel engine using sole diesel fuel were investigated and compared to those with the biodiesel blends. The blends containing 30%, 70%, 100% canola ester were prepared and tested in a single cylinder diesel engine. It indicates good response over B30 blend with 0.003% of DEE or Ethylal gives better performance of reduction of NOx content over the existing system.

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