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A Review on Emission Control Strategy by Adding Nano Additives in CI Engine

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Abstract - *The energy crisis is due to two reasons; one is a rapid increase in worldwide population and other use another instead of living style of human beings. The fossil fuel is also a major contributor to add the harmful pollutants into the atmosphere. The present work is devoted to a task measured experimental study of chemicals and biodiesel blended in a CI engine. Fuel modification plays a major role in increasing engine efficiency and decreasing emissions. In order to form an idea of the amount effect of Nanoparticle such as Alumina oxide (Al_2O_3), copper oxide (CuO_2) Cerium oxide (CeO_2), Titanium dioxide (TiO_2), Zirconium oxide (ZrO_2), ferric chloride ($FeCl_3$), Silicon dioxide (SiO_2), Cobalt Oxide (Co_3O_4) Zinc Oxide (ZnO_2) and Nickel Oxide (NiO_2). The addition of nanoparticles increases the oxidation rate, less in the amount the light-off temperature and creates large contact surface area with the base fuel thereby further improve the quality of the combustion with of a minimum amount emission. The experimental results reveal that the use of chemicals and biodiesel blend with Nano additive in diesel engine has exhibited good being improved in performance characteristics and reduction in exhaust emission*.

Key Words: Blended fuels, Nano additives, performance, Emissions, diesel engine, Oxidation rate, light-off temperature.

1. INTRODUCTION

World energy demand increase gradually which mainly comes from the Non-Renewable Resources. The energy resources are limited reduce simultaneously due to the high consumption of energy. More energy consumption leads to poisoning our environment. Due to these two main reasons worldwide engineers and scientist's engineers giving attentions to finding new, eco-friendly and renewable energy resources which can meet the energy demand without harming the environment. A lot of efforts have been made to search the alternative energy resource.

Increasing fuel prices and depleting fossil fuel resources in recent years drawn attention towards the use of alternative fuel for diesel engines. The use of vegetable oil is popular, economic and implementable source among the various fuel alternatives.

Numerous research works were carried out using various biodiesels derived from karanji, jatropha curcas, punga mia pinata, soya bean, sunflower, rapeseed, etc., and Some Chemicals their influence in a compression ignition engine was studied.

Owing to the depletion of the fossil fuels day by day, there is a necessity to find out a resolution to fulfill the energy requirement of the world. Petroleum fuels play a vital role in the fields of transportation, industrial development, and agriculture. Fossil fuels are fast depleting because of increased consumption. Steady with the estimation of the international energy agency, by 2025 global energy utilization will increase by about 42%

In order to overcome the complications associated with the biodiesel, use of chemical substances like fuel additives derived from organic and inorganic metals was used. A fuel additive generally improves the combustion efficiency and reduces the pollution. Metallic based compounds, such as iron, copper, manganese, barium, Nickel, calcium and platinum etc., which have been helped as a combustion catalyst for hydrocarbon fuels. Current advances in Nano science and nanotechnology allow production, control, and characterization of Nano energetic materials. Advanced Nanomaterials are more effective than bulk materials because of its higher surface area. The additional important benefit of Nanoparticle is its size because there is no chance for filter clogging and fuel injector as in the case of micron sized particles.

Nano fuels are a fresh class of fuels, and the application of the nanoscale energetic material in conventional fuel is an interesting concept, yet uncharted to its fullest potential. Very few studies have been carried out in the addition of several potential nanoparticles as additives to diesel, biodiesel and its blends. In this work, the literature survey on the effects of several Nano additives such as metal, metal oxide, magnetic, carbon nanotube, Nano-organic additives, and mixed Nano additives on engine performance are reported.

The change in diesel fuel properties (viscosity, flash point, and fire point) due to the introduction of Nanometal oxide additive was observed. The diesel fuel with Nano metal oxide additive had presented a marginal increase in

performance. Brake thermal efficiency was increased marginally as compared to conventional diesel fuel. For the DI Diesel engine, the hydrocarbon emissions were highest at lower load. It evaluated the performance and emission of a Four cylinder, four stroke vertical-in-line, water-cooled compression ignition pickup diesel engine at full load condition using commercial diesel, Palm Biodiesel and nano particle blended fuel.

It conducted an experiment to investigate the catalytic activity of Nanoparticles, especially in Nanosized form. The performance tests were conducted on a naturally aspirated four strokes single cylinder water-cooled compression ignition engine. It was observed that viscosity, flash and fire point increases with the addition of nanoparticle. Also found that hydrocarbon emissions were decreased by the addition of catalytic nanoparticle. On the addition of nanoparticle in diesel, the NOx emissions were found to be decreased about a maximum of 30%.

2. FOSSIL FUEL EMISSION

A 1998 biodiesel lifecycle study, jointly sponsored by DOE and the U.S department of agriculture, concluded biodiesel reduces net carbon dioxide emission by 78% compared to petroleum diesel. This is due to biodiesel's closed carbon cycle. The CO_2 released into the atmosphere when biodiesel is burned is recycled by growing plants, which are later processed into fuel.

All outdoor air pollution is estimated to pose 1% of our cancer risk. Scientific research confirms that the biodiesel exhaust has a less harmful impact on human health than petroleum diesel fuel. Biodiesel emissions have roughly 45-90% lower toxic emissions compared to diesel.

The transportation sector is one of the main sources of greenhouse gasses such as CO_2. This GHG emission is responsible for worldwide climate change. Worldwide vast number of health problems and respiratory diseases are caused by air pollution. Irritation of lungs and pneumonia, edema and bronchitis are caused by NOx emission. Also, NOx emission results in increased sensitivity to dust and pollen in asthmatics. Tissue development of young children and fatal growth in pregnant women are caused by CO emission. HC emission promotes morbidity in people who have circulatory or respiratory problems. Drowsiness, eye irritation, sneezing and coughing and symptoms akin to drunkenness are caused by PAHs. Lung diseases are caused by some hydrocarbons which have a close affinity for diesel particulates.

Ozone negatively affects health and also causes harm to ecosystems. Acidification is caused by emissions of nitrogen oxides and Sulphur emissions. On the basis of damage to human body, fine particulate matter, lead, and ozone are the most hazardous elements. Today, in developing countries, on the basis of exposure, toxicity, and ambient concentrations, the fine particulate matter has become the pollutant of greatest concern.

3. IMPACT OF NANO ADDITIVES ON IC ENGINES EMISSION CHARACTERISTICS

The increasing industrialization and modernization of the world have to a step up for the demand of petroleum-derived fuel which is viable to human health as well as environment due to emitting greenhouse gasses. It shows the reduction of engine emission using Nano additive. It found that the use of Nano additive in diesel engines produces lower CO and smoke opacity and NO_x emissions compared to diesel fuel at full load condition. He suggested that only low concentration blends in terms of performance efficiency and environmentally friendly emissions could be recognized as the potential candidates to be certified for full-scale usage in unmodified diesel engines.

3.1 Alumina Oxide Emission

In Alumina oxide (Al_2O_3), the investigation is carried out to study the performance and emission characteristics in a single cylinder, four stroke DI diesel engine. Alumina oxide Nanoparticles are added with biodiesel at mixed proportions forming 10, 30 and 60 parts per million. Significant improvement in the brake thermal efficiency near to that of neat diesel is observed for the Nanoparticle blended test fuels along with the reduction of nitric oxide, carbon monoxide, unburned hydrocarbon and smoke emission respectively.

3.2 Titanium Dioxide Emission

The addition of Nanoparticles in biodiesel increases the thermal efficiency and decreases the NOx emission. The present investigation is to study the effect of Nano fuel additives Titanium dioxide (TiO_2) on the performance and emission characteristics biodiesel (B100) in a single cylinder, four stroke, water cooled, compression injection diesel engine. According to the results of this experiment, additives are the best method for obtaining the reduction in the particulate matter, carbon monoxide, and unburned hydrocarbons emissions but minimum increase in the nitrogen oxides emission. If the additives are added in the biodiesel at appropriate proportion, it will helpful to increase the engine combustion and performance characteristics. Nano-additives are reducing the fuel

consumption and improve the thermal efficiency during combustion the additives release the energy to the fuel.

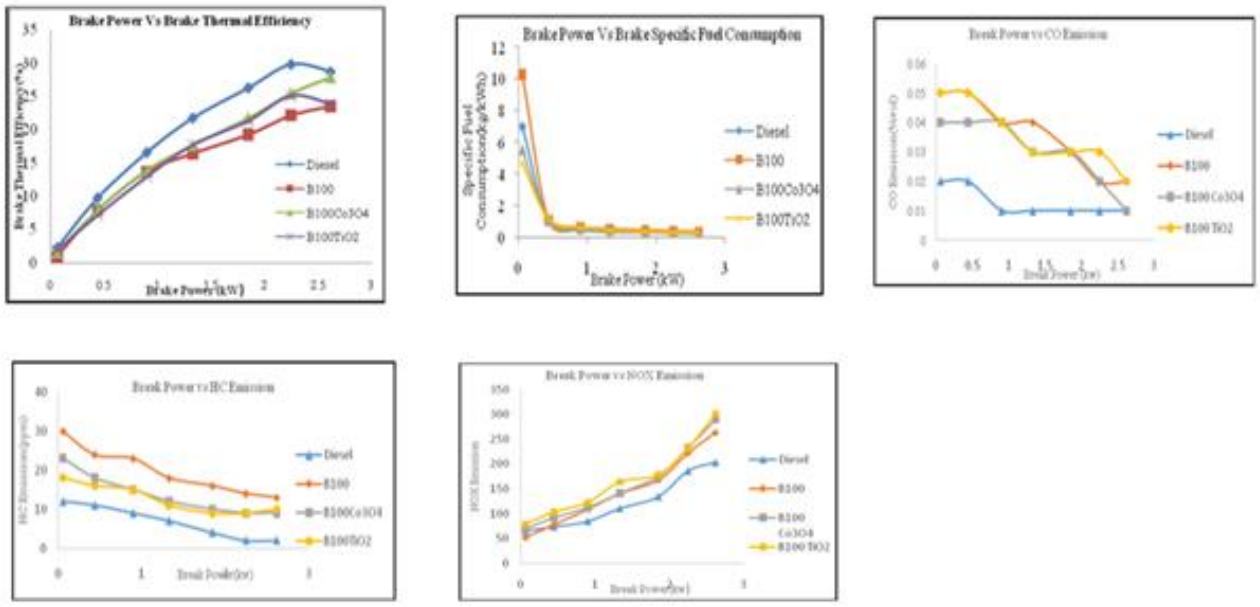

Figure1. Performance and Emission Characteristics of Titanium Dioxide Emission

3.3 Copper Oxide Emission

In the present investigation focused on fuel modifications in a diesel engine. Initially, the single cylinder diesel engine was operated with biodiesel without additives with diesel at different load at constantly rated speed. Copper Oxide Nanoparticles reduced HC, CO and smoke efficiency up to5033%, 33%, and 12.5% compared with a biodiesel blend. It may due to enhanced surface to volume ratio and improving the mixing rate of fuel and air in the combustion chamber. The NO_X emission was found to be slightly increased up to 3.2% with the addition of 50 ppm copper oxide with biodiesel compares with diesel.

3.4 Ferric Chloride Emission

The use of ferric chloride as a fuel-borne catalyst for biodiesel. The metal-based additive was added to biodiesel at a dosage of 20 µmol/L experiment were conducted to study the effect of ferric chloride added to biodiesel on performance, emission and combustion characteristics of a direct injection diesel engine operated at a constant speed of 1500 rpm at different conditions. The FBC added biodiesel resulted in a decreased brake specific fuel consumption of 8.6% while the brake thermal efficiency increased by 6.3%. FBC added biodiesel showed lower NO emission and slightly higher CO2 as compared to diesel. CO, HC and smoke Emission of FBC added biodiesel decreased by 52.6%, 26.6%, and 6.9% respectively compared to biodiesel.

3.5 Cerium Oxide Emission

This paper reports the results of experimental investigations on the influence of the addition of cerium oxide in nanoparticle form on the major physiochemical properties and the performance of diesel. The fuel is modified by dispersing the catalytic nanoparticle by ultrasonic agitation. The physiochemical properties of sole diesel fuel and modified fuel are tested with ASTM standard procedures. Cerium oxide acts as an oxygen-donating catalyst and provides oxygen for the oxidation of CO during combustion. The active energy of cerium oxide acts to burn off carbon deposits within the engine cylinder at the wall temperature and prevents the deposition of non-polar compounds on the cylinder wall which results in a reduction in HC emission by 56.5%. It was observed that a reduction in NOx emission is 50–60%. The tests revealed that cerium oxide nanoparticles can be used as an additive in diesel to improve complete combustion of the fuel and reduce the exhaust emissions significantly.

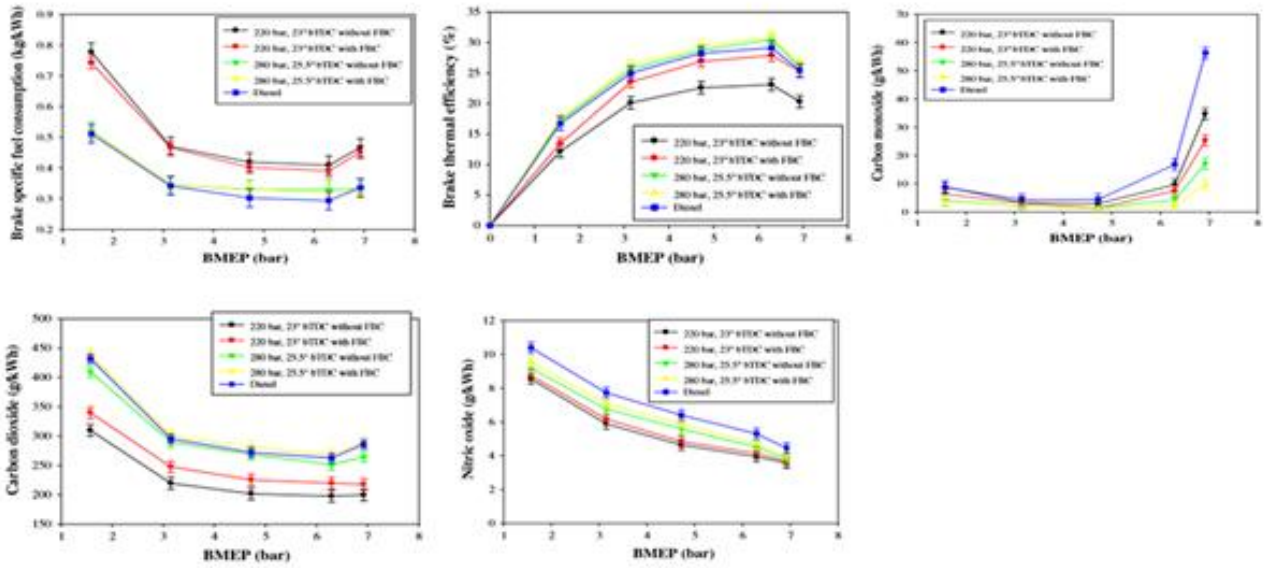

Figure2. Performance and Emission Characteristics of Ferric Chloride Emission

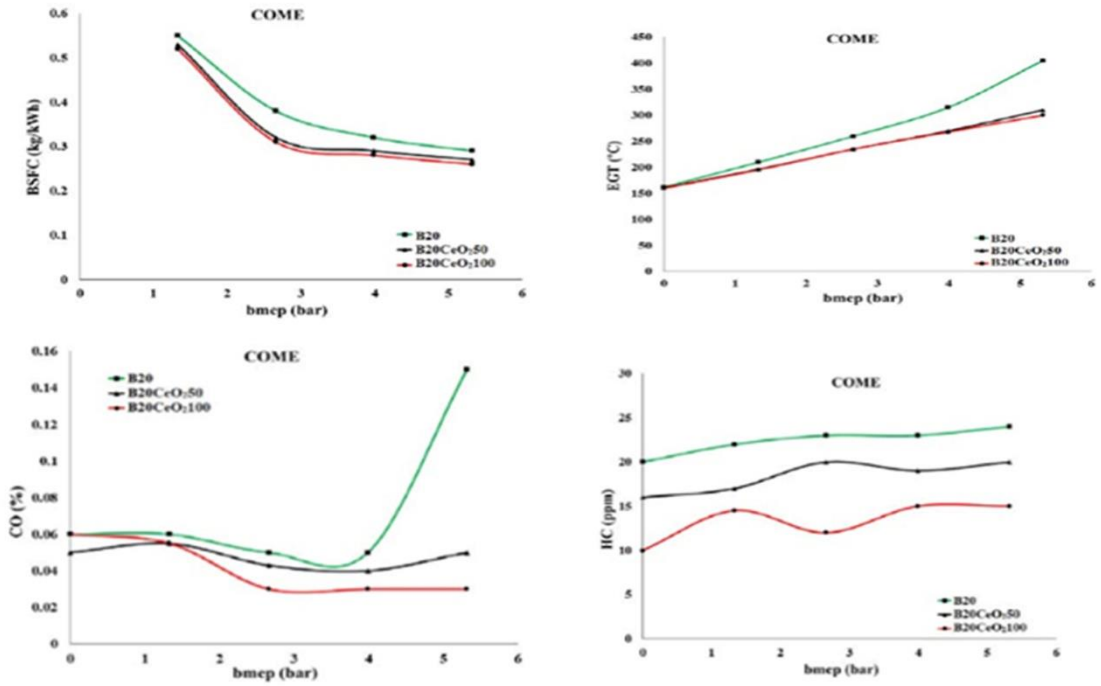

Figure3. Performance and Emission Characteristics of Cerium Oxide Emission

4. CONCLUSION

In the present study, the emission and performance characteristics of a diesel engine on the addition of Nanoparticles in biodiesel are experimentally investigated and the results are discussed below. In recent years, numerous Nano additives such as Alumina oxide (Al_2O_3), copper oxide (CuO_2) Cerium oxide (CeO_2), Titanium oxide (TiO_2), Zirconium oxide (ZrO_2), ferric chloride ($FeCl_3$), Silicon dioxide (SiO_2), Cobalt Oxide (Co_3O_4) etc., were used as additives so far. But, these Nano additives were not selected on any basis of physical, chemical and combustion parameters on whole. At the same time, very few literatures focused on the comparative study of two nanoparticles for same base fluid in combustion. Considering all the above perspectives, in the current research some nanoparticles were synthesized and experimented since they possess high volatilization temperature and heat of formation.

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