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Review on Performance and Emission Characteristics of Cl Engine by using Nanoparticles with Blended Biodiesel in Diesel Fuel

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ABSTRACT

The increase in energy demand has focused to find the best way of using conventional energy. Major portion of today's energy demand in India is being met with fossil fuels. Hence it is high time that alternate fuels for engines should be derived from indigenous sources. Due to shortage of diesel fuel and its increasing cost as well as hazardous emission emitted by diesel engine, the use of biodiesel and its blends has gained importance over the past two decades due to its environmental and economic benefits. Based on results available in literature the use of biodiesel and its blends with diesel improve diesel engine performance and reduce emissions. The need to minimize emissions at the lowest level is to ensure safety for the public and also to the engine. Nanoparticles have been found to be well efficient in emission control. There is a scope for performance improvement and emission reduction with diesel, biodiesel as base fuel with nanoparticle as additive. Nanoparticles have been found to be well efficient in emission control.

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I. INTRODUCTION

The increase in energy demand has focused to find the best way of using conventional energy. Therefore, improvement of fuels is an important issue. The increasing usage of this fossil fuel has a degrading effect on the environment through its polluting combustion product. Biodiesel fuel is one of the alternate fuels for diesel fuel. Biodiesel can be used with diesel fuel at different proportions, as it has very similar characteristics but lower exhaust emissions. Biodiesel fuel has healthier properties than those of diesel fuel such as renewable, eco-friendly, nontoxic, and basically free of sulphur. The burning of fossil fuels is connected with emissions such as CO2, CO, NOx, SOx, and particulate matter, which are currently the foremost global sources of emissions. Many investigations have shown that using of biodiesel in direct injection diesel engines can reduce carbon oxides, carbon monoxide, hydrocarbon, and particulate matter emissions, but nitrogen oxide emission may increase.

The recent advances in nano science and nanotechnology proved that the nano energetic materials have great advantages over micro sized materials. Ignition delay and ignition temperatures are the significant parameters to characterize the performance of a diesel engine. Tyagi *et al*. (2008) made an attempt to improve the ignition properties of diesel fuel by addition of nanoparticles to diesel. It was observed that in all the cases the ignition probability for the diesel-nanoparticles mixture was higher than that of pure diesel [1]. Nanometal oxide additives are reported to be successful in reducing diesel emissions. The metal based additives reduce diesel engine pollution emissions and fuel consumption values. The reason for emission drop is that the metal reacting with water to create hydroxyl radicals, which improve soot oxidation, or by direct reaction with the carbon atoms in the soot, thereby lowering the oxidation temperature. From the results, nonmaterial's can act as a burning rate catalyst because when dispersed into liquids they accelerate the burning rate and promote clean burning, also particulate matters and carbon monoxide are reduced. Due to complete combustion of fuel, emissions like CO, CO2 and NO*x* are appreciably reduced.

II. NANOPARTICLES: IT'S REQUIREMENTS AND TYPES

Nano-additives are considered as a propitious fuel-borne catalyst to improve the fuel properties, owing to their enhanced surface area/volume ratio, quick evaporation and shorter ignition delay characteristics. The size of nanoparticles varies from 1 to 100 nm [1]. Following are the main requirements of nanoparticles as fuel additive:

1. The nanoparticles act as catalyst should reduce exhaust emission as well as increase the oxidation intensity in the engine and in the particulates filters.
2. It should maintain the typical operational properties of engine.
3. The stability of additive in the fuel must be retained under all operational condition.

The type of nanoparticles for IC engine application is given in below table.

SR. NO.	TYPE	EXAMPLE
1	Metal based nanoparticles	Aluminum, iron, boron and ferric chloride
2	Metal oxide nanoparticles	Cerium oxide, alumina, TiO_2, MnO, CuO
3	Magnetic nanofluid particles	Fe_3O_4
4	Carbon nanotube particles	Single walled and multi walled CNT

II. LITERATURE REVIEW

In this section review of various literatures has been presented on effects of adding various nanoparticles in base fuel on performance and emission characteristics of diesel engine. A. Effects of metal based nanoparticles on performance and emission characteristics of CI engine Metal based nanoparticles are used as combustion catalyst to promote complete combustion and to reduce consumption of fuel and emission for hydrocarbon fuels. Metal based nanoparticles reduce diesel emission in two ways: (i) metals react with water vapor in the exhaust emission to produce highly reactive hydroxyl radicals (ii) metal serve as an oxidation catalyst which oxidize CO into CO_2, HC into CO_2 and water vapor and carbon (soot) into CO_2. The commonly used metal nanoparticles for hydrocarbon fuels are aluminum, iron, boron and ferric chloride. G.R. Kannan et al. [7] examined effects of 20 µmol/L ferric chloride ($FeCl_3$) added to waste cooking palm oil biodiesel on combustion, performance and emission characteristics of single cylinder direct injection CI engine operated at constant speed of 1500 rpm at different operating conditions.

The test results showed that the $FeCl_3$ added biodiesel resulted in decreased brake specific fuel consumption by 8.6% while brake thermal efficiency increased by 6.3% at optimized operating condition of 280 bar injection pressure and 25.5obTDC injection timing. The $FeCl_3$ added biodiesel showed lower nitric oxide emission (NO) and slightly higher carbon dioxide emission (CO_2) as compared to diesel at standard operating condition. Carbon monoxide (CO), total hydrocarbon (THC) and smoke emission of $FeCl_3$ added biodiesel decreased by 52.6%, 26.6% and 6.9% respectively compared to biodiesel without $FeCl_3$ at an optimized operating condition, but NO emission slightly increased by 4.1% with $FeCl_3$ added biodiesel compared to without $FeCl_3$ added biodiesel at optimum operating condition because $FeCl_3$ present in fuel oxidize nitrogen into nitric oxide during combustion process. At optimum operating condition higher cylinder pressure, heat release rate and shorter ignition delay period was observed with $FeCl_3$ added biodiesel. Rakhi N. Mehta et al. [8] investigated burning characteristics, engine performance and emission parameters of a single cylinder CI engine using nanofuels which were formulated by adding nanoparticles of aluminum (A1), iron (F1) and boron (B1) in base diesel. These fuels showed reduced ignition delay and improved combustion rates.

The brake thermal efficiency increased by 9%, 4% and 2% for A1, F1 and B1 respectively as compared to diesel at maximum loading conditions. At higher load the SFC reduced by 7% when engine fuelled with A1 as compared to diesel, while SFC for F1 and B1 was almost same to that of diesel. Volumetric reduction of 25-40% in CO emission, 8% and 4% in hydrocarbon emission was observed when engine fuelled with A1 and F1 respectively as compared to diesel. The NOX emission marginally increased compare to pure diesel because of increase in burning temperature in the combustion chamber. B. Effects of metal oxide nanoparticles on performance and emission characteristics of CI engine The metal oxide nanoparticles used for hydrocarbon fuels are TiO_2, ZnO, MnO, Al_2O_3 and CuO. The metal based nanoparticles act as oxygen donating catalyst which provide oxygen for oxidation of CO or absorbs oxygen for the reduction of NOx. Arul Mozhi Selvan et al. [9] evaluated performance and emission characteristics of CI engine by using 25 ppm cerium oxide (CeO_2) nanoparticles as additive in neat diesel and diesel-methyl ester of castor oil-ethanol blends (D70B10E20). The authors found that the SFC was lower and BTE was higher with addition of CeO_2 in diesel and D70B10E20 blend compare to diesel and D70B10E20 blend. The addition of CeO_2 in diesel and D70B10E20 blend lower emission of CO, HC and smoke, while marginally increased NOX emission compare to pure diesel and D70B10E20 blend. Sajith et al. [10] carried out experimental investigation on performance and emission characteristics of single cylinder constant speed diesel engine fuelled with CeO_2 nanoparticles (10 to 20 nm) added to jatropha biodiesel with dosing level of CeO_2 vary from 20 to 80 ppm. The tests results showed that BTE increased and SFC reduced by adding nanoparticles in biodiesel compare to pure biodiesel.

The nanoparticles promote longer and more complete combustion compared to base fuel because CeO_2 act as an oxygen buffer and thus increase efficiency. Also CeO_2 oxidize carbon deposits from the engine leading to efficient operation and reduced fuel consumption. The addition of CeO_2 nanoparticles to biodiesel decreased CO, HC and soot emission compare to biodiesel without CeO_2. CeO_2 nanoparticle has the ability to undergo transformation from stoichiometric CeO_2 (+4) valence state to Ce_2O_3 (+3) (cerous oxide) via relatively low energy reaction. CeO_2 supplies oxygen for the reduction of HC as well as soot and converted to Ce_2O_3 as per reactions. M.A. Lenin et al. [11] carried out comparative study on performance and emission characteristics of diesel engine fuelled with 100 mg/L manganese oxide (MnO) and copper oxide (CuO) nanoparticles added in diesel fuel. The brake thermal efficiency of diesel+MnO fuel was higher compare to diesel+CuO and neat diesel for all loads. The brake thermal efficiency for neat diesel and diesel+CuO fuel was nearly same. The emission of CO and NOx for diesel+MnO fuel was lower compare to neat diesel and diesel+CuO fuel for all loads.

III. CONCLUSION

1. The nanoparticles act as combustion catalyst which reduce delay period and promote complete combustion when added to base fuel and hence increase efficiency of engine and lower brake specific fuel consumption.

2. There is reduction in CO emission with all type nanoparticles except magnetic nanoparticles added to base fuel compare to base fuel without nanoparticles because nanoparticles oxidize CO into CO2. With magnetic nanoparticles CO emission increase compare to base fuel without nanoparticles.

3. The activation energy of nanoparticles burn off carbon deposits within combustion chamber which lower HC and smoke emission.

4. With nanoparticles added emulsion fuel because of micro-explosion and secondary atomization phenomenon the performance of engine improved and reduced emissions.

REFERENCE

1. Syed Aalam, C.G. Saravanan and M. Kannan, "Experimental Investigation on CRDI System Assisted Diesel Engine Fulled by Diesel with Nanotubes", American Journal of Engineering and Applied Sciences 2015, 8 (3): 380.389

2. Ghanshyam S. Soni, 2Prof. Dr. Pravin P. Rathod, 3Prof. Jigish J. Goswami,"Performance and emission characteristics of CI engine using diesel and biodiesel blends with nanoparticles as additive - A review study", 2015 IJEDR | Volume 3,Issue 4 | ISSN:2321-9939

3.D.N.Basavarajappa1,N.R.Banapurmath*2a*,S.V.Khandal2 b,G.Manavendra3,"Performan ce Evaluation of Common Rail Direct Injection (CRDI) Engine Fuelled with Uppage Oil Methyl Ester (UOME)", Int. Journal of Renewable Energy Development 4 2015: 1-10

4. Heejung Jung, David B. Kittelson, Michael R. Zachariah, "The influence of a cerium additive on ultrafine diesel particle emissions and kinetics of oxidation", 2005 Published by Elsevier Inc. on behalf of The Combustion Institute. doi:10.1016/j.combustflame.2004.11.015

5. Ranaware A. A.1, Satpute S. T.2, "Correlation between Effects of Cerium Oxide Nanoparticles and Ferrofluid on the Performance and Emission Characteristics of a C.I. Engine", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)ISSN: 2278-1684, PP: 55-59

6. Abbas Alli Taghipoor Bafghi, Hosein Bakhoda, Fateme Khodaei Chegeni," Effects of Cerium Oxide Nanoparticle Addition in Diesel and Diesel-Biodiesel Blends on the Performance Characteristics of a CI Engine" World Academy of Science, Engineering and Technology International Journal of Mechanical, Aerospace, Industrial, Mechatronic and Manufacturing Engineering Vol:9, No:8, 2015.

7. G.R. Kannan, R. Karvembu and R. Anand, "Effect of metal based additive on performance emission and combustion characteristics of diesel engine fuelled with biodiesel", Applied Energy, vol. 88, pp. 3694- 3703, May 2011.

8. Rakhi N. Mehta, Mousumi Chakraborty and Parimal A. Parikh, "Nanofuels: combustion, engine performance and emission", Fuel, vol. 120, pp. 91-97, December 2013.

9. V. Arul Mozhi Selvan, 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, pp. 1-6, September 2009.

10. Sajith, C.B. Shobhan and G.P. Peterson, "Experimental investigations on the effects of cerium oxide nanoparticles fuel additives on biodiesel", Advances in Mechanical Engineering, vol. 36, pp. 1-16, 2010.

11. M.A. Lenin, M.R. Swaminathan and G. Kumaresan, "Performance and emission characteristics of a DI diesel engine with a nanofuel additive", Fuel, vol. 109, pp. 362-365,March2013.

