Effect of Nano Additives on Biodiesel Ignition Probability - A Review

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***Abstract*: The main objective of this paper to discuss the research output of previous research for getting better ignition probability with lower noxious emissions by improving the biofuel quality. Some additives play effective role in biodiesel fuel for improving fuel's quality and minimize the problem without modification engine technology. This paper is a brief review of the possible additives to improve ignition probability of biodiesel fuel used in industries, transportation and domestic utilizations. also this paper presents the results of an experimental investigation, into the effect of various nano additives on the ignition probability of biodiesel, on the evaporation time of a single droplet, on hot surfaces (stainless- steel).experiments are performed at atmospheric pressure. result shows that nano -additives increased the ignition probability of biodiesel and there by more effective for improving engine power than pure Diesel and B5 fuels by 7.78% and 1.36%, respectively. The nano additives are significantly effective on biodiesel fuel for reducing brake specific fuel consumption reached by 13.22% and 10.01%, respectively as compared with pure Diesel. Moreover, the exhaust emissions (NOx, CO and CO2) decreased from the engine using the nano additive in Diesel fuel.**

I. INTRODUCTION

Bio-diesel is an alternative to petroleum-based fuels derived from vegetable oils, animal fats, and used waste cooking oil including triglycerides. Since the petroleum crises in 1970s, the rapidly increasing petroleum prices and uncertainties concerning its availability, growing concern of the environment and the effect of greenhouse gases (GHGs) during the last decades, has revived more and more interests in the use of vegetable oils as a substitute of fossil fuel. [11] Diesel engine exhausts are typically severe, which contain, depending on the engine design and operational parameters, large amounts of particulate matter (PM) or smoke emissions and varying amounts of carbon monoxide (CO), unburned hydrocarbons (UHCs), nitrogen oxides (NOx), sulphur oxides (SOx) and carbon dioxide (CO_2). Biodiesel, derived from the oils and fats of plants like sunflower, rape seeds, Canola or Jatropha Curcas, neem etc. can be used as a substitute or an to diesel. As an alternative fuel biodiesel can provide power similar to conventional diesel fuel and thus can be used in diesel engines. Biodiesel is a renewable liquid fuel that can be produced locally thus helping reduce the countries dependence on imported crude. Production and utilization of locally developed biodiesel may lead to overall sustainable development in developing nation. so presently improving ignition probability of biodiesel is very important so this paper study attempts to improve the ignition properties of biodiesel fuel by investigating the influence of adding various nano additives.

Ignition properties of diesel improved by adding aluminium and aluminium oxide nano particles to diesel.[1] Himanshu tyagi et al. they conducted an experiment in which they used different types of fuel mixtures were used; both particle size (15 and 50 nm) as well as the volume fraction (0%, 0.1%, and 0.5%) of nano particles added to diesel were varied. For each type of fuel mixture, several droplets were dropped on the hot plate from a fixed height and under identical conditions, and the probability of ignition of that fuel was recorded based on the number of droplets that ignited. These experiments were repeated at several temperatures over the range of 688-768 °C. It was observed that the ignition probability for the fuel mixtures that contained nano particles was significantly higher than that of pure diesel

The effect of adding a nano-titanium metalloid (TiO2) to B5 fuel was studied by Karoon Fangsuwannarak et al. [2] It was found that TiO2 based-additive is more effective for improving engine power than pure Diesel and B5 fuels by 7.78% and 1.36%, respectively. Meanwhile, with using TiO2 additive, the maximum engine torque on average increased by 1.01% and 1.53% in the wide range between 1,700 and 3,000 rpm as compared with Diesel and B5 fuels, respectively. The TiO2 and natural organic additives is significantly effective on Diesel fuel for reducing brake specific fuel consumption reached by 13.22% and 10.01%, respectively as compared with pure Diesel. Moreover, the exhaust emissions (NOx, CO and

CO2) decreased from the engine using the TiO2 additive in Diesel fuel and natural organic additive in Diesel fuel.

II. EFFECT OF NANO ADDITIVES MIXING WITH BIODIESEL

Himanshu Tyagi et al.[1]studied the effect of adding nano aluminum and aluminum oxide with diesel and they conducted an experiment in which they used different types of fuel mixtures were used; both particle size (15 and 50 nm) as well as the volume fraction (0%, 0.1%, and 0.5%) of nano particles added to diesel were varied. For each type of fuel mixture, several droplets were dropped on the hot plate from a fixed height and under identical conditions, and the probability of ignition of that fuel was recorded based on the number of droplets that ignited. These experiments were repeated at several temperatures over the range of 688-768 °C. It was observed that the ignition probability for the fuel mixtures that contained nano particles was significantly higher than that of pure diesel.

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Mu-Jung Kao et al.[3]studied the effect of adding a Aqueous Aluminium Nano fluid the results show that hydrogen burns in a diesel engine in the presence of an active aqueous aluminium nano fluid. The nano particles are made by applying a plasma arc to aluminium nano powder submerged in water. The average diameter of the aluminium nano particles is about 40–60 nm and they are covered with thin layers of aluminium oxide due to the high oxidation activity of pure aluminium. This provides a large contact surface area with water and high activity for the decomposition of hydrogen from water during the combustion process. During combustion the alumina serves as a catalyst and the coated aluminium nano particles are denuded and decompose the water to yield the hydrogen. The combustion of the diesel fuel mixed with aqueous aluminium nano fluid shows the following phenomena: total combustion heat increases while the concentration of smoke and nitrous oxide in the exhaust emission from diesel engine are decreased.

D. Ganesh et al.[4]studied the effect of adding a nano Magnalium (Al-Mg) and cobalt oxide (Co3O4) on the performance and emission characteristics of Jatropha biodiesel (B100) in a single cylinder, air cooled, direct injection diesel engine. Ball mill (Magnalium) and Sol-Gel (Cobalt oxide) processes were adopted for Nano particle preparation. The obtained particle size range is from 38 – 70 nm. The particle size is characterised using scanning electron microscope (SEM). The Nano particles (100 mg/l) were dispersed in the fuel by an ultrasonicator with the assistance of optimised surfactant concentration. It was noticed that the addition of Nano cobalt oxide additive reduced specific energy consumption at part load and full load conditions. Cobalt oxide acts as an oxygen buffer which improves the combustion and reduces the emissions. The introduction of Nano-fuel additive resulted in maximum reduction of about 60% in unburnt hydrocarbon (UBHC) and 50% reduction in carbon monoxide at full load and 75% load respectively for neat biodiesel operation. It was observed that NOx emission were higher at neat biodiesel operation compared with neat diesel operation and it was countered by introduction of Nano-fuel additive which resulted in 45% reduction in NOx emission at the same biodiesel operation. Magnalium particles are highly energetic materials and it reduces the energy consumption and improves the thermal efficiency, the reason is that, the additive releases energy during combustion, in addition to the liquid fuel. Magnalium improves the atomisation by means of micro explosion phenomena and hence it reduces the pollution formation. Due to micro explosion, the air/fuel mixing will be proper and hence it results in 70% reduction in HC emission and 41 % reduction in CO emission for B100 with additive at part load and full load conditions respectively. It was also noticed that, additive act as a heat sink and reduces the in-cylinder temperature which results in 30% reduction in NOx emission at 75% load for B100 with additive.

V.Arul Mozhi Selvan et al.[5] Studied the effect of adding cerium oxide nano particles in neat diesel and diesel-biodiesel ethanol blends In the first phase of the experiments, stability of neat diesel and diesel-biodiesel-ethanol fuel blends with the addition of cerium oxide nano particles are analyzed. After series of experiments, it is found that the blends subjected to high speed blending followed by ultrasonic bath stabilization improves the stability. The phase separation between diesel and ethanol is prevented using vegetable methyl ester (Biodiesel) prepared from the castor oil through transesterification process. In the second phase, performance characteristics are studied using the stable fuel blends in a single cylinder four stroke computerized variable compression ratio engine coupled with an eddy current dynamometer and a data acquisition system. The cerium oxide acts as an oxygen donating catalyst and provides oxygen for the oxidation of CO or absorbs oxygen for the reduction of NOx. The activation 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 results reduction in HC emissions. The tests revealed that cerium oxide nano particles can be used as additive in diesel and diesel-biodiesel-ethanol blend to improve complete combustion of the fuel and reduce the exhaust emissions significantly.

Matthew Jones et al.[6] studied the effect of adding nano aluminum and aluminum oxide in biofuel. N-Al and n- Al2O3 particles of 50- and 36-nm diameters, respectively, were utilized in this investigation. Combustion experiments were performed with volume fractions of 1, 3, 5, 7, and 10% for n-Al, and 0.5, 1, 3, and 5% for n-Al2O3. The results indicate that the amount of heat released from ethanol combustion increases almost linearly with n Al concentration. N-Al volume fractions of 1 and 3% did not show enhancement in the average volumetric HoC, but higher volume fractions of 5, 7, and 10% increased the volumetric HoC by 5.82, 8.65, and 15.31%, respectively. N-Al2O3 and heavily passivated n-Al additives did not participate in combustion reactively, and there was no contribution from Al2O3 to the HoC in the tests. A combustion model that utilized Chemical Equilibrium with Applications was conducted as well and was shown to be in good agreement with the experimental results.

Hao Liu et al.[7]studied the effect of adding oil-based nano diamond lubricant in diesel engine. Tribology, engine performance, fuel economy and the temperature field of one piston are important aspects of this work. To this end, surface- modified nano diamond lubricant of 0.1 wt% was used in a four-stroke diesel engine. The results indicate that adding nano diamond particles to engine oil has a perceptible effect on engine performance, increasing the maximum engine power and the maximum torque relatively to 1.15, 1.18 % respectively, while decreasing the fuel consumption relatively to 1.27 % as compared to the engine oil.

D.H. Qi et al.[8]studied the Effect of diethyl ether and ethanol additives on the combustion and emission characteristics of biodiesel-diesel blended fuel engine. They conducted an experiment to evaluate the effects of using diethyl ether and ethanol as additives to biodiesel/diesel blends on the performance, emissions and combustion characteristics of a direct injection diesel engine. The test fuels are denoted as B30 (30% biodiesel and 70% diesel in vol.), BE-1 (5% diethyl ether, 25% biodiesel and 70% diesel in vol.) and BE-2 (5% ethanol, 25% biodiesel and 70% diesel in vol.) respectively. The results indicate that, compared with B30, there is slightly lower brake specific fuel consumption (BSFC) for BE-1. Drastic reduction in smoke is observed with BE-1 and BE-2 at higher engine loads. Nitrogen oxide (NOx) emissions are found slightly higher for BE 2. Hydrocarbon (HC) emissions are slightly higher for BE-1 and BE-2, but carbon monoxide (CO) are slightly lower. The peak pressure, peak pressure rise rate and peak heat release rate of BE-1 are almost similar to those of B30, and higher than those of BE-2 at lower engine loads. At higher engine loads the peak pressure, peak pressure rise rate and peak heat release rate of BE-1 are the highest and those of B30 are the lowest. BE-1 reflects better engine performance and combustion characteristics than BE-2 and B30.

G.R. Kannan et al.[09] studied the effect of diesel engine with diestrol-water micro emulsions fuels to investigate the performance, emission and combustion characteristics of the engine under different load conditions at a constant speed of 1500 rpm. The results indicated that biodiesel and micro emulsion fuels had a higher brake specific fuel consumption (BSFC) than that of diesel. A slight improvement in the brake specific energy consumption (BSEC) was observed for micro emulsion fuels. The brake thermal efficiency of biodiesel and micro emulsion fuels were comparable to that of diesel. The emission characteristics like carbon monoxide (CO), carbon dioxide (CO2), unburnt hydrocarbon (UHC), nitric oxide (NO) and smoke emissions for biodiesel and micro emulsion fuels were lower than diesel fuel at all load conditions. The cylinder gas pressure of micro emulsion fuels was lower than diesel at low loads but it became almost identical to diesel at medium and full load conditions. The heat release rate for micro emulsion fuels was higher than biodiesel and diesel fuels for all loads. Biodiesel showed shorter ignition delay for the entire load range and the longer ignition delay observed for micro emulsion fuels.

R. Z. Kavtaradze et al.[10]they studied the ignition delay in diesel engine utilizing different fuels. Formulas for the calculation of ignition delay during engine operation utilizing different fuels (natural gas, ~98%CH4; synthesis gas of two types, namely, 70%N2 + 30%CH4 and 60%H2 + 20%CH4 + + 20%N2; and conventional liquid diesel fuel) are derived as a result of experimental investigations performed in a special setup. A brief description of the experimental method is given, and the derived formulas are analyzed. The investigations have been performed at the Institute of Internal Combustion Engines of the Munich Technical University.

Summary of literature review:

Author	**Additive used**	**Compo sition**	**Conclusion**
Himanshu Tyagi et al	Al and Al_2o_3	0.20%	Ignition probability incresed
Karoon Fangsuwannar ak et al	TiO_2	0.15%	Improved engine power
Mu-Jung Kao et al	Aqueus Alumin-ium Nano	0.30%	Combustion heat increased
D. Ganesh et al	Al-Mg	0.30%	Reduction in carbon monoxideand HC
V.Arul Mozhi Selvan et al	cerium oxide	0.40%	Reduction of NOx
Matthew Jones et al	N-Al and N-Al2O3	0.30%	Improved ignition probabiliy

III. CONCLUSION

From the above study, adding a nano additives to the biodiesel results in increased in the ignition probability of biodiesel. It was noticed that the addition of Nano additive reduced specific energy consumption at part load and full load conditions. The introduction of Nano additive resulted in maximum reduction of in unburnt hydrocarbon (UBHC) and reduction in carbon monoxide at full load for neat biodiesel operation. It was found that nano additives is more effective for improving engine power than pure Diesel and Biodiesel fuels . Meanwhile, with using nano additive, the maximum engine torque on average increased. nano additives is significantly effective on biodiesel fuel for reducing brake specific fuel consumption reached by as compared with pure biodiesel. Moreover, the exhaust emissions (NOx, CO and CO_2) decreased from the engine using the nano additive in biodiesel fuel and increasing the maximum engine power and the maximum torque relatively, while decreasing the fuel consumption relatively to as compared to the engine oil.

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