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# Investigation on Emission Characteristics of Variable Compression Ratio Engine using Nanoparticle Blended Diesel Fuel

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***Abstract:** In current scenario, vehicular emission contributes to major pollution source. Thus, it becomes necessary to reduce emission by improving the performance of the engines. Fuel borne catalyst proves to be a promising solution to reduce emission prior to combustion due to its ease of implementation without much modification of the existing engine design. The combined effect of Aluminum oxide (Al2O3) and cerium oxide (CeO2) nanoparticles, blended with diesel on the emission characteristics of a Variable Compression ratio (VCR) engine was carried out in the present study. The effect of various mass proportions of nanoparticles on the emission characteristics was determined. The net particle mass loading rate ranged between 0.5% to 1%. The nanoparticles were mixed in diesel with the aid of ultrasonication process. The results showed that for the nanoparticle blended diesel, a good deal of reduction was achieved in the emission characteristics with Unburnt Hydrocarbon (UBHC), carbon monoxide (CO), and NOx got reduced by 34%, 25%, and 5% compared to pure diesel.*

***Keywords:** Nanoparticle; Aluminum Oxide; Cerium Oxide; VCR engine.*

## I. INTRODUCTION

In vehicular emission contributes to major pollution source. Thus, it becomes necessary to reduce emission by improving the performance of the engines. Several processes such as post treatment of exhaust gases with catalytic converter, modification of the combustion chamber and piston geometry to improve combustion efficiency and water- fuel emulsion injection into combustion chamber to reduce combustion chamber temperature are deeply researched. The above mentioned processes involve huge cost and greater design changes in the engine geometry. A fuel borne catalyst proves to be a promising solution, since it involves altering the fuel properties through the addition of additives in the form of nanoparticles which will enhance the fuel properties for clean combustion process. The effects of Aluminum oxide nanoparticle and Carbon Nano Tubes blended biodiesel. They saw that the Break Thermal Heat Efficiency (BTHE) of the motor expanded by 28.9% contrasted with unadulterated biodiesel. The writers [2] led a test on the burning attributes of the fuel beads with nano and smaller scale measured aluminum oxideparticles and saw that nanosized particles can suspend for a more extended time in the fuel. The authors [3] observed the scavenging nature of cerium oxide nanoparticle on nitric oxide radicle. They observed that CeO2 (+3/+4) valence states react with nitric oxide leading to the reduction of the NOx formation due to potent redox reaction. The authors [4,5] observed through experimentation that for oxygenated contents in fuel, the particulate matter emission of Compressed Ignition (CI) engine decreased whereas nitrogen oxide emission increased. The authors [6, 7] investigated the effects of cerium oxide (CeO2) nanoparticle addition in diesel and diesel-biodiesel-ethanol blends in a VCR engine and observed that the ignition delay was less leading to low Unburnt Hydrocarbon (UBHC) emission whereas the NOx emission increased for nanoparticle-fuel mixture. The authors [8] have studied the droplet combustion of micro particle aggregates of oxygen containing nanoparticles and observed that nanoparticle laden fuel's burning rate increased by 44% when compared to neat diesel. The writers [9] have considered the start and burning of miniaturized scale and Nano-sized aluminum molecule and reasoned that the pressure proportion assumes an essential job in start and complete ignition of Nano molecule aluminum. The brake warm proficiency was expanded in B20CuO75ppm at all heaps than perfect diesel. The particular fuel utilization is higher for the B20CuO75ppm than slick diesel at the whole burden contrasting and the distinctive dosing dimension of mixes. The writers [10]conducted an exploratory examination because of the expansion of cerium oxide nanoparticles on the major physiochemical properties and the execution of CI motor. The nanoparticle is dispersed in the fuel by ultrasonic agitation. Cerium Oxide Nanoparticles reduced HC, CO and smoke efficiency up to50.33%, 33%, and 12.5% compared with a biodiesel blend Thus, Aluminum oxide (Al2O3) and Cerium oxide (CeO2) nanoparticles prove to be promising fuel borne catalysts to improve the emission characteristics of Compressed Ignition (CI)engine. The effect of various mass proportions of nanoparticles on the engine emission characteristics is carried out in the present work.

## II. PROPOSED METHOD EXPERIMENTAL SETUP

The Aluminum oxide and Cerium oxide nanoparticle swereweighed at fixed proportions by mass and mixed in diesel fuel with the aid of an ultrasonicator for 60 minutes.

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The nanoparticle mixed diesel fuel sample properties are presented in **table 1.**The experiment was carried out immediately after the sonication process of each fuel blend to avoid settling down by aggregation of the nanoparticles in the fuel samples. The experiment was carried out in a 4-stroke, Direct Injection, single cylinderVCR engine with 3.5KW@1500rpm power. Each fuel sample was tested in the engine for 30 minutes followed by a cooling down period of 60 minutes and a clean diesel run for 30 minutes. This was to avoid the interference of the effect of one fuel blend sample over the other.

| Nanoparticle Proportion | | Representation | Density (Kg/m³) | Kinematic Viscosity @40°C | Flash Point (°C) | Fire Point (°C) | Cetane Number | Calorific Value (KJ/Kg) |
|---|---|---|---|---|---|---|---|---|
| Al2O3 (PPM) | CeO2 (PPM) | | | | | | | |
| 25 | 25 | A25C25 | 830.5 | 12.8 | 52 | 58 | 43 | 32901.7208 |
| 25 | 50 | A25C50 | 854.4 | 10.8 | 63 | 67 | 52 | 35435.09096 |
| 25 | 75 | A25C75 | 869.9 | 11.3 | 69 | 74 | 58 | 39858.0392 |
| 50 | 25 | A50C25 | 831.4 | 11.3 | 56 | 59 | 48 | 33317.6104 |
| 50 | 50 | A50C50 | 862.7 | 10.5 | 65 | 72 | 56 | 36962.62752 |
| 75 | 25 | A25C75 | 842.9 | 11 | 58 | 62 | 51 | 34573.52168 |

**Table 1: Properties of Nanoparticle blended Diesel Fuel samples**

## III. RESULTS AND DISCUSSION

The comparison of UBHC, CO and NOx for various nanoparticle mass loading rate is discussed in this section. From **Figure 1** it is seen that the UBHC emission is significantly less for nanoparticle blended diesel fuel when compared to pure diesel.

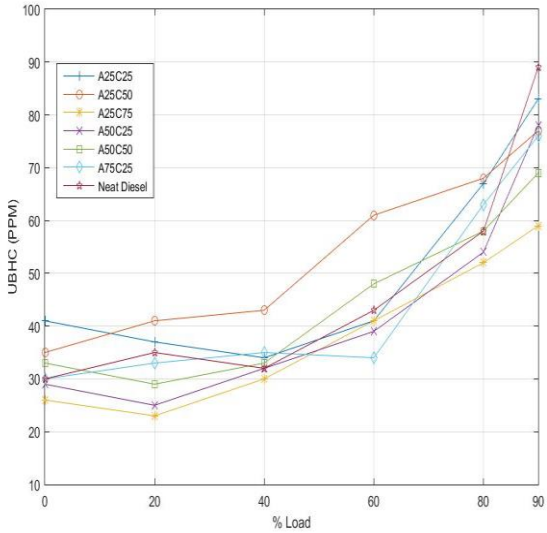


**Figure 1:Comparison of UBHC emission of Nanoparticle blended Diesel Fuel with Neat Diesel**

This is due to the increased surface area to volume ratio of nanoparticle laden fuel [1, 2, 6]. TheUBHC emission reduction occurred for A25C75 with 34% reduction when compared to neat diesel. The ranking of nanoparticle mixed diesel fuel samples based on reduction in the emission of UBHC indicates that, the UBHC reduction primarily depends on the proportion of cerium oxide nanoparticle in the fuel sample.

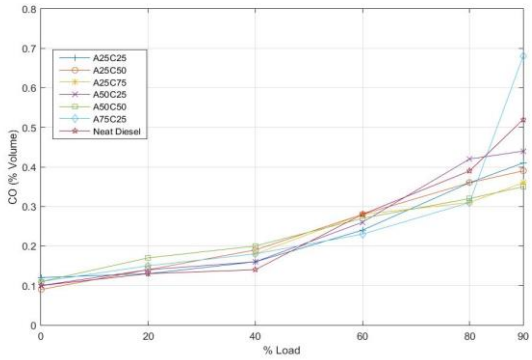


**Figure 2: Comparison of CO emission of Nanoparticle blended Diesel Fuel with Neat Diesel**

From **Figure2,** it is evident that the CO emission of nanoparticle laden diesel fuel samples is significantly less than that of pure diesel fuel. This is due to the active catalytic property of nanoparticles which reduces the ignition delay and improves the combustion process[7]. The maximum reduction in CO occurred for A50C50 with 25% reduction of CO emission.

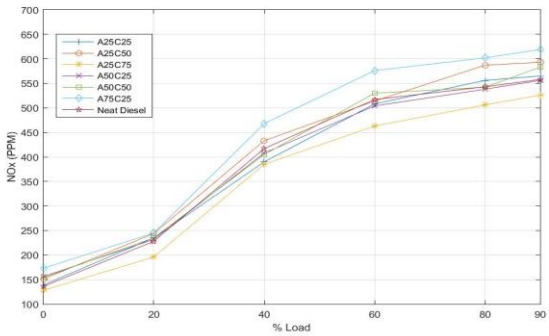


**Figure 3: Comparison of CO emission of Nanoparticle blended Diesel Fuel with Neat Diesel**


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From **Figure 3**, it can be observed that the NOx emission increases for nanoparticle blended diesel fuel samples when compared to purediesel. The NOx emission is reduced for A25C75 by 5% at peak load. This is because of the scavenging property of cerium oxide nanoparticle on nitric oxide particle.

## IV. CONCLUSION

The emission characteristics of nanoparticle blended diesel fuel at different nanoparticle mass loading rates have been experimentally investigated with the aid of a Variable Compression Ratio engine. The emission of UBHC shows that it decreases with increase in the proportion of cerium oxide nanoparticles. Thus, the reduction of UBHC emission depends primarily on the proportion of cerium oxide nanoparticles.The CO emission of nanoparticle blended diesel fuel emission is significantly less for nanoparticle blended diesel fuel due to active catalytic nature of the constituent nanoparticles.The nanoparticle laden diesel fuel has higher NOx emission due to the active contribution of oxygen by the nanoparticle and the NOx emission depends on the proportion of aluminum oxide nanoparticle in the diesel fuel.

## REFERENCE

1. J. SadhikBasha, R.B.Anand, "The Influence of nano additives blended biodiesel fuels on the working characteristics of a diesel engine", Journal of Brazilian Society of Mechnaical science and Engineering 35(2013) 257-264.
2. YananGan, Li Qiao, "Combustion characteristics of fuel droplets with addition of nano and micron-sized aluminum particles" ,The Journal of the Combustion and Flame (2011) 354–368.
3. Janet M. Dowding,TalibDosani, Amit Kumar, Sudipta Seal ,William T. Self, "Cerium oxide nanoparticles scavenge nitric oxide radical (_NO)", Chem. Commun., 2012, 48, 4896–4898
4. V. Arul MozhiSelvan, R. B. Anand and M. Udayakumar," EFFECTS OF Cerium Oxide Nanoparticle Addition In Diesel And Diesel-Biodiesel-Ethanol Blends On The Performance And Emission Characteristics Of A Ci Engine", ARPN Journal of Engineering and Applied Sciences, Vol. 4, No. 7, September 2009.
5. X. Shi, Y. Yu, H. He, S. Shuai, J. Wang, R. Li," Emission characteristics using methyl soyate–ethanol–diesel fuel blends on a diesel engine", Fuel 84 (2005) 1543–1549
6. A. Prabu, "Nanoparticles as additive in biodiesel on the working characteristics of a DI diesel engine", Ain Shams Engineering Journal 9 (2018) 2343–2349.
7. Rajneesh Kumar and Anoop Kumar Dixit, "Combustion and Emission Characteristics of Variable Compression Ignition Engine Fueled with Jatropha curcas Ethyl Ester Blends at Different Compression Ratio", Journal of Renewable Energy Volume 2014, Article ID 872923.
8. Philip M. Guerieri, RohitJ. Jacob, JefferyB. DeLisio, MilesC. Rehwoldt, Michael R. Zachariah,"Stabilizedmicroparticle aggregates of oxygen-containing nanoparticles in kerosene for enhanced droplet combustion", The Journal of the Combustion and Flame 187 (2018) 77–86
9. Prabakaran V, Mugunthan V, Mohamed Yaseen Sharif K S, Naveen Kumar R, Nithish K, 2017, "Comparison of Performance, Combustion and Emission Parameter for Copper Oxide Nano Particles Blended with used Vegetable oil Biodiesel in an IC Engine", International Journal of Innovative Research in Science, Engineering and Technology, Volume 6, Special Issue 8, May 2017
10. Krishnan V, Anbarasu G, 2017, "A Review on Emission Control Strategy by Adding Nano Additives in CI Engine", International Research Journal of Engineering and Technology, Volume: 04 Issue: 04, Apr -2017


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