Performance of Cotton Seed Biodiesel with Nano Additives in Diesel Engines: A Review

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Abstract

Increasing fuel prices and depleting fossil fuel resources in a modern day drawn attention towards the use of alternative fuel for diesel engines. Biodiesel fuels are measured as best alternative for diesel fuel as it is renewable, eco-friendly, non-hazardous with wide cultivation of cotton seed oil would be a very good feedstock for preparation of biodiesel as non-edible vegetable feed stocks for biodiesel production. The burning of fossil fuel is connected with emission such as CO_2, CO, NO_x, SO_x and particulate matter. Nano-additives like CeO_3, ZnO_2, TiO_2, CoO_2, CuO, FeO_2, Al_2O_3, CNT, are considered as a propitious fuel-borne catalyst to improve the fuel properties and reports to be successful in dropping diesel emissions.In this article, a comprehensive review is conducted highlightingwith the variations in physio-chemical properties, and its effect on performance and emission aspects.

Keywords: *Biodiesel; CeO_2 Nanoparticles; Performance; Stability of the blend ;Ultrasonicator.*

1. Introduction

Now a day the rapid growth in industrialization, automotive industries, causes the climatic change that affects several ecosystems on the earth andthe major reason for this climate change is global warming.Probably in this century, it is believed thatcrude oil and petroleum products will become very scarce and costly to find and produce. Although fuel economy of engines is greatly improved, increase in the number of automobiles alone dictates that there will be a great demand for fuel in the near future. Alternative fuel technology, availability, and use must and will become more common in the coming years. Another reason motivating the development of biodiesel fuels for diesel engine is concerned over the emission problems of gasoline engines. When we have combined with other air polluting systems, the large number of automobiles is a major contributor to the air quality problem of the world. Although another reason for biodiesel fuel development is the fact that a large percentage of crude oil must be imported from other countries which control the larger oil fields.

Energy is an important input in all sectors of any countries economy and the standard of living of a given country can be directly related to the per capital energy consumption.Moreover, as a non-renewable source, availability of petroleum as fuel is getting depleted day by day due to the increase in their usage for power generation and transportation. It is estimated that many of the country's fuel or oil requirement is fulfilled through import from foreign countries incurring huge foreign exchange affecting the economy.Again the industrial, agricultural and transportation segments mainly rely on petroleum diesel, in spite of its limited availability, the rise in demand is rapid along with increased depletion. Therefore, the threat of global warming and the stringent government regulation makes the engine manufacturers and the consumers to follow the emission norms to save the environment from pollution likethe burning of fossil fuel withemission such as carbon dioxide (CO_2), carbon monoxide (CO), nitrogen dioxide (NOx), sulpher dioxide (Sox), particulate matter and unburned hydrocarbons (HC) are a great threat to mankind, flora, fauna, ozone layer and the environment.

To solve these problems, the addition of nanoparticles to the biodiesel through various forms significantly improves the properties and it contributes to enhanced performance with reduced emissions. Although the use of A diesel engine has an excellent reputation for its low fuel consumption, reliability and durability characteristics because of its higher brake thermal efficiency due to its high compression ratio and leaner fuel-air mixture. Again the use of blend diesel withbiodiesel through Nano additives is good for the environment because it is made from bio resources and has lower emission compared to petroleum diesel.

2. Biodiesel and Importance of Additives

Biodiesel fuel is preferred as a renewable diesel engine fuel with a less effect on greenhouse gases due to participation of CO_2 to photo synthesisand positive impacts on smoke emissions with absence of the aromatic and sulfur contents. It is a mono-alkyl esters of long chain fatty acids which are non-toxic in nature, non-explosive, less flammable and more importantly it uses as biodegradability.It is an ester based oxygenated fuel make form any vegetable oil (edible or non-edible) or animal fat. Bio-diesel is produced by a simple chemical reaction between vegetable oil and alcohol in the presence of an acid or base as catalyst. It contains around 10% built-in oxygen by weight and has no sulphur and has excellent lubricity properties that built-in-oxygen makes it more efficient fuel than petro-diesel hence its cetane number is higher than that of petro-diesel. It can be blended with petro-diesel in any proportion. Although, Bio-diesel is the name of the clean burning alternative fuel, produced from domestic, renewable resources. They cannot contain petroleum, but it can be blended at any level with petroleum diesel to create a bio-diesel blend.

Biodiesel can be used in compression-ignition (diesel) engines with little or no modifications. Also it is defined as mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats which confirm to ASTM D6751 specifications for use in diesel engines and it refers to the pure fuel before blending with diesel fuel.Biodiesel is produced from various available natural sources namelyCotton seed, Coconut, Sunflower oil Palm, Jatropha, Pongamia, Grape seed, Mahua, Castor, Tobacco seed, Rubber seed, Rice bran, Neem seed, etc.In this Article review investigation cotton seed oil is taken as base oil (biodiesel) and Cerium Oxide (CeO2) as Nano additive.

3. Biodiesel Standard (ASTM D 6751)

All engines are designed and manufactured for a fuel that has certain characteristics. In the US, the industry organization that defines the consensus on fuels is the American Society for Testing and materials (ASTM). In the case of diesel fuel (and biodiesel), the responsibility for setting standards lies within ASTM Committee D02 on Petroleum Products and Lubricants. In order to assure that the standards are rigorous and robust, ASTM committee D02 is comprised of fuel producers, engine equipment manufacturers, and third party interests (users, government agencies, consultants). ASTM also uses a complicated ballot process in which a single negative vote is enough to defeat a ballot, so this is a true consensus organization. An ASTM standard is not easily achieved. Some standards can take over 10 years to gain agreement and be issued by ASTM. This rigorous, time-consuming process is why ASTM standards are recognized and adopted by others worldwide.

ASTM fuel standards are the minimum accepted values for properties of the fuel to provide adequate customer satisfaction and/or protection. For diesel fuel, the ASTM standard is ASTM D 975. All engine and fuel injection manufacturers design their engines around ASTM D 975. In cooperative discussions with the engine community early in the biodiesel industry's development, engine manufacturers strongly encouraged the biodiesel industry to develop an ASTM standard for biodiesel fuel which would allow them to provide their customers with a more definitive judgment on how the fuel would affect engine and fuel system operations compared to ASTM D 975 fuel for which an engine was designed.

In June of 1994, a task force was formed within ASTM Subcommittee E on Burner, Diesel, Non-Aviation Gas Turbine, and Marine Fuels of ASTM Committee D02, with the expressed objective of developing an ASTM standard for biodiesel. The biodiesel standard, ASTM PS 121-99, was approved by Subcommittee E, and subsequently issued by ASTM in June of 1999 (for copies, see the ASTM web site at www.astm.org). In December of 2001, ASTM approved the full standard for biodiesel, with the new designation of D-6751 (succeeds PS 121-99). This standard covers pure biodiesel (B100), for blending with petrodiesel in levels up to 20% by volume. Higher levels of biodiesel are allowed on a case-by-case basis after discussion with the individual engine company, since most of the experience in the US thus far has been with B20 blends.

The approval of this biodiesel standard, and the technical reviews necessary to secure its approval, has provided both the engine community and customers with the information needed to assure trouble free operation with biodiesel blends.Blending pure biodiesel is denoted as B100. The blending percentage of biodiesel with diesel was set to 0%, 10%, 20%, 30%, and 40% and they are mentioned as B0, B10, B20, B30, and B40. All the biodiesel blends were stored in different conical flasks and sealed with aluminium foil for further tests.

4. Physical and Chemical Properties of Biodiesel fuel

A. Density

Density of the B100 biodiesel must be as close to the pure diesel so that blending becomes better. Density of B20 blends are more close to the density of pure diesel as the percentage of the biodiesel is less in the blend. B20C has density closer to that of Diesel. If there is a large variation in density, the fluids separate out from each other forming two different layers of fluids. It has been observed that Bio diesel has higher density than petroleum diesel which means that volumetrically-operating fuel pumps will inject greater mass of biodiesel than conventional diesel fuel. This in turn will affect the air–fuel ratio hence the local gas temperatures and NOx emissions increases.

B. Flash and Fire Point

Flash point and fire point of the fuel must be higher so that the fuel doesn't catch fire during storage. Hence, to be on safer side, the preferred flash point values must be above 110°C for B100. From the graph it is evident that diesel has lesser value of flash point in comparison with Blends because diesel is less volatile when compared to biodiesel.Flash point is ignition temperature when it is exposed to the flame. It can also be defined as the lowest temperature at which fuel emits enough vapors to ignite (Sanford et al., 2009). Its greater importance is in defining flammability and combustibility of a material. Flashpoint of biodiesel (150°C) is much higher than petro diesel (55-66°C) (Knothe et al., 2005). This property makes biodiesel safe for storage and transportation over petro diesel. The flash point determination was carried out by heating a sample of the fuel in a stirred container and passing a flame over the surface of the liquid; if the temperature is at or above the flash point, the vapor will be ignited and an easily detectable flash would be observed (Kaisan et al., 2013).

C. Kinematic Viscosity

The viscosity of the biodiesel must be in the range of 3-6 centistokes. Higher viscosity leads to less accurate operation of the fuel injectors because of which there is poor atomization and increase in fuel droplet size. But in mean time fuel leakages will be reduced and that also leads to higher injection pressures.

D. Gross Calorific Value

The calorific value of pure diesel is 46580 KJ/KG. The calorific value will directly affect the efficiency of the fuel as it gives the amount of heat of combustion. The oxygen is generally 10-12% in biodiesel because of which it has lower energy density and heating value, so it needs more amount of fuel to be injected for same Engine power output.

E.PH

The pH value is found to be nearer to that of neutral value of 7, Hence pH for the entire sample and diesel is neutral.

F.Cloud Point

Cloud point is the temperature of a liquid specimen in which the smallest observable cluster of hydrocarbon crystals (milky cloud) appear first upon cooling under prescribed conditions. As a matter of fact, the crystal starts at lower circumferential wall of the test jar where the temperature is lowest (ASTM D 2500-05). As the temperature keeps on decreasing below, more amount of material solidifies and the compound approaches the pour point (no flow). This crystal, if it appears in the biodiesel, can clog fuel lines.

Generally, it was observed that CP and PP of biodiesel is higher than that of petroleum diesel however can be decreased by blending with petroleum diesel (especially CP) (Rajagopal et al., 2012). The Cloud Point of biodiesel depends on chain length of saturated FAME, degree of unsaturation, and orientation of double bonds.

G.Pour point

Pour point is the lowest temperature (below the cloud point) at which the oil specimen can still be moved in the presence of large amount of crystal within the fuel. Hence, it is a measure of fuel gelling point (Dwivedi and sharma, 2013). Biodiesel fuels derived from fats or oils with significant amounts of saturated fatty compounds will display higher CPs and PPs (Knothe, 2005). Blending biodiesel with diesel fuel improves the cold flow properties of the biodiesel blend (Pradhan, 2007).

H.Cold filter plugging point and low temperature flow test

Cold filter plugging point (CFPP) is the lowest temperature (expressed in 1°C) at which a given volume of diesel type of fuel still

passes through a standardized filtration device in a specified time when cooled under certain conditions (Dwivedi and sharma, 2013). American Society for testing Material (ASTM, 1999) defines it as temperature at which a given volume of fuel fails to pass through a standardized filtration device in a specified time when cooling proceeds under the prescribed conditions. This gives an estimate for the lowest temperature that a fuel will give trouble free flow in certain fuel systems (Dwivedi and sharma, 2013).
Low temperature flow test reports the lowest temperature at which 180mL of a sample can pass through the filter in 60 seconds or less, while the CFPP reports the lowest temperature at which 20mL of sample can pass through the filter in 60 seconds or less. Although both the tests are identical, the LTFT is a better approach because it takes into account the rigorous conditions within the engine (Edith et al., 2012).

I. Cold flow property

One of the major problems associated with the use of biodiesel is there poor flow properties at low temperature (Knothe, 2005). Higher-melting point components in the fuel at low temperatures start to nucleate and form solid crystals due to the presence of high amount of saturated fatty acid (Dwivedi and sharma, 2013). Prolonged exposure of fuel at a temperature below cloud point cause growth of crystal and it will affect their flow ability and other related property. Cold flow properties are expressed by cloud point, pour point, low temperature filterability test and cold filter plugging point (Dwivedi and sharma, 2013). Biodiesel cold flow properties depends on many factors including impurities, oil feedstock type, alcohol types, amount of free fatty acid, bound glycerin, moisture content, and amount of fatty acid ester (Pradhan, 2007), and also directly depend on its fatty acid methyl ester composition (Rajagopa et al., 2012).In generally, the vegetable oil feedstocks for biodiesel are categorized into two, namely edible and non-edible sources.

5. Trans-esterification

Transesterification is the reaction of vegetable oil or animal fat with an alcohol, in most cases methanol, to form esters and glycerol. The transesterification reaction is affected by alcohol type, molar ratio of glycerides to alcohol, type and amount of catalyst, reaction temperature, reaction time and free fatty acids and water content of vegetable oils or animal fats. The transesterification reaction proceeds with or without a catalyst by using primary or secondary monohydric aliphatic generally, the reaction temperature near the boiling point of the alcohol is recommended. Nevertheless, the reaction may be carried out at room temperature. The reactions take place at low temperatures (~65°C) and at modest pressures (2 atm, 1 atm = 101.325 kPa). Biodiesel is further purified by washing and evaporation to remove any remaining methanol. The oil (87%), alcohol (9%), and catalyst (1%) are the inputs in the production of bio-diesel (86%), the main output. Pretreatment is not required if the reaction is carried out under high pressure (9000 kPa) and high temperature (~240°C), where transesterification take place with maximum yield obtained at temperatures ranging from 60 to 80°C at a molar ratio of 6:1. The alcohols employed in the transesterification are generally short chain alcohols such as methanol, ethanol, propanol, and butanol. It was reported that when transesterification of cotton seed oil using methanol, ethanol and butanol was performed, 96–98% of ester could be obtained after 1 h of reaction.

6. Nanofuel

Nanofuel is a renewable and eco-friendly alternative diesel fuel for CI engine. Nanofuel has higher viscosity, density, pour point, flash point and cetane number than diesel fuel. Using optimised blend of nanoparticles and diesel can help to reduce some significant percentage of the world's dependence on fossil fuels without modification of CI engine. Moreover additives are an essential part of today fuels, together with the carefully formulated fuels composition. They contribute to efficiency reliability and long life of an engine Such as using optimised blend of nanoparticles and diesel instead of conventional diesel fuel significantly reduces emission of particulate matters (PM), carbon monoxide (CO), sulphur oxides (SOx), and unburned hydrocarbons (HC). With the use of fuel additives in the blend of nanoparticles and diesel improves performance, combustion and also improves fuel properties which enhance the combustion characteristics.

7. Fuel additives and its importance

Additives are organic based or metal based substances which are easily soluble in fuel and its main purpose is to improve, maintain and provide beneficial characteristics to the fuel without affecting the performance and combustion parameters. The fuel additives are added in smaller quantities ranging between 100 ppm to several thousand ppms. The fuel additives are broadly classified as refinery products, distribution system products, and automotive performance enhancement products. They are again subdivided into following categories namely antioxidants, cetane improvers, anti-knocking agents, anti-freezing agents, stability improvers, additives to prevent corrosion, cold flow improvers, fuel borne catalysts, anti-wear agents, etc.The base catalysts commonly used are sodium hydroxide (NaOH) and potassium hydroxide (KOH). The methods used for biodiesel production are ultrasonic reactor method, supercritical process, lipase-catalyzed method and batch reactor method.

8. Nanoparticles: Its Types and Requirements

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. Following are the main requirements of Nano particles 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.

There are different types of nanoparticles.

i. Metal based nanoparticles; such as Aluminum, iron, boron and ferric chloride.
ii. Metal oxide nanoparticles; such as CeO_2, alumina, TiO_2, MnO, CuO.
iii. Magnetic Nano fluid particles; Fe3O4 and
iv. Carbon nanotube particles; those are Single walled and multi walled CNT.

9. Effect of Nano Metallic Additive on Fuel's Physio-chemical Properties

Attia et al. studies investigated the effect of B20-Jojoba methyl ester with addition of aluminium oxide nano particle on properties of fuel, performance and emission characteristics of the diesel engine. The result showed that there was a considerable change in fuel properties. It was also noticed that the addition of Al2O3 reduced the kinematic viscosity of the fuel along with an increase in density and Cetane number.

PrabhuArockiasamy et al. This man mentioned that the addition of 30 ppm Al2O3 and CeO2 with Jatropha methyl ester improved the kinematic viscosity, density and calorific value as 4.25 Cst, 875 kg/m3 and 38.9 MJ/kg for JBD30A blend. JBD30C blend was found to have similar fuel property values as 4.30 Cst, 876 kg/m3 and 38.7 MJ/kg respectively. The addition of alumina with Jatropha biodiesel improved the fuel properties.

Syed Aalam and Saravanan also according to this person's experimental investigation for B20-Mahua biodiesel by adding aluminum nanoparticles, he obtained similar improved fuel properties of biodiesel.

Selvan et al. Again this person investigated that the effect of blend of Ceriumoxide (CeO2) and Carbon nanotube (CNT) in a single cylinder 4 stroke water cooled variable compression ratio engine using diesel-castor oil-ethanol blends. After he wouldblend at 25ppm, 50ppm and 100 ppm of 32 nm sized CeO2 and 100 nm sized CNT, the brake thermal efficiency (BTE) and cylinder pressure is increased. He concludes that the mixture of Nano additives resulted in advanced peak pressure occurrence with a cleaner combustion mean thatit reduced exhaust gases.

Jung He found that the suspension of nanoparticles in oxygenated fuel blends, especially methanol reduces global warming and the main global greenhouse gas or carbon dioxides (CO_2). They studied or investigate that the addition of Nanosuspension could be a new cutting-edge technology for effective of carbon dioxidesreduction in industrial systems including integratedgasification combined cycle (IGCC). In generally, they concludein their research to reducing CO_2 by adding Nano additives to biofuel blends for CI engine.

Rao and SrinivasRao they had studied experimentalinvestigation of performance and emission characteristics of single cylinder four stroke water cooled CI engine fuelled with ZnO2 and CeO_2 added diesel. CeO_2 was blend with diesel in the proportions of 40 ppm and 80 ppm whereas, ZnO2 nanoparticles were blend with diesel in 250 ppm and 500 ppm range by using ultrasonicator kept at a frequency of 20 KHz for 15 to 30min. Based on this studied, the BSFC for ZnO250, ZnO500 were same as Ce_2O40, CeO80 respectively but, BTE increased with addition of nanoparticle. In addition, BTE was maximum and it was 29.5% for ZnO500 and CeO_280ppm.

Karthikeyan et al. According to these researchers, they concluded that the engine performance was not proportionately increasing with respect to nano additive concentration byanalyzed the performance and emission characteristics of 4 stroke CI engine fuelled with ZnO_2 nanoparticle added pomoline stearin wax biodiesel-diesel blend. On other hand, the BSFC decreased for ZnO added blends compared to biodiesel whereas BTE increased for ZnO blends than biodiesel and the CO, HC emissions were lower than B20 for ZnO added blends. Therefore, the effect of adding various nanoparticle additives to the properties of various biodiesel and its impact on use as a fuel in diesel engine with respect to performance, combustion and emission characteristics.

W.M. Yang et al. this researcherevaluated that performance and emission characteristics of 4 cylinder diesel engine fuelled with emulsion fuel with 82.4% diesel, 4% water and 12.6% nano-organic additives by volume. The BSFC of emulsion fuel was higher than that of diesel fuel whereas the BTE of engine was 5% higher than pure diesel because of micro-explosion of water droplet contained in emulsion fuel and there was slight reduction in BP, BMEP and IMEP with emulsion fuel compare to diesel because of lower heating value. In other ways, the NO_X, HC, and CO significantly reduced with emulsion fuel compare to that of diesel.

Studies by Demirba et al. and Jayed et al. also according to these researchers, there was the importance of adding nano metal additives in biodiesel and its effect in improving the physio-chemical properties of the nano metal blended biodiesel. Therefore nano additives have more and more advantages to increase the flash point and Cetane number than neat fuel.

10. Discussion on change in physio-chemical properties upon addition of Nano metal additives

H**. Venkatesan et al., Vol.7, No.2, 2017** he put investigation on performance of biodiesel with diesel blend, on his review article on Nano additives as the following tables. From table 1. Comparison of physio-chemical properties of diesel, biodiesel and nano metal additive blended fuel. The reason for adding metal based nano additives to the diesel / biodiesel is to enhance the performance of the engine by improving the properties of fuel.Addition of diesel+250ZnO,diesel+500 ZnOand diesel+40CeO2, diesel+40CeO2 increased the flash point and Cetane number [4,] whereas the addition of nanoparticles (JME, JME2S5W, JME2S5W25CNT, JME2S5W50CNT, JME2S5W100CNT) to the emulsified fuel increased the values of viscosity, density, calorific value and Cetane number [12].

11. Effect of Nano Metallic Additive on Engine Performance and Emission Parameters

S. Karthikeyan et al he have conducted experimentation on performance, combustion, emission characteristics using grape seed oil biodiesel blends with Nano additives and found that the heat release rate increases with addition of cerium oxide Nanoparticles. Addition of cerium oxideNanoparticles causes rapid combustion and longer ignition delay and increases engine perforformances like, BTE, BP and decreases BSFC.

Y. He et al According to his investigation experiments carried out study on cottonseed oil as a partial substitute for diesel oil in fuel for single-cylinder diesel engine. The experimental results obtained showed that a mixing ratio of 30% cottonseed oil (CSME) and 70% diesel oil was practically optimal in ensuring relatively high thermal efficiency of engine, as well as homogeneity and stability of the oil mixture.The aluminium nanoparticle was added with various proportions catalyst.

V. Sajith et al. According to his experimental investigation on performance and emission characteristics of single cylinder constant speed diesel engine fuelled with CeO2 nanoparticles (10 to 20 nm) added to jatropha biodiesel with dosing level of CeO2 vary from 20 to 80 ppm. The tests results showed that BTE increased whereas, SFC reduced by adding nanoparticles in biodiesel compare to pure biodiesel. In addition, CeO2 oxidize carbon deposits from the engine leading to efficient operation and reduced fuel consumption. Therefore, the addition of CeO2 nanoparticles to biodiesel decreased CO, HC and decreases emission compare to biodiesel without CeO2. And also he concluded that the emission of NOx reduced with an average reduction of 30% with dosing level of 80 ppm CeO2 nanoparticles.

M.A. Lenin et al. Also he was studied 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. Again, the emission of CO and NOx for diesel+MnO fuel was lower compare to neat diesel and diesel+CuO fuel for all loads.

Barathiraja et al. He was studied the performance and emission characteristics of a single cylinder four stroke water cooled diesel engine fuelled with nano alumina added diesel. Nano particle dosage level in diesel was 25 ppm, 50 ppm and 75 ppm. BTE at maximum load was 39.6% whereas, BSFC was higher for all nano fluids compared to blend diesel whereas, emission of engines was reduced for all nano fluids compared to diesel.

Balaji and Cheralathan According to their experiments investigating the performance and emission characteristics of diesel engine fuelled with CNT added NOME. The emission and performance curves were compared with NOME and neat diesel. Also BTE for CNT added NOME increased upto 2.12% for CNT100, by 4.17% for CNT200 and 3.43% for CNT300.

SoukhtSaraee et al. Analyzed the performance and emission characteristics of a six cylinder air cooled DI diesel engine fuelled with silver nanoparticle added diesel with sorbitanmonooleate as surfactant. Fuel consumption, engine speed, peak cylinder pressure and exhaust emissions values were compared with diesel as base line reading.

Rashedul et al. Reviewed the various biodiesels, various types of fuel additives and its effect on the characteristics of biodiesel on addition. Oxygenated additives were suggested to control the cylinder temperatures. Co, Mg, Mn, Ni metal additives increased the exhaust emissions.

Sajeevan and Sajith mentioned about the performance and emission characteristics of a single cylinder four stroke naturally aspirated water cooled CI engine fuelled with ceria nanoparticle added diesel. BTE increased with the addition of nanoparticles. Diesel with 35 ppm ceria added blend showed lesser NOx and CO emissions compared to other blends and neat diesel.

H. Venkatesan et al., Vol.7, No.2, 2017 He puts the comparison of emission parameters under various test conditions and additives as the following. On the engine types of one cylinder 4-stroke AC, WC DI diesel engine at all loads and full load test condition performance for biodiesel of B20JME, Diesel, JME, B20WCFB, MME, blend or nano additives with Al2O3, CuO, CeO2 results to decreases UBHC, CO, NOx, and smoke [Ref. 1,2,30] but, increases the BTE and reduced the BSFC.

12. Conclusions

Depending on the review, it is understood that the addition of nanoparticles plays a major role in improving the fuel properties as well as enhancing the performance of diesel engine and reducing the exhaust emissions. Also the addition of nanoparticles to cotton seed biodiesel increases BTE and decreases BFC which depends upon the base fuel used. We can identify the amount of nanoparticle added, the way they have been mixed well with the diesel fuel, and how the operating condition of blend biodiesel are good with the diesel engine. As we have understood from many researcher and journal paper, additives of nanoparticles thus shows well results in all aspects, diesel and biodiesel blends are, CeO_2,CNT and Al_2O_3, ZnO. May be all nanoparticles cannotbe achieved with the performance enhancement of diesel fuel and biodiesel blend.Therefore, selecting optimal range of nanoparticle addition is the main target to improve the blend fuel properties,to get good results on enhanced performance and reduced emission in a diesel engine. Depending on a lot of researcher'sideas, we should be done on this area to select the suitable nanoparticle additive based on the best fuel properties.

Table 1: Abbreviations.

Sr.no	Abbreviations		Sr.no	Abbreviations	
1	Al_2O_3	Aluminum oxide	23	JBD	Jatropha biodiesel
2	CNT	Carbon nanotube	24	SBD	Soyabean biodiesel
3	CeO_2	Cerium oxide	25	HOME	Honge oil methyl ester
4	ZnO	Zinc oxide	26	AIT	Auto ignition temperature
5	ZnO_2	Zinc peroxide	27	CRDI	Common rail direct injection
6	TiO_2	Titanium di-oxide	28	BSFC	Brake specific fuel consumption
7	CoO_2	Cobalt di-oxide	29	BMEP	Brake mean effective pressure
8	CuO	Copper oxide	30	BTE	Brake thermal efficiency
9	FeO_2	Ferrous oxide	31	BSEC	Brake specific energy comsumption
10	UBHC	Unburned hydrocarbon	32	EGT	Exhaust gat temperature
11	CO	Carbon monoxide	33	CP	Cylinder pressure
12	NOx	Oxides of nitrogen	34	MENO	Neem oil methyl ester
13	NaOH	Sodium hydroxide	35	CTAB	Cetryltrimethyl ammonium bromide
14	KOH	Potassium hydroxide	36	JME	Jatropha methyl ester
15	BHT	Butylatedhydroxytoluene	37	WCFB	Waste chicken fat biodiesel
16	COSME	cotton seed methyl ester	38	MME	Mahua methyl ester
17	BHA	Butylatedhydroxyanisole	39	CBD	Canola biodiesel
18	ASTM	American Society for Testing and materials.	40	NOME	Neem oil methyl ester
19	B20	Blend of Diesel (80%) and biodiesel (20%)	41	GSME	Grape seed oil methyl ester
20	AONP	Aluminum oxide nano particle	42		
21	NP	Nano particle	43		
22	TME	Tail oil methyl ester	44		

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