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An Experimental Investigation to Study the Effects of Various Nano Particles with Diesel on Di Diesel Engine

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ABSTRACT

The world at present is confronted with the twin crisis of fossil fuel depletion and environmental degradation. Increase in energy demand, stringent emission norms and depletion of oil resources have led the researchers to find alternative fuels for internal combustion engines. Various alternative fuels like CNG and LPG have been commercialised all over the world. The objective of this project is to analyze the possible effects of adding nano particles with diesel. The project is conceived after understanding the real need to improve the efficiency of the diesel engine without influencing the emissions to a severe degree. The nano particles are using for project is Zinc Oxide and Copper oxide, this project involves two separate tests on same composition of these nano particles with the values of diesel used as a reference. In the present work, experimental investigations have been carried out on using ZnO nano particle with diesel. The present work mainly focuses on comparing the different nano particles with diesel to improve the performance of compression ignition engine. In phase II we take another nano particle was to take to investigate to improve the performance of DI Diesel engine.

Keywords: *Diesel, Zinc oxide nano particle alternate fuel.*

1. INTRODUCTION

Today the prime mover used for heavy duty machines are the engines, the efficiency of the engine is improved by reducing the fuel consumption rate or effectively utilizing the fuel. This project deals with an innovative method to improve the efficiency by reducing the fuel consumption and improving the combustion using nano- particles. The various alternate fuels such as bio fuels, alcohol based fuels, nano-fuels, etc. made to satisfy the insatiable human need for fossil fuels (diesel and petrol) for ease of transport is well documented and appreciated by its own accord. In this paper, the characteristic of the diesel engine using diesel as fuel is taken as the benchmark reading and the nano particle like copper oxide and zinc oxide were mixed with the diesel and the performance were compared.

2. LITREATURE REVIEW

Md. Hossain et al. (2012) emphasized the demand for the diesel fuel, because the fuel diminishing year by year. The alternate solution is search for a new fuel. So the author used the coconut oil with different propositions and found the optimal mix of coconut oil with diesel. The performance was carried out with a single cylinder diesel engine. So in this work also the single cylinder diesel engine is used to test the performance of the engine. Andrea Kleinova and Jan cvengros (2011) demonstrated the performance of the engine with the diesel ethanol blending. Ajav and Akingbehin (2002) analysed the various properties of the diesel blended with ethanol at various propositions. The paper finally concludes that the relative density and the viscosity of the fuel depend on the temperature and the blending should be done such a way that the density and viscosity should be less than the diesel. Oghenejoboh and Umukoro (2011) implemented the concept of bio diesel form the seeds.

Jamil et al. (2006) developed the filter for soot deposition in the diesel filter using one dimensional varying nano equations. Tajammul and Hasib (2009) developed a nano catalyst to convert the carbon-di-oxide into hydrocarbons. Titanium-di-oxide was used to withstand the high temperature of 700 K and the velocity of 7000 /h. Yanan Gan and Li Qiao (2001) investigated the burning characteristics of fuel droplets containing nano and micron-sized aluminium particles. Arul Mozhi Selvan et al (2009) experimented the performance and emission characteristics of a compression ignition engine while using cerium oxide nano particles as additive in neat diesel and diesel-biodiesel-ethanol blends. Hongbin Ma et al (2008) investigated the Diesel Nan particle for Nucleation Mechanisms. These nano particles are mainly formed by nucleation as diesel engine exhaust gas cools and dilutes in the atmosphere.

3. NANO PARTICLE CHARACTERISTICS

Nano particles typically measure 1 to 100 nm in diameter. This property of the material changes as the size of the particle changes. In this project work zinc oxide are taken for experimentation. Zinc oxide nano particles were used. The chemicals used for synthesis are Zinc acetate 2.1g in 100ml, Ammonium carbonate 0.96g in 100ml, Polyethylene glycol (5%) 5g in 100ml. The structure of zinc oxide and copper oxide is given in the figure 1.

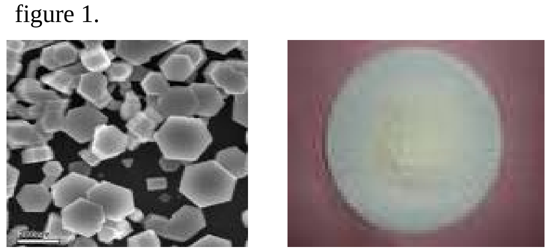

Fig 1: Structure of Zinc Oxide Nano Particles

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4. EXPERIMENTAL SETUP AND PROCEDURE

The engine used for testing is single cylinder four stroke vertical water cooled diesel engine. The load is given using the electrical dynometer and the readings are measured using sensors and the data acquation system. The exhaust gas analyzer is used to measure the level of various gases formed during combustion Figure 2.

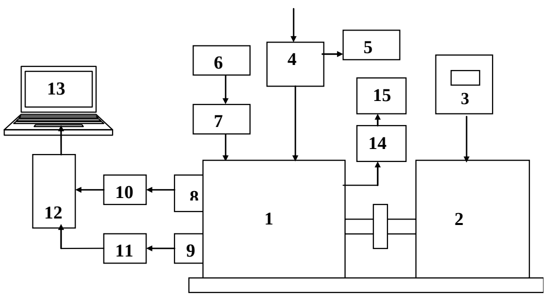

Fig 2: Experimental setup

1. Diesel engine
2. Electrical Dynamometer
3. Dynamometer controls
4. Air box
5. U-Tube manometer
6. Fuel tank
7. Fuel measurement Flask
8. Pressure pickup
9. TDC position sensor
10. Charge Amplifier
11. TDC Amplifier Circuit
12. A/D converter
13. Computer
14. Exhaust gas analyzer
15. AVL Smoke meter

The blending of the Nano particles with the diesel is the most pivotal step in our project. There are two important issues that we need to alleviate through this blending procedure are to ensure that the nano particles are well dispersed in the diesel and to ensure that the clinker phenomenon does not occur wherein the nano particles stick together to form circular clusters due to the high temperature inside the engine cylinder and clog the nozzle. This was achieved in this project by using magnetic stirrer. A magnetic stirrer or magnetic mixer is a laboratory device that employs a rotating magnetic field to cause a stir bar (also called "flea") immersed in a liquid to spin very quickly, thus stirring it. The dispersion is measured using the laser spectrometer. The nano particles are mixed with the diesel fuel at the rate of 250 ppm and 500 ppm.

Table 1: Properties of the Fuel Blend

Properties	Zinc Oxide
Formula	ZnO
Appearance	White Powder
Molecular Weight	81.39 AMU
SG/Density	6.61 g/cm^3
Aérage Particule Size	24-71 nm
Bulk Density	0.15 g/cm^3
Crystal Phase	Hexagonal

Table 2: Specification of The Engine

NAME	KIRLOSKAR AV1
BORE	80 mm
STROKE	110 mm
DISPLACEMENT VOLUME	661.5 cc
RATED SPEED	1500 RPM
BRAKE HORSE POWER	5 HP
NOZZLE HOLE DIAMETER	0.25 mm
COMPRESSION RATIO	16.5:1
NOZZLE OPENING PRESSURE	200 bar

5. RESULT AND DISCUSSION

The cylinder peak pressure for the Nano particle – DF blends is higher than DF at higher loads. The cylinder peak pressure for DF of 69 bar was attained at a crank angle of 5˚ after TDC. In case of DF blended with 250 ppm of Zinc Oxide (DF + ZnO (250ppm)) the cylinder peak pressure of 75.6 bar was achieved at crank angle of 2˚ after TDC. In case of DF blended with 500 ppm of Zinc Oxide (DF + ZnO (500ppm)) the cylinder peak pressure of 78 bars was achieved at crank angle of 2˚ after TDC. The increase in combustion peak pressure and advancement of peak pressure in terms of crank angle in nano particle concentration due to the better and complete ignition. This is given in the figure 3.

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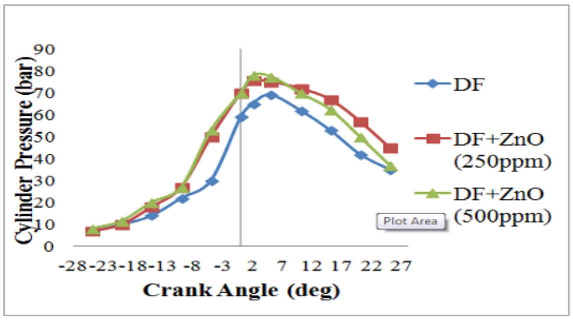

Fig 3: The variation of Cylinder Pressure at different Crank Angles for Zinc Oxide Nano particle-DF blends and DF.

The comparison of heat release rate for nano particle diesel blends and DF operation at full load is shown in Fig.3. DF shows lower heat release rate during the initial stage and longer combustion duration at full load. It can be observed that the maximum heat release rate of 68J/°CA is recorded for DF, while DF + ZnO (250 ppm) records its maximum heat release rate of 78J/°CA. It can also be noticed that the maximum heat release rate is 85J/°CA for DF + ZnO (500 ppm).

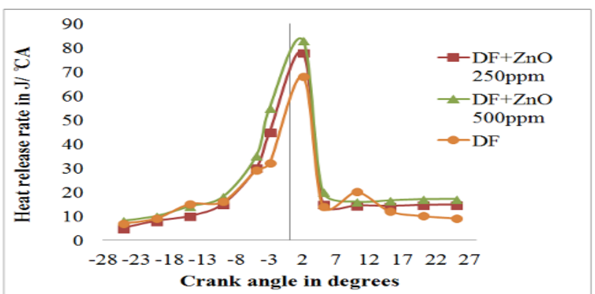

Fig 4: The variation of heat release rate with crank angle for ZnO - DF blends and DF.

It can be observed that the NOx emission for Nano particle DF blend operation is higher in the entire load range compared to DF operation. The concentration of NOx varies from 6.74 g/kWhr at low load to 2.3g/kWhr at full load for DF and from 7.2g/kWhr at low load to 2.25g/kWhr at full load for DF + ZnO (250 ppm). For DF + ZnO (500 ppm), it varies from 7.415g/kWhr at low load to 2.94g/kWhr at full load and is shown in the figure 5.

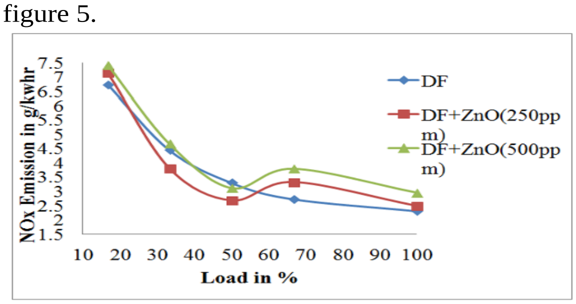

Fig 5: The variation of NOx with load for ZnO - DF blends and DF

The smoke increases with increase in load. The smoke of 5.2% of opacity was measured for DF at low load condition while with DF-ZnO 250 ppm blend it is 6.7% and for DF-ZnO 500 ppm blends it is 7.3%. Similarly at full load, smoke of 27.2 % opacity is observed for DF, for DF-ZnO 250 ppm blend it is 28.3% and DF-ZnO 500 ppm blend it is 29.3%. The increase in smoke is due to addition of nano particles which adds up to the quantity of smoke when compared with DF andf is given in the figure 6.

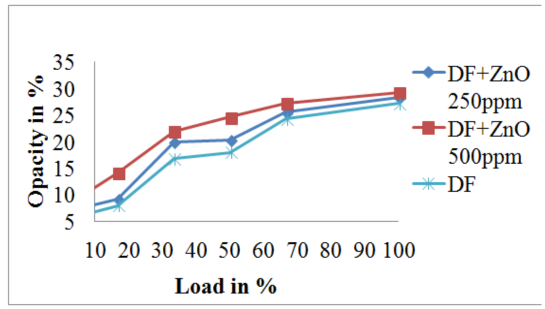

Fig 6: The variation of Smoke emission with load for DF and ZnO -DF operation.

It can be observed that the thermal efficiency is 35.82% at full load for diesel. It can be observed that the engine fuelled with DF + ZnO (250 ppm) and DF + ZnO (500 ppm) gives break thermal efficiency of 36.8% and 37.35% respectively at full load. The total heat release for each ZnO-DF blends is greater than diesel. Hence, the brake thermal efficiency is higher for the ZnO-DF blends than diesel and is given in the figure 7.

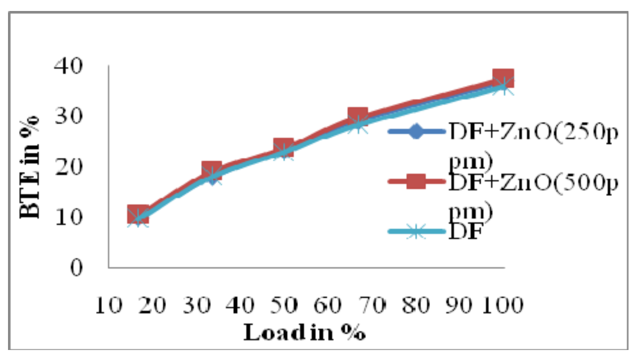

Fig 7: The variation of brake thermal efficiency with load for ZnO-DF blends and DF

6. CONCLUSION

The ignition delay reduced, peak pressure and heat release rate increased due the presence of particles. The reasons for the same are explained above under each chapter. Due to these observation, and we found that the brake thermal efficiency increased minutely. As a drawback, it was also found that the emissions NOx, increased. It was found the mixing of nano particles with diesel to be innovative and it has a lot of promise for the future. Looking into the future, we can also try Different nano particles in same composition and weight can be used and the results can be analyzed.

NOMENCLATURE

ZnO + DF	Zinc oxide Blend with Diesel Fuel, ppm
BTE	Brake thermal efficiency, %
CA	Crank angle, degree
DI	Direct Injection
NOx	Nitrogen oxide, g/kwhr

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