An Approach of Investigation of NOx in CI Engine and Reducing it by Water Mixing with Diesel

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Abstract: There is a large use of C.I engine with many advantages, they produce a massive range of pollutants. Diesel engines are known as one among the largest individuals to environmental difficulties resulting from exhaust emissions and they are the motives for fitness unsafe as well. Nitrogen oxides (NOx) and particulate matters (PM) are the main pollution from diesel engines. The present investigation focuses on the have a look at on simultaneous reduction of NOx and smoke emissions by using water emulsion of Cottonseed oil methyl ester (CSME) in a single cylinder, direct injection diesel engine. The quantity of water changed into various from 10 % to 30 % (by way of vol.) in steps of 10%. Water-emulsified diesel gasoline has been tested to reduce nitrogen oxides (NOx) and smoke concurrently at the surprisingly low cost compared to different emission manipulate strategies.

Keywords- Diesel engine, Water-diesel emulsion, NOx, Combustion Chamber, water mixing

I. INTRODUCTION

There are basically two types of Internal Combustion Engines (I.C Engine). One is Petrol engine (S.I Engine) and other is Diesel engine (C.I Engine). Diesel engine has a better efficiency, good durability, fuel economy, and power than the Petrol Engine. So Diesel engine mainly used in heavy duty applications. Diesel engine generally used in transporting, industrial, agricultural and power generating sector. Diesel engine has many advantages but it produce large amount of pollutants which is hazardous to the human health. Diesel engine is a major source of black smoke, particulate matters (PM), sulphur oxide (SO2), carbon dioxide (CO2), carbon-monoxide (CO) [1]. Combustion of fossils fuels is the biggest contributor to the climate change representing 57% of the total greenhouse gases [2]. Researchers have to do two main tasks in developing I.C Engines. One is improving the efficiency of diesel engines and other is to reduce the emissions from engine. [4] EGR reduces the NOx but it increases the soot (PM) formation. Another method is enriching oxygen, it reduces the level of soot (PM) formation but on other hand it increases the production of NOx. We cannot use these both methods in combination because of high cost [8]. There are four methods of introducing water into combustion zone.

1. Circulating the water into engine intake air
2. Injecting water droplet directly into combustion zone with separate injectors.
3. Mix the water and air in line prior to the injection (unstable emulsion).
4. Mixture of water and diesel as stable emulsion as a single phase [4].

Water in Diesel emulsion (W/D emulsion) is one of the methods to reduce the emissions from engine exhaust and improve performance of engine. W/D emulsion uses as fuel in C.I engine without any change in engine. [3]. Water in W/D emulsion is generally used for clean combustion. Presence of water reduces nitrogen oxides (NOx) and soot (PM) formation. Actually the water in diesel reduces the flame temperature hence it reduces NOx production.

II. RELATED WORKS

When diesel and water mixed directly, diesel comes at top and water settles at bottom because diesel is lighter than the water. Prof. B Hopkinson introduced the water in diesel emulsion in diesel engine for improvement of the thermal efficiency and minimizes the exhaust emissions of engines.[7] Emulsion fuel is mixture of two completely immiscible liquids which are not blend completely. In emulsion one substance is completely distributed throughout the other substance [8]. By taking proper surfactants (emulsifiers) we can bind these two together. Surfactant is the compound that lowers the tension between the two liquids which are immiscible. It bound them together to prepare a proper stable

emulsion. Surfactants are used to make kinetically stable W/D emulsion fuel. It depresses the tension between water and diesel molecules. Interface surface tension among two liquids, solids, and gases absorbed by the surfactants.[9] In water diesel emulsion, water mixes homogeneously with the diesel on volume basis. A surfactant is used to make stable emulsion. This W/D emulsion doesn't require any change in engine so it is very convenient fuel to use. Emulsions are basically classified into two types. One is water in oil emulsion and other is oil in water emulsion (Fig. 1). Water in diesel emulsion comes under the water in oil emulsion type.[8]

III. MATERIALS AND METHODS

Preparation of bio-diesel: Cotton seed oil was selected for this study and it is converted into its methyl ester by the transesterification process. In transesterification reaction, 8gram of KOH catalyst per litre of oil was mixed with 200 ml of methyl alcohol to produce methoxide. The methoxide and the Cottonseed oil mixture were heated at 65°C with constant strirring. The reaction was allowed for one hour and the final products were allowed to settle in the separating funnel for 8hrs and then the settled glycerin layer was drained off. After decantation of glycerol, the methyl ester was washed with distilled water to remove excess methanol. The properties of cotton seed oil methyl esters were found out and compared with that of diesel. The comparison shows that the methyl ester properties have relatively closer to properties of diesel fuel. The properties of diesel, cotton seed oil and its methyl ester are listed in Table.1. Water was added in the ratios of 10%, 20% and 30% with biodiesel by volume and emulsified.

Table 1 Properties of Diesel, Cotton seed oil and its methyl ester

PROPERTIES	DIESEL	COTTONSEED OIL	CSME
Density (kg/m^3)	840	910	880
Viscosity(mm^2/s)	3.8	55.6	5.37
C.V (MJ/kg)	42.5	38	38.45
Flash Point (^{o}C)	50	207	200
Fire Point (^{o}C)	60	230	220
Cetane Number	47	42	52

When combined right, diesel being a lighter liquid than water comes to the pinnacle and water slowdown within the backside. By using an appropriate surfactant the molecules of water and diesel may be certain together. The balance of the emulsion made is very vital because if it's not strong for an appreciable length of time it won't be almost useful. Using water mixing agent with diesel has many advantages on exclusive approaches. It has been describing in lots of preceding researches that it reduces the flame temperature consequently reducing the NOx emissions substantially. Mixing of water additionally improves atomization and combining that's attributed to droplet microemulsion. The better mixing is due to the stepped forward vaporized jet gas momentum giving air more way to get into the fuel jet. This additionally helps in reduction in NOx from the diffusive burning portion of combustion event as well as decreasing the carbon formation. This effects along with the chemical consequence of water effects in the increase in ignition put off. There is likewise an in-depth proof that mixing water with diesel can reduce the soot particulates and smoke emission. There has been a developing importance in diesel fuel enterprise to supply and observe the diesel water the combination of usable fuels for diesel engines. However its effect on the heat instability passage the combustion chamber components i.e. Cylinder heads and cylinder liners, chamber temperature, and thermal loading. In the supply work, there is carried out a CFD analysis mixing diesel and water with 94.5 % diesel + 4.5% water + 0.5% of 20 + 0.5% span 20 Now a solid-liquid was received. The liquid becomes milky white in color and persevered as it is a completely lengthy time frame. This will use a new fuel.

Experimental set up: A Kirloskar Diesel engine of AV1 version, 4 strokes, direct injection, water cooled diesel engine changed into used to research this study. The schematic of the experimental set-up is shown in Fig. 1. The engine changed into coupled with an eddy contemporary dynamometer. Fuel glide charges are obtained with the calibrated burette. The cylinder pressure changed into measured through a piezoelectric sensor (Make: Kistler and model 6056A). The pressure signals had been amplified with a price amplifier (Make: Kistler and version 5011B) and analyzed with a combustion analyzer to

reap the warmth release charge. A crank angle encoder became hired for crank-perspective signal acquisition. The exhaust gas emissions like CO, HC, and NO have been measured with the assist of AVL-444 five fuel analyzer and the smoke emissions were measured by way of Bosch smoke meter. Inlet and outlet water temperatures and exhaust fuel temperatures were measured by the use of K kind thermocouples. The engine specs are indexed in Table.1. The experiments have been carried out in different hundreds like 25, 50, seventy-five% and 100% load with emulsified biodiesel. Similar experiments were carried out with diesel fuel, biodiesel fuel on the way to make comparisons.

Table 2 Test Engine specifications

Engine	Kirloskar, AV-I,
Power(kW)	3.67
Bore (mm)	80
Stroke(mm)	110
Compression ratio	16.5:1
Speed (rpm)	1500
Number of cylinders	1

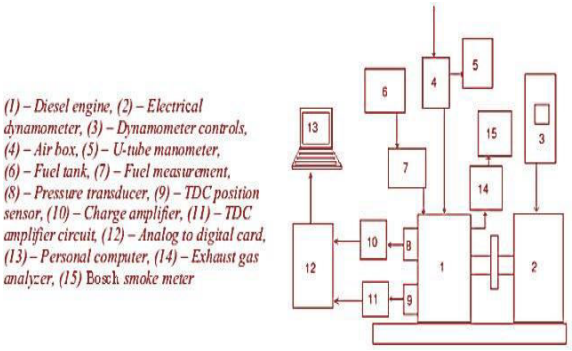

Fig. 1 Experimental setup

IV. RESULTS AND DISCUSSIONS

The variations of brake thermal efficiency (BTE) with brake power for all test fuels shown in Fig.2. The brake thermal efficiency increases with the increase in load for all test fuels. The BTE of biodiesel is lower than that of diesel fuel due to its lower calorific value and volatility. The BTE of biodiesel with water emulsified fuel gives slightly higher BTE at full loads compared to biodiesel. This may be due to the micro explosion phenomenon and volatility difference between water and fuels, which enhances the air fuel mixing during higher engine loads and hence the improvement in combustion efficiency. This could be the possible reason for higher BTE even though the calorific values of the emulsions are less than that of biodiesel.

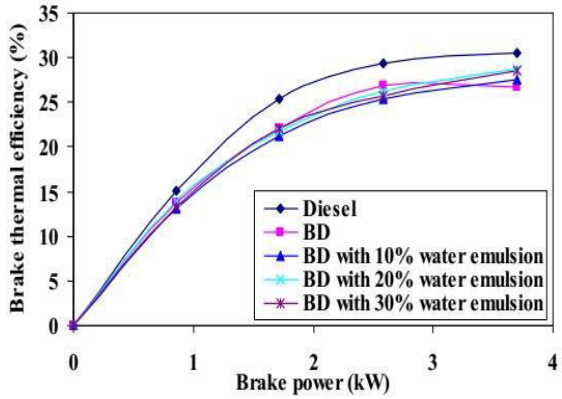

Fig. 2. Variations of brake thermal efficiency with BP

Figure 3 shows the variation of brake specific fuel consumption (BSFC) with brake power for all the test fuels. The BSFC of all the test fuels are decreases with increase in load. It is observed that the 10% water emulsion of biodiesel has higher specific fuel consumption as compared to diesel and biodiesel fuel. The BSFC of diesel fuel and biodiesel fuel are fuel is 0.242 kg/kW-h and 0.257 kg/kW-h where as for 10% water emulsion biodiesel is 0.278 kg/kW-h at full load. This is due to lower energy content of biodiesel which has resulted in more fuel consumptions for all the emulsified biodiesels.

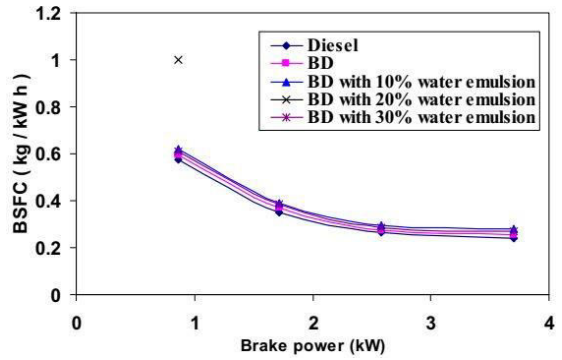

Fig. 3. Variations of brake specific fuel consumption with BP

IV. CONCLUSION

In this have a look at, the test changed into carried out to have a look at the performance, combustion and emission traits of a diesel engine with 10%, 20% and 30% water emulsified biodiesel and the results had been in comparison with the biodiesel gas. From this experimental take a look at, the subsequent conclusions were drawn.

1. The brake thermal performance is improved by 3.23%, 7.0% and 6.67% for 10%, 20%, and 30% emulsified biodiesel as compared to biodiesel at full load.

2. The exhaust gasoline temperature is reduced via 26% to 30% emulsified biodiesel and for 20% and 10% emulsified biodiesel is sixteen% and 6% is discovered respectively as compared to biodiesel at full load.

3. The CO emission is multiplied for all emulsified biodiesel because of water content gift inside the biodiesel, whereas the HC emission is reduced by means of 29% for 30% emulsified biodiesel and for 20% and 10% emulsified biodiesel it's miles 21% and 12% respectively compared to biodiesel at complete load.

4. The NO emissions are decreased by means of 30% to 30% emulsified biodiesel and 24% reduction for 20% emulsified biodiesel and sixteen % discount for 10% emulsified fuel in comparison to biodiesel and full load.

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