International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 12 | Dec 2020 www.irjet.net p-ISSN: 2395-0072

EFFECT OF CERIUM OXIDE NANO ADDITIVE IN WATER EMULSIFIED DIESEL – BIODIESEL BLEND ON PERFORMANCE AND EMISSION PARAMETERS OF DIESEL ENGINE

Nitturu Hanif[1], Dr. K. Govindarajulu[2]

[1]PG Research Scholar, Advanced Internal Combustion Engines, Department of Mechanical Engineering, Jawaharlal Nehru Technological University Anantapur College of Engineering (Autonomous), Anantapuramu, Andhra Pradesh, India.

[2]Professor, Department of Mechanical Engineering, Jawaharlal Nehru Technological University Anantapur College of Engineering (Autonomous), Anantapuramu, Andhra Pradesh, India.

Abstract - *Alternative fuels are receiving considerable attention, especially biodiesel, which is recognized for its environmental benefits. The importance of biodiesel is increasing in past few years due to the oil crisis and depletion of crude oil reserves globally. The biodiesel can be extracted from different sources and blend with engine fuels to counter factors like fuel scarcity, pollution, cost and increasing of consumers. In the present study, the effects of water emulsion and cerium oxide nano additive on the performance and emissions of a compression ignition engine using biodiesel blends are investigated on a four stroke, single cylinder diesel engine. The emulsion technique is used to reduce the oxides of nitrogen emission.*

Biodiesel is produced from cottonseed oil and blended with diesel to form different blend proportions on volume basis, namely B10, B20 and B30 are made to run in CI engine. Among the various blends tested B10 shows better results when compared with diesel in brake thermal efficiency (BTE), brake specific fuel consumption (BSFC) and lower HC and CO_2 emissions. However, the other emissions like nitrogen oxide (NOx) and carbon monoxide (CO) were shown marginally higher.

The water in oil emulsion (B10W3) is prepared by adding 3% (vol) water in the presence of 2% Tween20 Surfactant. Cerium oxide (CeO_2) as nano additive is blended with water emulsified diesel-biodiesel (B10W3) in different proportions such as 0.03gram, 0.06gram and 0.09gram (30ppm, 60ppm and 90ppm) were taken. Cerium oxide is used to improve the combustion efficiency of the emulsified blends. Brake thermal efficiency of the emulsified fuel increases slightly with the composition of cerium oxide and maximum BTE is obtained at 90ppm (B10W3$CeO_2$90). The BSFC for all the emulsified fuel blends is closer to the diesel at full load. The use of water emulsion reduces the oxides of nitrogen whereas the oxygenated fuel additive is responsible for the reduction of other emissions. Finally the performance and emissions such as NOx, CO, HC and CO_2 are compared and presented.

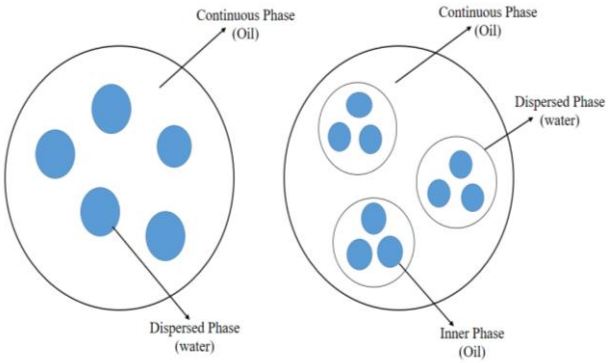
Key Words*: *cerium oxide (CeO_2), Water, Cotton seed oil, Water emulsified Diesel (WED)

1. INTRODUCTION

Diesel engines are among the most reliable and efficient energy conversion devices. For instance, they are advantageous compared with gasoline engines because of owning higher thermal efficiency, lower fuel consumption rate, and lesser tail-pipe emissions. Nevertheless, given the widespread application of these engines in various domains and the consequent environmental pollution, efforts are devoted to further mitigating their associated emissions. In another word, the environmental concerns associated with the combustion process of diesel fuel have sparked an intense interest in enhancing the sustainability aspects of this widely used fuel. Accordingly, various strategies and approaches have been introduced and implemented such as incorporating biodiesel into mineral diesel fuel or even using straight biodiesel.

Water emulsified biodiesel seems to be simple and economical way to reduce NOx emission from diesel engine. Water droplets present in emulsified fuels improves the air-fuel mixing which might be helpful in more efficient operation of engine.

When emulsified diesel is injected into high temperature combustion chamber of Internal Combustion engine, the water particles Evaporate first and the diesel droplets surrounding water particles disperse into smaller fuel droplets. This phenomenon is called micro explosion. Water vaporization increases fuel dispersion in the form of smaller fuel droplets and the contact surface area between fuel and air is increased. As a result combustion becomes more efficient and proper mixing. As water absorbs some heat in the form of latent heat for its vaporization, peak combustion temperatures are lowered. This improved combustion and the lowering of peak temperature reduce smoke, particulate matter and NOx formation.



(a) (b)

Fig: 1.1. Physical Structures of (a) Two-Phase W/O Emulsion
(b) Three-Phase O/W/O Emulsion

At present, the reserve of fossil fuel is decreasing very rapidly due to increased use of energy in different sectors including the automobile sector all over the world. Scientists and researchers are continuously investigating and searching for alternate fuels for Internal Combustion engines. Several fuels such as bio-gas, compressed natural gas (CNG), Vegetable oils, biodiesels, ethanol and butanol are tried. More recently, water emulsified diesel (WED) is found to be one of the best alternative fuels which improves efficiency and also reduces pollution. Emulsified diesel can be directly used without any engine modifications in the compression ignition (C.I) Engines.

Mixture of two or more liquids which are normally immiscible is called emulsion. The emulsion should have two phases i.e. dispersed phase and continuous phase. A few researchers reported higher ignition delay and increased CO emission with water emulsified fuel. The lower cylinder temperature delayed the combustion and also affected the thermochemical conversion of hydrocarbons. Any additive which can improve the fuel reactivity in lower temperature might be helpful to overcome the negative effects of water emulsified fuels. The nanoparticles have such potential due to their higher specific surface area, catalytic nature, lower melting temperature and large amount of energy release per unit volume.

Stability of emulsified fuel is one of the most important issues to be considered before using this as a fuel in diesel engine. If water-diesel emulsion is not stabilized then water and oil will be separated before its combustion in the cylinder and creates unwanted problems or the engine may cease to work. The water-fuel emulsions are stabilized by addition of emulsifying agent or surfactant. Water and oil separate each other due to difference in their surface tension. The use of surfactants reduces or eliminates the difference of the surface tension and there by stop the separation process.

Advantages of WED: Micro-explosion of water in the emulsified fuel leads to secondary atomization of fuel. As a result the combustion is more efficient thus the fuel efficiency is increased. The use of emulsified diesel oil in CI engine provides greater thermodynamic efficiency in comparison to normal diesel oil. The BSFC is higher for emulsified fuel because of its lower calorific value. Vaporization of water present in the emulsion fuel lowers the peak temperature of the combustion and thus reduces NOx formation. The improved combustion reduces the PM emission in case of emulsified diesel. Thus the pollutant emission is greatly reduced for emulsified diesel when compared with pure diesel.

Disadvantages of WED: The use of water emulsion mainly effect the engine parts such as cylinder chamber, piston and there is a problem in the fuel tank and fuel supply system. It is also seen that the use of this water emulsified diesel has shown negative effects such as loss of metal at high loads and high temperatures. The surfactants used for emulsification can strip the fuel tank, plugging of fuel filters and fuel line deposits. The other difficulties with emulsified fuel are stability, power loss, torque loss, compliance with the new engine technologies such as common rail, EGR. The brake specific fuel consumption is higher for emulsified fuel compared to pure diesel. So, extra fuel mass is to be carried by the vehicles in case of emulsified fuel. It is also found that at part load, CO emission is more for emulsified fuel than that of neat diesel. Water emulsified fuel blends adversely affected unburned hydrocarbons and carbon monoxide emissions at full load conditions owing to an increase in carbon content of the fuel blends but it lowered nitrogen oxide emissions. Researchers conducted the experiments on water emulsion in diesel-biodiesel blend and concluded that the water at low concentration showed better results and improved performance and it also helps in increasing the stability of water in oil emulsion.

Ayat Gharehghani et.al reported that with the usage of waste cooking oil with addition of water and Cerium oxide nano additive there is increase in the brake thermal efficiency and decrease in specific fuel consumption. Initially with addition of water there decrease in the exhaust gas temperatures which is favorable for reduction of NOx but there is more CO and HC emissions. After the addition of CeO2 it is seen that it is favorable for complete or better combustion [1].

Hosseinzadeh-Bandbafhaa et.al reported that Water inclusion into Waste cooking oil resulted in slight improvements in the emissions characteristics of the fuel blend which could be ascribed to the micro-explosion phenomenon. In addition, the effect of water on decreasing the combustion temperature. The addition of CNPs to B5W3 generally enhanced BP and BTE while it reduced BSFC. The addition of CNPs to B5W3 adversely affected HC and CO emissions at full load, mainly due to increased carbon content of the fuel blends. The addition of water deteriorated the economic features of the fuel blend [2].

Neeraj Kumar et.al investigated that present study was conducted on Mahua oil and Span80 and Tween80 were used for characterization of and CeO_2 is used as nano additive Nano oxide added water emulsified biodiesel (NWEB) blend prepared with optimal emulsifying parameters. The average yield of Mahua biodiesel produced following acid-base transesterification process was observed to be 97.2%. The predicted optimal emulsifying parameters were found as 60ppm concentration of nano-oxide, 10% water, 1% surfactant and 2500 rpm of stirrer. The actual separation for nano-oxide added water emulsified biodiesel blend (NWEB) prepared with optimal emulsifying parameters was found to be 0.84% after 30 h as compared to a predicted separation of 0.90% [3].

K.Sivasami et al investigated the study on simultaneous reduction of NOx and smoke emissions by water emulsion of cotton seed oil methyl ester (CSME) in a single cylinder direct injection diesel engine. The quantity water is varied from 10% to 30% by volume. The BTE is increased by 3.23%, 7% and 6.67% for BD10W, BD20W and BD30W compared to BD at full load. NOx emissions are decreased by 30% for BD30W, 24% for BD20W and 16% for BD10W at full load. Smoke emissions are decreased by 32% for BD30W, 25% for BD20W and 15% for BD10W at full load. The CO emission is increased for all emulsified biodiesel due to water content present in the biodiesel, whereas HC emission is decreased by 29% for BD30W, 21% for BD20W and 12% for BD10W at full load. Exhaust gas temperature is decreased by 26%, 16% and 6% for BD30W, BD20W and BD10W respectively at full load [4].

Motivation: Water emulsion is one of the simple method to reduce the harmful NOx emission from the CI engine without any engine modification. The water content in the emulsion fuel should reduce the in cylinder temperature during the combustion. The main drawback of this method is due to water present in the emulsified fuel calorific value decreases and brake specific fuel consumption is increases. The emission of CO and HC is also more compared to diesel. Fuel additives are considered as efficient way for improving fuel properties and to diminish engine emissions. In line with this, the present investigation was focused on the simultaneous applications of water (3%vol) and cerium oxide nano particles (30,60 and 90ppm) as metal based additive into cottonseed oil biodiesel-diesel blend (B10) and their impacts on the performance and emission characteristics of a single cylinder four stroke diesel engine were investigated.

Emission levels of hydrocarbon and NOx are appreciably reduced with the addition of cerium oxide nanoparticles. It is understood that cerium oxide being thermally stable promotes the oxidation of hydrocarbon and reduction of nitrogen oxide, thus acting as an effective catalyst, when added in the nanoparticle form.

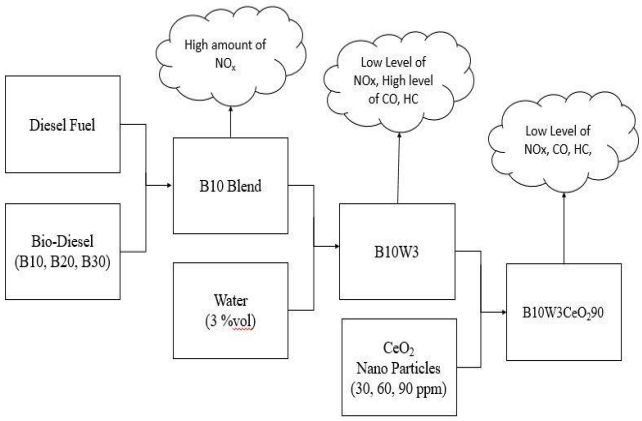


Fig: 1.2. Schematic Representation of work done in project

2. MATERIALS AND METHOD OF PRODUCTION

Cotton is one of the most significant commercial crops of India and is the sole largest natural source of fibre. A moderate temperature of 25-35 degree Celsius is best suited for cotton cultivation in India. It is processed in huge quantity through modern machines based on the quality requirement. The reason for such a huge production is the climate that is most favorable in northern part of the country.

(a) (b)

Fig: 2.1. (a) Cotton seed from cotton plant
(b) Cotton Seeds

2.1. Production of Cotton Seed Oil

Initially before getting into actual process of production the major thing is cleaning this is generally done by the Magnetic Separator, Vibrating Sieve, de-stoner, and decorticator. Through cleaning the polluting influence, you can lessen the loss of oil and enhance the oil yield and the earth of generation plant. The material has been delivered after pre-treatment contains the polluting influences ≤ 0.1%. After this process the cleaned seeds is allowed for splitting where with the help of toothed breaking roller in to cotton seeds piece into a correct uniform pieces. To make split Cotton seeds part pcs into uniform littler pieces with thickness ≤ 0.5mm, less powder, non-oil spilled, squeezing delicately by hand and the proportion of littler powder than 1mm sifter work is ≤ 10% - 15%.

The obtained mixture of seeds is allowed to soak to obtain more yielding. Matching advanced style of oil removing press machines to get more oil, or you can utilize

dissolvable after pre-squeezing by oil expellers to get more oil. Dissolvable extraction is the ordinarily utilized business system to recoup oil from oilseeds. Matching advanced style of oil removing press machines to get more oil, or you can utilize dissolvable after pre-squeezing by oil expellers to get more oil. Dissolvable extraction is the ordinarily utilized business system to recoup oil from oilseeds.

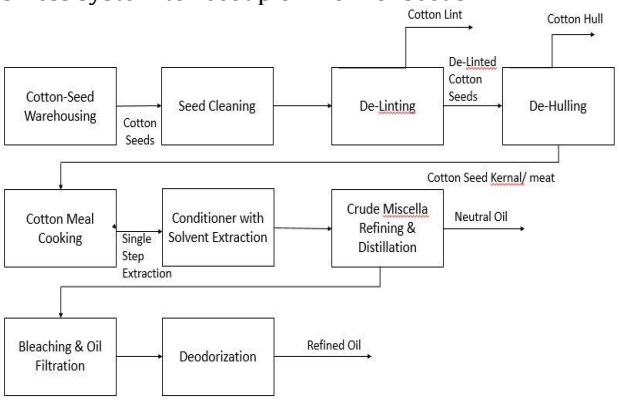


Fig: 2.2. Schematic representation of production of Cotton Seed oil

2.2. Trans-Esterification of Cotton Seed Oil

In this work the acquired crude cottonseed oil which is separated from the seeds contains high viscosity, and less unpredictable and it has low atomization properties so to do that we convert fatty oil to methyl ester. In the model preparation of biodiesel, one liter of Cottonseed oil is warmed in an attractive stirrer contraption, containing a hot plate and stirrer. The oil which is obtained used to 65^0C and in equivalent, KOH (Potassium hydroxide) beds were deteriorated with methanol in an alternate vessel which tends the response towards the development of Potassium methoxide. The molded Potassium methoxide arrangement is then poured in the warmed oil. At first the oil is taken into attractive stirrer device the Cotton Seed oil is made to warm at temperature at 65^oC. A measuring glass is taken with a methanol and KOH beds mixed it well so both blends and Potassium methoxide solution.

Fig: 2.3. (a) Magnetic Stirrer Apparatus
(b) CSME + Glycerol Separation

This Potassium methoxide is poured in to the attractive stirrer contraption containing oil and mixed well, which will in general structure Cotton Seed Methyl Ester (CSME) and glycerol. The acquired blend is permitted to settle for about 3hrs with the goal that glycerine gets isolated from methyl ester. Cotton Seed Methyl ester is isolated and heated water is passed into it, and washed so glycerine gets isolated as white fluid. The obtained Cotton Seed methyl ester is undergone subsequent washing with hot water to certain temperature to eliminate leftover waste and limited quantity of water combustion present in it.

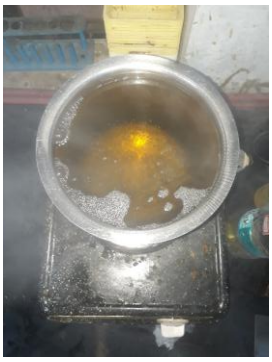


Fig: 2.4. Heating of CSME after washing to remove excess water vapor

2.3. Cerium oxide

Cerium oxide is known for ceric oxide, ceria. The cerium oxide is one of the rare earth metal. The colour of cerium oxide is found to be pale yellow or white. The molecular formula is represented in CeO_2. With the addition of cerium oxide as nano additive in biodiesel improves the performance and decrease emission characterizes. The addition of Cerium oxide reduces the percentage of NOx produced from the exhaust. It is known that the addition of cerium oxide at concentration ranging from 0 to 500ppm Shows that the one with lower ppm has slightly effected the performance of internal combustion engine i.e., at 50ppm. If you increase the percentage of ppm beyond 100 it is seen that decrease in the oxygen stability there by decreases the emission characterizes.

Average Particle Size	Color	Crystallographic structure	Purity
30-50 nm	Light Yellow	spherical	99.9 %

Fig. 2.5. Cerium Oxide (CeO2) Nano particle specification

Fig: 2.6. Cerium Oxide Nano Additive

3. Preparation of emulsion fuel by Cotton seed Methyl Ester (CSME) with CeO_2

The preparation of blends i.e. with Cotton seed methyl ester cannot be directly employed with water. To make the water to completely blend with the Cotton seed methyl ester Tween 20 is used as surfactant it increases the stability of water in oil emulsion. Ultra-sonication is a profoundly powerful methods for making scatterings between the nanoparticles in a fluid, fit for staying in suspension for a long time.

Ultrasonic waves were made in a liquid interference by soaking an ultrasound test or horn in to suspension. The Nanoparticles ranging from 30 to 90 ppm are gauged and scattered into the water emulsified diesel-Cotton Seed Methyl Ester bio diesel mix it is seen that from the past exploration execution tests were led with various mixes, for example, B10 (10%CSME+90%Diesel), B20 (20%CSME +80%Diesel), and B30 (30%CSME+70%Diesel) it is seen that B10 has demonstrated great outcomes, for performance and exhaust emissions. Thus, in this work B10 mix is picked and emulsified with water using the tween20 emulsifier then varying the percentage of Cerium oxide nano additive which is blended using ultra sonicator. Ultrasonicator cycle was done at a recurrence of 50 kHz, 120 W for 45 min length. The readied fuel tests were named as B10W3+ 30CeO_2, B10W3 + 60CeO_2, B10W3 + 90CeO_2. The fuel properties of B10W3 + 30CeO_2, B10W3 + 60CeO_2, B10W3 + 90CeO_2 are resolved by the ASTM norms.

Fig: 3.1. CSME blended with water –diesel emulsion and various proportions of CeO_2 (30, 60, 90ppm)

3.1. Properties of Cotton Seed methyl ester biodiesel and its blends

Transesterification is the way toward decreasing the viscosity and density which is ideal for the utilization as biodiesel in internal combustion engine. The properties of Cotton Seed Methyl Ester (CSME) blended with diesel and CeO_2 nano additives blended in water emulsified diesel-cottonseed oil blend were estimated. The underneath table reveals to us the properties of diesel and blended fuels. It is seen that the calorific value of diesel-Cotton Seed methyl ester blends is near that of diesel.

Property	Diesel	B10	B20	B30
Density(kg/m^3)	823	853	862	868
Kinematic Viscosity(Cst)	3.6	4.43	4.6	4.62
Flash point(^{o}C)	74	110	115	122
Calorific Value(kJ/kg)	42,700	41,510	41,480	41,463

Table: 3.1. Properties of raw Diesel and CSME blended with diesel (B10, B20 and B30)

Property	B10W3	B10W3 $CeO_2$30	B10W3 $CeO_2$60	B10W3 $CeO_2$90
Density(kg/m^3)	857	861	863	867
Kinematic Viscosity(Cst)	4.45	4.48	4.50	4.52
Flash point(^{o}C)	116	118	121	123
Calorific Value(kJ/kg)	40,816	40,992	41,204	41,416

Table: 3.2. Properties of raw B10W3 and water emulsified with B10 added with CeO_2

4. EXPERIMENTAL TEST RIG AND ARRANGEMENT

The experiment was conducted on a 4-stroke computerized Kirloskar Engine equipped with AVL DIGAS 444 Exhaust Gas Analyzer (EGA) for measuring emission parameters and eddy current dynamometer is used for addition of loads on flywheel. The temperatures inside and out is analyzed using thermocouples and piezo-sensors. The performance and emission parameters such as Brake thermal efficiency, brake specific fuel consumption, exhaust gas temperature and CO, NOx, HC, CO_2 was measured using the probe connected from Exhaust form the engine for Diesel,B10, B20, B30, B10W3, B10W3$CeO_2$30, B10W3$CeO_2$60 and B10W3$CeO_2$90 were analyzed.

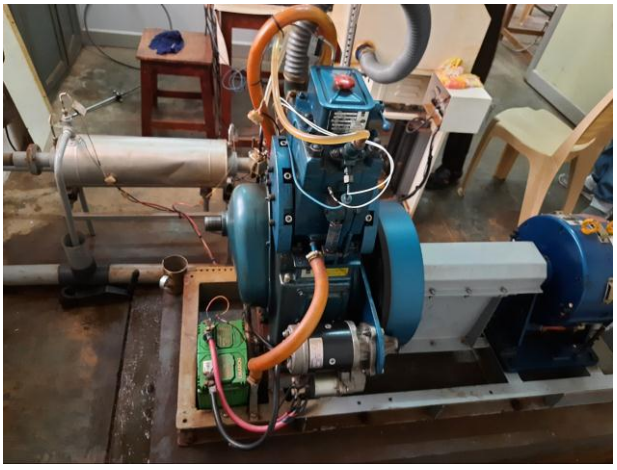


Fig: 4.1. Experimental setup for Performance and Emission characteristics

Fig: 4.2. AVL DIGAS 444 Exhaust Gas Analyzer (EGA)

5. RESULT & DISCUSSIONS

5.1. Brake Thermal Efficiency (BTE)

The evaluation of BTE as increase in engine loads for various mix proportions of Cerium oxide in water emulsified Cotton Seed methyl ester and diesel fuel are appeared below. The increases in BTE is seen because it gives a shorter ignition delay. The increase in the BTE is due to the better atomization of fuel and the combustion is complete. Due to the presence of Cerium oxide the breakage of oxide molecule is seen which is favorable for the combustion reaction to complete with the evolution of CO_2 and water vapor. Further with the addition of CeO_2 Nano additive the unburnt hydrocarbons are burnt again in the chamber which help to reduce fuel consumption. When increase in the Nano additive from 30ppm to 90ppm the brake thermal efficiency is also increases.

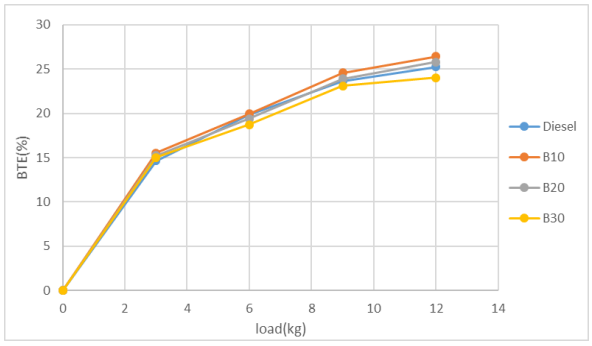


Fig:5.1. Comparison of BTE for Diesel and CSME blends

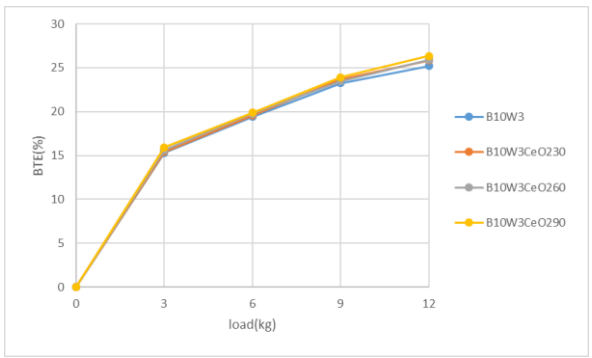


Fig: 5.2. . Comparison of BTE for B10W3 and B10W3 with CeO_2 blends

5.2. Brake Specific Fuel Consumption (BSFC)

Brake specific fuel consumption (BSFC) with respect to brake power for various fuel blends and diesel as shown below. At lower loads it is seen that BSFC is more for Diesel. And is observed that the BSFC for B10 blend is similar to that of diesel at higher loads. It is seen that the BSFC for B10 shows good improvements of diesel and B30 is considerably lesser than of diesel. Among all B30 blend have maximum BSFC at full load. There is an additional decrease in fuel consumption due to the addition of Cerium oxide where availability of oxygen increases. There by rate of combustion increases. Besides, the consistency of B10W3CeO290 is similar to diesel.

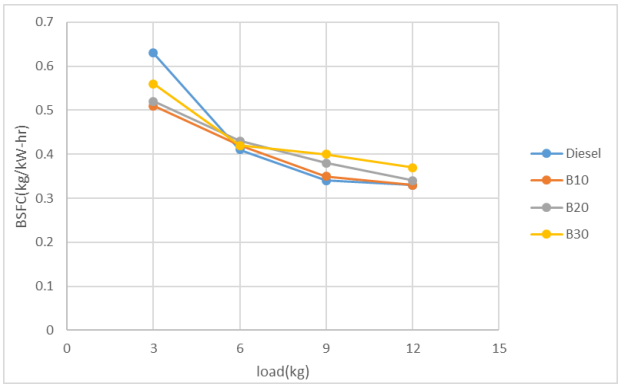


Fig: 5.3. Comparison of BSFC for Diesel and CSME blends

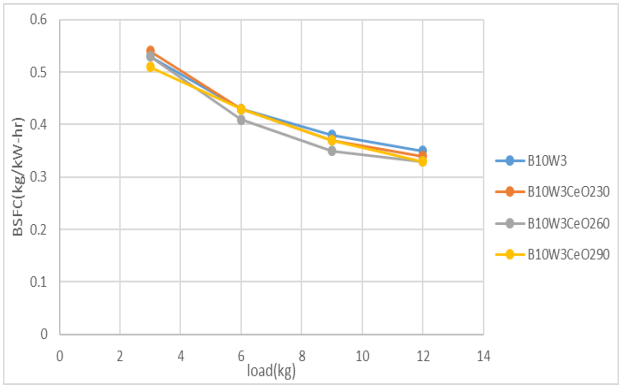


Fig: 5.4. Comparison of BSFC for B10W3 and B10W3 with CeO_2 blends

5.3. Exhaust Gas Temperature (EGT)

The variation in the exhaust gas temperature with the increase in the load is observed. The exhaust gas temperature for B10 is nearer to diesel, but progressively rises with an increase in the percentage of CSME and CeO_2 in the blends. The addition of Water which formed as emulsion has reduced the exhaust temperatures. The lean biodiesel blends are having lower exhaust temperature when compared to that of diesel. This may be due to, complete combustion, least energy loss in the exhaust gases.

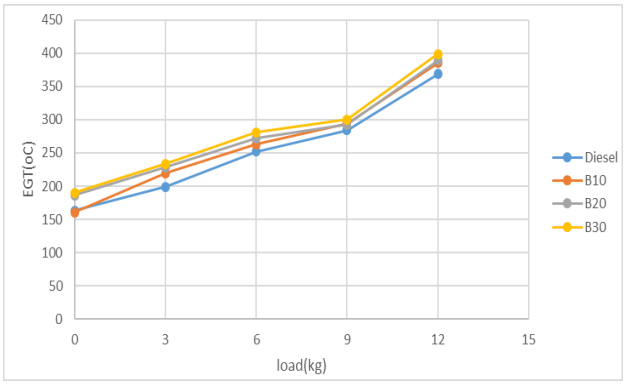


Fig: 5.5. Comparison of EGT for Diesel and CSME blends

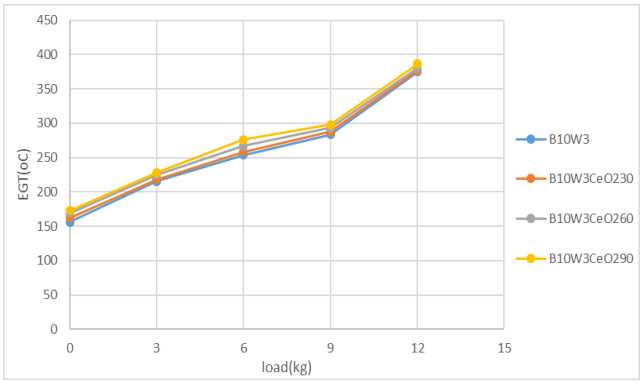


Fig: 5.6. Comparison of EGT for B10W3 and B10W3 with CeO_2 blends

5.4. Carbon Monoxide (CO)

Carbon monoxide is the major emission evolved in the internal combustion engine, which is the major source for cause of greenhouse effect. It is analyzed that with addition of water due to low Calorific value and incomplete mixing the unburnt hydrocarbons got increased and thereby increasing CO emissions. It is observed that when Cerium oxide (CeO_2) Nano additive is added to the water emulsified diesel-cotton seed methyl ester CO emission is reduced this is because due the inbuilt oxygen present in biodiesel and cerium oxide tends to complete combustion.

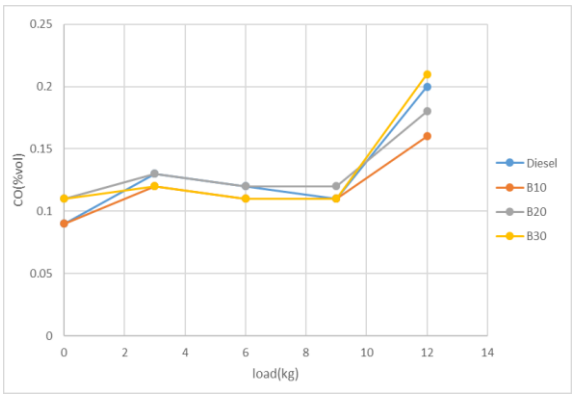


Fig: 5.7. Comparison of CO Emissions for Diesel and CSME blends

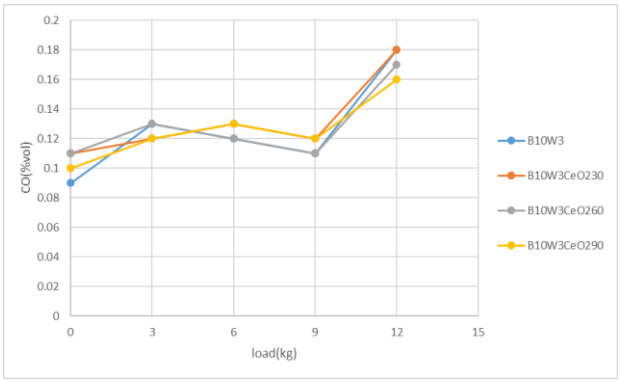


Fig: 5.8. Comparison of CO Emissions for B10W3 and B10W3 with CeO_2 blends

5.5. HC Emissions

The unburned hydrocarbon outflows for the mixes of Cotton Seed methyl ester with CeO2 and water emulsified diesel are looked at. The increase of HC Emission is seen with increment in the level of the CSME blend percentage. It is because of the presence of inbuilt oxygen which thus structure as lean fuel combination when mixed with diesel. The rich mixes of biodiesel burned- through more fuel with an expansion in the engine load, and hence, delivered high fuel-air proportions, which can cause a slight augmentation in the HC outflow.

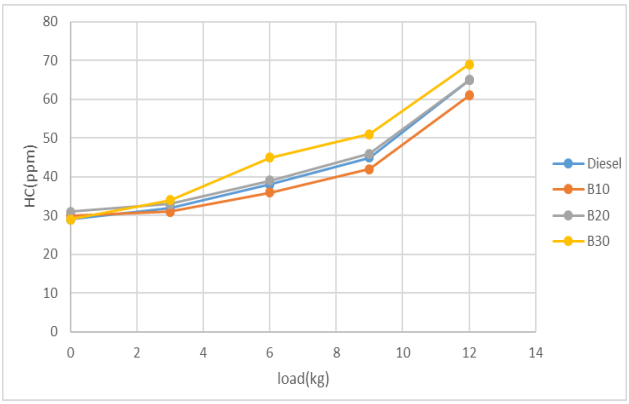


Fig: 5.9. Comparison of HC Emissions for Diesel and CSME blends

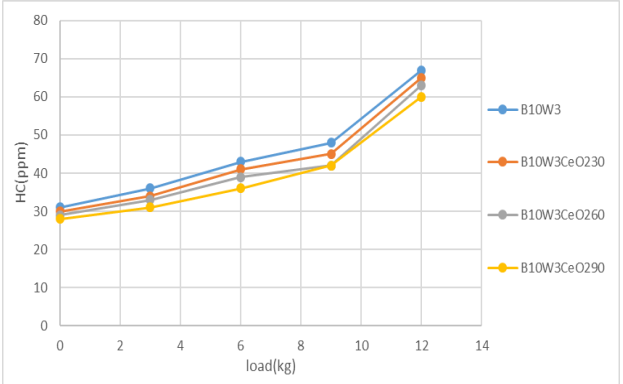


Fig: 5.10. Comparison of HC Emissions for B10W3 and B10W3 with CeO_2 blends

5.6. Carbon Dioxide (CO_2)

Carbon dioxide is major by-product of the combustion phenomenon which tells us the complete combustion takes place. In this analysis it is observed that the with the addition of Cotton Seed methyl ester and Cerium oxide (CeO2) due to the presence of inbuilt oxygen present in the bio diesel favors for the formation of carbon dioxide and water vapor. Hence additionally the biodiesel with Nano additives were tested and it is shown that the with the increase in the percentage of Nano additive there is increase in the Carbon dioxide this is mostly due to the sufficient amount of oxygen available in the mixture tends towards better combustion.

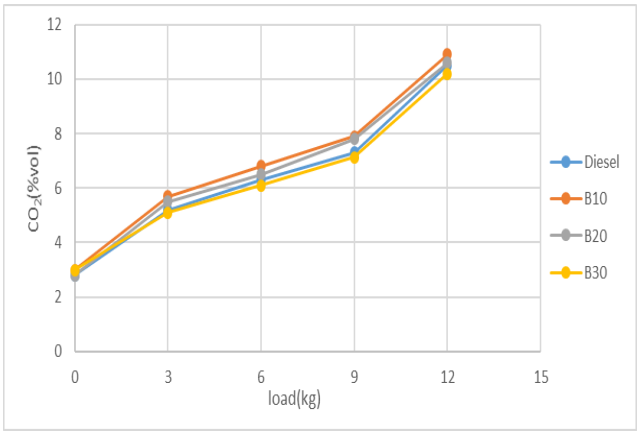


Fig: 5.11. Comparison of CO_2 Emissions for Diesel and CSME blends

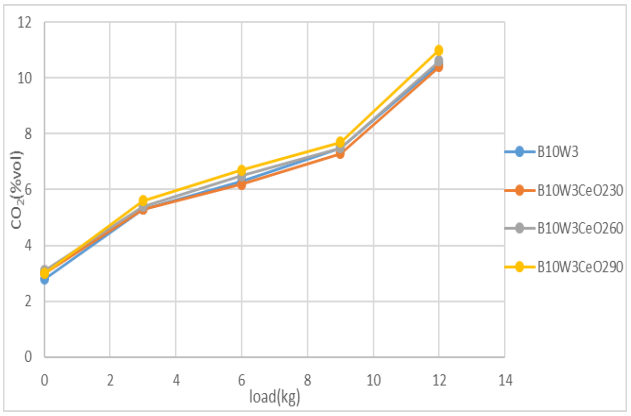


Fig: 5.12. Comparison of CO_2 Emissions for B10W3 and B10W3 with CeO_2 blends

5.7. Oxides of Nitrogen (NO_x)

The main theme of adding Water emulsion is the reducing NO_X. Oxides of nitrogen are the major emissions in an internal combustion engine here in case of biodiesel such as CSME consist of high amount of inbuilt oxygen where during the process of combustion the Cerium oxide molecule break at high temperature with the evolution of oxygen and this oxygen is utilized by the nearby hydrocarbons and come as by products as carbon dioxide and water vapor.

Normally the nitrogen is highly stable due to the presence of 3 valence electrons in the outer most orbit. Hence due the high temperatures developing in the engine the nitrogen molecule get energized after it attains the required ionization energy the N2 breaks and react with the oxygen to the form the oxides of nitrogen.

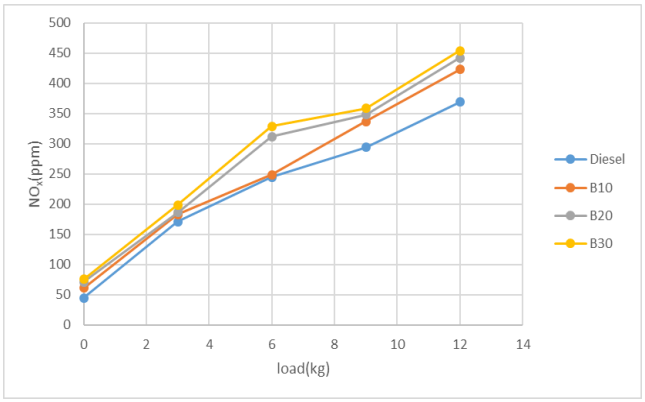


Fig: 5.13. Comparison of NO_X Emissions for Diesel and CSME blends

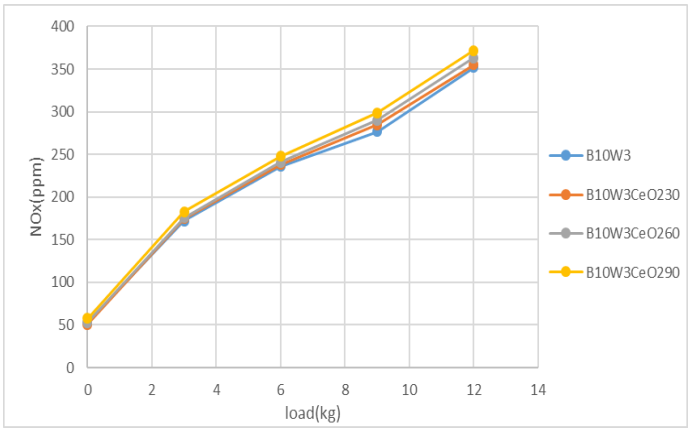


Fig: 5.14. Comparison of NO_x Emissions for B10W3 and B10W3 with CeO_2 blends

6. CONCLUSIONS

The investigation of Cerium oxide Nano additive in water emulsified Diesel-Cotton Seed methyl ester (CSME) blend on performance and emission parameters of 4-stroke single cylinder diesel engine is done. For this fuel blends (B10, B20, B30, B10W3, B10W3$CeO_2$30, B10W3$CeO_2$60 and B10W3$CeO_2$90) were prepared and tested. The brake thermal efficiency of the fuel has been increased with addition of CeO_2 Nano additive i.e. there is 4.36% increase in BTE at full load.

The brake thermal efficiency of diesel at full load is 25.24 and the maximum BTE is for B10 i.e., 26.43 at full load, the combustion was improved. The addition of Water at specific percentage has slightly reduced the BTE and by addition of CeO_2 the BTE was increased i.e. the maximum BTE after addition of CeO_2 is for B10W3$CeO_2$90 (26.34%) i.e. 4.36% increase when compared with diesel. The CeO_2 Nano additive blended with water emulsified Diesel+CSME shows lower fuel consumption when compared with the

conventional diesel fuel. The minimum fuel consumption is seen for B10 i.e., 0.33 kg/kW-hr at Full load.

The higher NO_X is observed for B30 because of complete mixing of CSME with the diesel and good atomization and high calorific value of the fuel. It is observed that with the addition of Water there is decrease in the NO_X i.e. 16.78% when compared with B10 at full load. When CeO_2 is added the NOx emission is slightly increased for $B10W3CeO_290$ i.e. 5.3% when compared to B10W3 at full load. The maximum decrement is seen for the B10 and $B10W3CeO_290$ at full load.

The exhaust gas temperature was increased with the blend percentage of Cotton seed methyl ester and Cerium oxide (CeO_2) Nano additive because due to the presence of Inbuilt oxygen in it which is favourable for complete combustion. The maximum EGT is seen for B30 at full load. The temperature is less for B10W3 and it also got increased with addition of CeO_2 Nano Additives.

There is increase in the UNBHC is seen with the addition of water due to improper mixing and low combustion temperatures and low calorific value of water emulsion.The CO emissions were decreased with CSME and CeO_2 addition there is decrease in the CO is seen for B10 and $B10W3CeO_290$ this is due to sufficient amount of oxygen present in the biodiesel. The CO emissions of $B10W3CeO_290$ and diesel are slightly similar. Due to high oxygen availability the CO2 was increased and it is maximum for B10 and $B10W3CeO_290$ at full load.

From the above investigation $B10W3CeO_290$ shows better performance and low emission characteristics at all load conditions. It is recommended that $B10W3CeO_290$ is preferable for 4-stroke single cylinder diesel engine

7. REFERENCES

[1] Simultaneous Reduction of CO and NOx Emissions as well as Fuel Consumption by Using Water and Nano Particles in Diesel–Biodiesel Blend by Ayat Gharehghania, Sasan Asiaeib , Esmail Khalifec , Bahman Najafid , Meisam Tabatabaeie,f

[2] Effects of aqueous carbon nanoparticles as a novel nanoadditive in wateremulsified diesel/biodiesel blends on performance and emissions parameters of a diesel engine by Homa Hosseinzadeh-Bandbafhaa, Esmail Khalifeb, Meisam Tabatabaeic, Mortaza Aghbashloa, Majid Khanalia, Pouya Mohammadic, Taha Roodbar Shojaeia , Salman Soltanian

[3] Characterization of nano-oxide added water emulsified biodiesel blend prepared with optimal emulsifying parameters by Neeraj Kumar, Hifjur Raheman*

[4] Multi-response optimization to improve the performance and emissions level of a diesel engine fueled with ZnO incorporated water emulsified soybean biodiesel/diesel fuel blends by Suresh Vellaiyana, Arunkumar Subbiahb , Prabha Chockalingamc

[5] Performance and emission evaluation of a marine diesel engine fueled by water biodiesel-diesel emulsion blends with a fuel additive of a cerium oxide nanoparticle by Jiaqiang Ea,c , Zhiqing Zhang, Jingwei Chena,c, MinhHieu Phama,c , Xiaohuan Zhaoa , Qingguo Penga,c , Bin Zhanga,c , Zibin Yind

[6] Nanoadditives: Enhancement of Combustion and Performance Characteristics of a CI Diesel Engine by Shaafi Tajudeen and R. Velraj

[7] Exergoeconomic analysis of a DI diesel engine fueled with diesel/biodiesel (B5) 2 emulsions containing aqueous nano cerium oxide by Mortaza Aghbashloa, Meisam Tabatabaeib, Esmail Khalifec , Taha Roodbar Shojaeia,c, Ali Dadaka

[8] Combined effects of water emulsion and diethyl ether additive on combustion performance and emissions of a compression ignition engine using biodiesel blends by P. Dinesha, Shiva Kumar, Marc A. Rosen b

[9] Performance evaluation of diesel engines (PEDE) for a diesel-biodiesel fueled CI engine using nano-particles additive by Ayat Gharehghania , Hossein Pourrahmania

[10] The role of water-in-diesel emulsion and its additives on diesel engine performance and emission levels: A retrospective review by Suresh VellaiyanK.S. Amirthagadeswaran

[11] Engine performance and exhaust emission analysis of a single cylinder diesel engine fuelled with water-diesel emulsion fuel blended with manganese metal additives by Ahmad Muhsin Ithnin*, Wira Jazair Yahya, Jasmine Baun Fletcher and Hasannuddin Abd Kadir

[12] Effect of nanofluid additives on performances and emissions of emulsified diesel and biodiesel fueled stationary CI engine: A comprehensive review by Vivek W. Khond n , V.M. Kriplani 1

[13] A novel emulsion fuel containing aqueous nano cerium oxide additive in diesel–biodiesel blends to improve diesel engines performance and reduce exhaust emissions: Part I – Experimental analysis by Esmail Khalife a,b,c , Meisam Tabatabaei b,d,⇑ , Bahman Najafi, Seyed Mostafa Mirsalim e , Ayat Gharehghani, Pouya Mohammadi b , Mortaza Aghbashlo f , Akram Ghaffari c , Zahra Khounani b,d , Taha Roodbar Shojaei g , Mohamad Amran Mohd Salleh g

[14] Preparation of Water-Biodiesel Emulsion Fuels with CNT & Alumina Nano-Additives and their Impact on the Diesel Engine Operation by J. Sadhik Basha

[15] Combustion, performance, and emission analysis of diesel engine fueled with water-biodiesel emulsion fuel and nanoadditive by Suresh Vellaiyan & Arunkumar Subbiah & Prabha Chockalingam

[16] Impact of hydrogen generated by splitting water with nano-silicon and nano-aluminum on diesel engine performance by Rakhi N. Mehta a,b , Mousumi Chakraborty, Parimal A. Parikh

[17] A study on performance, emission and combustion characteristics of diesel engine powered by nano-

emulsion of waste orange peel oil biodiesel by A.R. Mahesh Kumar, M. Kannan, G. Nataraj

[18] Enhancement in combustion, performance, and emission characteristics of a biodiesel-fueled diesel engine by using water emulsion and Nano additive by Suresh Vellaiyan

[19] The exhaust gas temperature was increased with the blend percentage of Cotton seed methyl ester and Cerium oxide (CeO_2) Nano additive because due to the presence of Inbuilt oxygen in it which is favourable for complete combustion. The maximum EGT is seen for B30 at full load. The temperature is less for B10W3 and it also got increased with addition of CeO_2 Nano Additives.

BIOGRAPHIES

Mr. NITTURU HANIF
M.Tech (Advanced IC Engines)
Dept. of Mechanical Engineering
JNTUACEA (Autonomous)
Anantapuramu, Andhra Pradesh, India.

Prof. K. Govinda Rajulu

Dr. K. GOVINDARAJULU, M.Tech, PhD, F.I.E, M.I.S.T.E, C.E
Professor & Principal
Dept. of Mechanical Engineering
JNTUACEA (Autonomous)
Anantapuramu, Andhra Pradesh, India.