Effects of CeO_2 and Al_2O_3 Nanoparticles Added to Diesel in a Four Stroke Single Cylinder CI Engine

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***Abstract:-* In the recent years, due to advancement in technology there is drastic growth in vehicular population with improved performance. But even though as a result there is a noticeable reduction in ambient air quality because of the pollutants released by these vehicles. This leads to rise in Green House Gas emission because of additional CO_2 released to the environment. Hence investigators focus on fuel consumption and emission reduction techniques. Because of diminishing fossil fuel sources, there is rising demand to change over substitute fuels. In present work a mixture was prepared by mixing of nanoparticle as a fuel additive. Additives are habitually prepared from organic, inorganic and metal oxides components. In recent days because of enhancement in technology metal oxides are attracting greatly, particularly transition metals which diminish soot formation temperature. Usage of metal additive in Nano form is enhanced compared to micron-form, because it helps the combustion in molecular level and also there is no obstruction in fuel injectors. Nano form of metal atomic particles is more appropriate to diffuse. Addition of nanoparticle additive is one of the method to achieve better and efficient combustion. The present work was to investigate the result of metal oxide on the emission physical features of Diesel fuel and its combinations with metal oxides in a solo cylinder, air chilled, direct injection diesel engine. The Nano particle size is in the range of 50-100 nm. Using magnetic stirrer the nanoparticles were dispersed in the fuel. It was detected that addition of nanoparticle to Diesel blend reduces the carbon monoxide, HC and smoke emission. The NO_x emission showed an increase because nanoparticles act as an oxygen providing catalyst and it increases the in-cylinder temperature at both fragment load and complete load conditions.**

***Key Words*: CeO_2, Al_2O_3, Four Stroke Single Cylinder CI Engine, HC, NO_X, CO_2**

I. INTRODUCTION

Diesel engines play a vigorous role in all the main sectors like industrial, transport, and power due to their transcendence in the fuel economy and durability. At the same time, diesel engines release damaging pollutants such as NO_X (Nitrogen oxides), HC (Hydrocarbons), smoke, particulate matter, and stinky odor which destroy our green environment. Till date many investigators have contributed their efforts to decrease the emissions from diesel engines majorly by three methods, (i) Changing engine design (ii) Fuel alteration/reformulation, and (iii) Exhaust gas treatment techniques. A huge variety of fuel additives are added to the blends to progress the engine effectiveness and to diminish exhaust emissions. A collection of additives are metal based fuel additives that have been used as combustion catalysts for hydrocarbon fuels. These metals are manganese, iron, copper, barium, cerium, platinum, aluminum which have catalytic activity in burning process. The metal-based additives diminishes diesel engine emissions and fuel consumption. Reason for emission reduction is

- The metal functions either by reacting with water to yield hydroxyl radicals, which improve soot oxidation.
- By straight response with the carbon atoms in the soot, thereby dropping the oxidation temperature.

II. OBJECTIVES

The present work involves the effective utilization of diesel by using alumina nanoparticle as well as cerium oxide nanoparticles as a fuel additive and evaluating the emission characteristics.

Figure 1.0 Cerium Oxide Placed In Crucible

Figure 2.0 Pure Alumina Placed In Crucible

III. PROPERTIES OF METAL ADDITIVES

TABLE 1.0 PROPERTIES OF ALUMINA AND CERIUM

Metal	Alumina	Cerium
Molecular formula	Al_2O_3	CeO_2
Appearance	White Powder	Pale Yellow-White Powder
Density	3.95 to 4.5g/cm^3	7.65 gm/cm^3
Melting point	2072 °C	2400 °C
Boiling point	2977 °C	3500 °C
Solubility in water	Insoluble	Insoluble

IV. METHODOLOGY

- Adding nanoparticles with Diesel
- Experimenting the engine with the base fuel.
- Experimenting the engine with nanoparticles added fuel.
- Compare the emission characteristics with and without Nano additives.

V. EXPERIMENTAL SETUP

Figure3. The Experimental setup

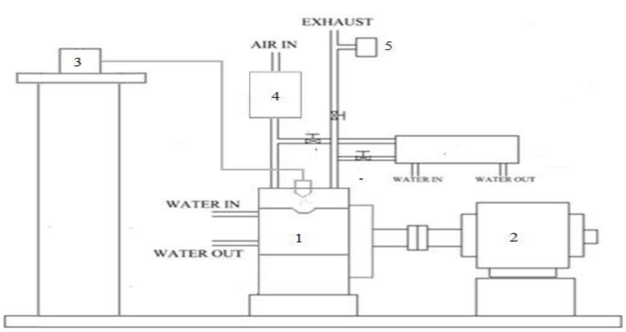

Figure 4. Line diagram of setup

1. Engine
2. Electrical Dynamometer
3. Fuel tank
4. Surge tank
5. Exhaust Gas analyser

TABLE 2.0 ENGINE SPECIFICATION

1	Model	Kirloskar AV1
2	Engine Type	One cylinder, four stroke, vertical, water cooled, naturally aspirated
3	Cylinder volume	553cc
4	Compression ratio	16:5:1
5	Combustion chamber	Hemispherical bowl in piston
6	Speed	1500 rpm
7	Orifice meter diameter	20 mm
8	Coefficient of discharge	0.62
9	Connecting rod length	232 mm
10	Stroke Length	110 mm
11	Bore diameter	80 mm
12	Eddy current dynamometer arm length	235 mm
13	Calorific value of diesel	46500 kj/kg
14	Density of diesel	840 kg/m^3
15	Rated power	3.75 kw at 1500 rpm

VI. RESULTS AND DISCUSSION

The experiment was performed firstly with diesel and then with four different blends of diesel (($D+Ce0_2$(50mg), $D+CeO_2$(100mg), $D+Al_2O_3$(50mg), Al_2O_3(100mg)). The analysis of Nano metal additives (Alumina and Cerium) and the outcome of Nano metallic particles with diesel on emission characteristics in relation with the experimental results are discussed.

6.1 Smoke Emissions

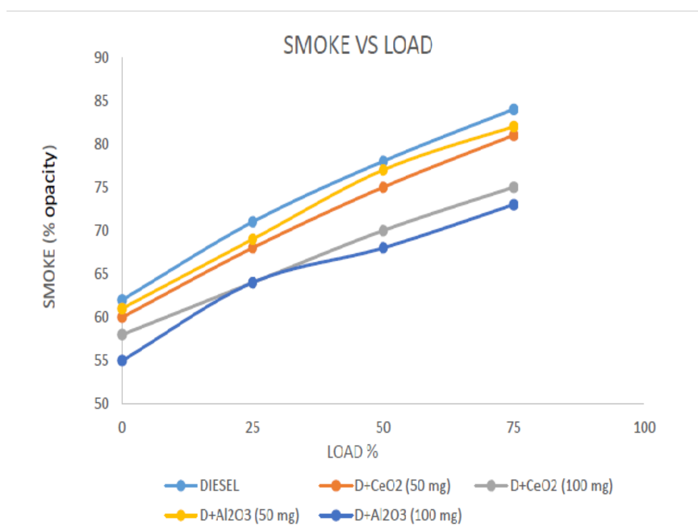

Figure 5. The deviation of smoke emissions with load

The Figure 5 shows difference of smoke emission used for diesel and its Nano chemical mixtures (Alumina then Cerium) matched with neat diesel as shown. As a result of this, reduced soot formation, thus no smoky exhaust. The Smoke level declines with alumina diesel fuel combinations when comparing by neat diesel and other blends.

6.2 Oxides of Nitrogen

At high load the NO_X emission is increased, because faster premixed combustion, result in increased in cylinder temperature and so NO discharge increases. The minimum NO_X emission is detected for neat diesel at low load conditions. The NO_X discharge is minor for diesel when matched to all other blended fuels. The Figure 6 displays deviation of nitrogen oxide discharge for diesel then its Nano additive blends (Alumina and Cerium) compared with neat diesel is shown below.

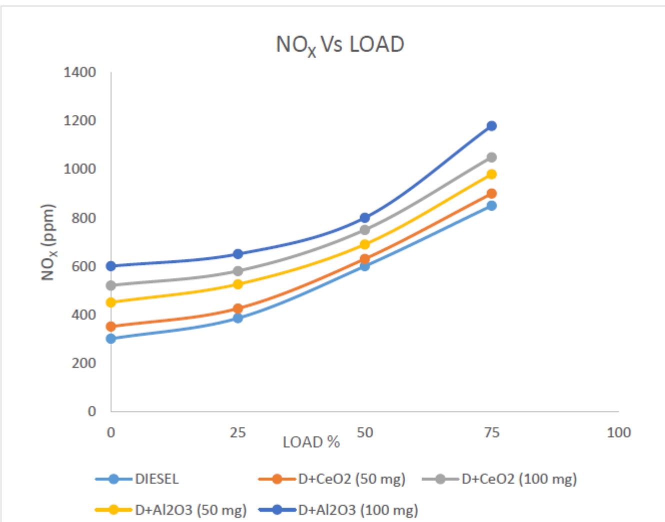

Figure 6. Deviation of oxides of nitrogen with respect to load

6.3 Hydrocarbon Emissions

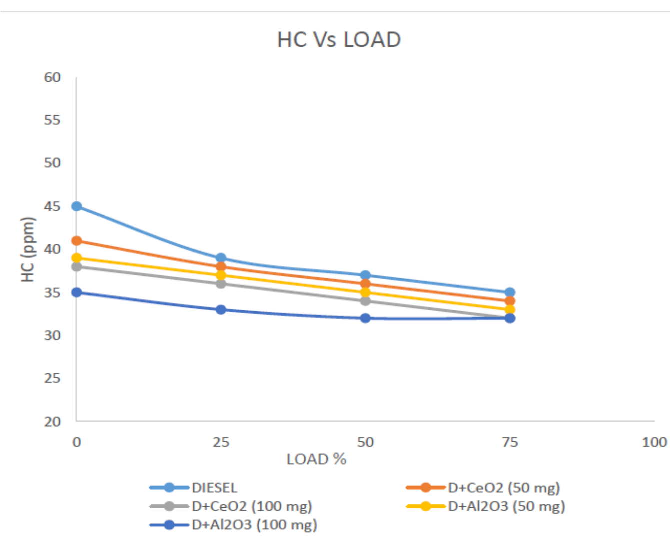

Figure 7. Deviation of Hydrocarbon Emissions with Load

The addition of aluminium oxide and cerium oxide nanoparticles on diesel blends reduces the HC discharge by matching with neat diesel then diesel combinations. The usage of nanoparticles (oxygenated additives) which promotes the complete burning is the reason for drop in hydrocarbon. HC production is reduced for all the combinations compared towards neat diesel, this is because higher oxygen content present in diesel blends. By adding more nanoparticles to diesel, we can further reduce the HC emission. The Figure 7 shows variation of hydrocarbon emission for diesel and its Nano additive blends (Alumina and Cerium) compared with neat diesel is shown below.

6.4 Carbon Monoxide Emissions

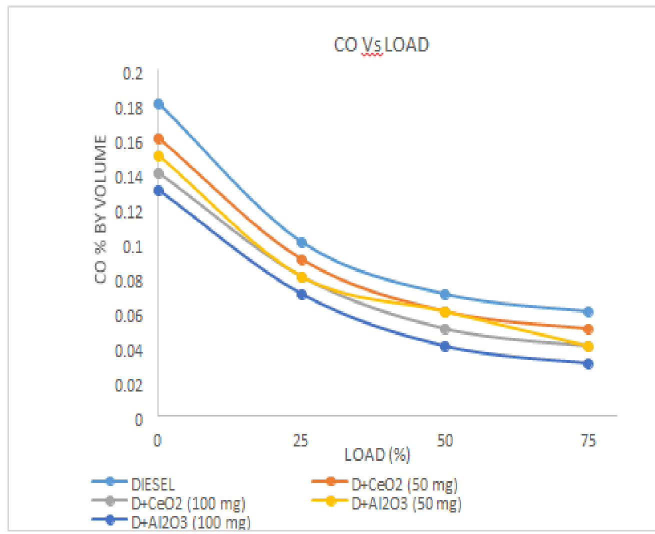

Figure 8. Deviation of CO discharge with load

The CO release declines with the usage of diesel. But the addition of Nano additive to diesel further decrease the CO emission when compared to clean diesel. This is due to oxidation takes place between the Nano additive (Aluminium oxide and cerium oxide) which converts CO to CO_2. The increase in Nano additive proportion increases the oxidation, thus reducing the CO emission. The least CO emission is observed for the alumina blends at the part load condition. The Figure 8 shows the deviation of carbon monoxide discharge meant for various blends of Nano additive with Diesel compared to neat diesel is shown below.

VII. CONCLUSIONS

In the present study the discharge features of neat diesel mixtures with the addition of different proportion of Aluminium oxide and cerium oxide nanoparticles are examined to assess the emission drop potential on the one cylinder CI engine. Based on the experiments the following decisions were drawn.

- The percentage of CO discharge declines by the usage of Alumina nanoparticles in diesel compared with clean diesel at part load condition.

- By adding of alumina nanoparticle to diesel decreases the HC emission at full load while matching with neat diesel.
- The percentage of smoke discharge decreases with the use of Alumina nanoparticles in diesel compared with neat diesel at part load condition.

There is scope for research on compatibility of nanomaterial how these fuel blends to overcome the emission regulation. Environmental studies can be made to reveal a total picture on impact of using nanoparticle blended fuels. The NO_X discharge is minor for the neat diesel than the oxygenated mixtures. When Alumina Nano additive is added to diesel mixtures further NO_X rises at full load condition. The addition of Alumina nanoparticle with diesel combinations further declines the smoke compared to clear diesel at complete load condition. Because of improved in combustion when oxygenated stabilizer is added to diesel.

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