International Journal of Research Publication and Reviews, Vol 3, no 11, pp 1255-1265, November 2022

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

The Study On The Effect Of Nanoparticles On The Performance And Emissions Characteristics Of A 4-Stroke Diesel Engine With Biodiesel And CeO_2, ZnO, Al, Graphite Nano Particles.

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ABSTRACT:

The effects of nanoparticles in diesel-biodiesel blends on fuel characteristics, combustion, performance, and emission characteristics in diesel engines have been the subject of much investigation. We are investigating a few nanoparticles and their impact on engine parameters in this study. The following findings are observed after studying Cerium oxide nanoparticles, Titanium oxide, Zinc oxide, Aluminum, and graphite nanoparticles for this review. In an experiment with corn oil methyl ester diesel and 50 ppm of cerium dioxide came to the conclusion that COB10+50 ppm of ceO2 recorded 34.7% BTE at full load whereas COB10 recorded 34%. By using waste cooking oil methyl ester (WCOME) and ZnO (80 ppm) nanoparticles at full load, produced biodiesel from used cooking oil. Diesel, B20WCO, and B20WCO+ZnO(80ppm) fuels have BTEs of 33%, 35.3%, and 37.2%, respectively. When compared to diesel, the BTE of the B20 blends made from used cooking oil falls at all loads (except from full load). Biodiesel blends from used cooking oil with alumina nanoparticle at 30, 60, and 90 ppm were studied and the increases in BTE was observed 10.63%. As the methanol component of the fuel blends rises, the brake thermal efficiency further declines. Brake thermal efficiency (BTE) changes with different engine loads and tested fuels.While B100of CeO2 has a BSFC of 0.4kg/kw-h at 50% load, B100of Diesel has a BSFC of 0.3kg/kw-h at 50% load. The BSFC for B10E4N30 is noticeably reduced by an average of 10%; the inertial effect of the fuel system caused increased initial fuel injection. NO emissions are 5.4% for CATBD but only 2.4% for CTABD50CeO2. so as to reduce NO emission .NOx emissions decreased by 0.039/kwh when PME was compared to PME50CeO2. The colloidal state of water, TiO2, and its combination with polymeric diesel oil in emulsions (PDO). As a result of the test results, the EGT was lowered, and the emissions were also recorded.

KEYWORDS: BTE- Break thermal efficiency, BSFC: Break specific fuel consumption , Emissions,CeO2 nano particles ZnO nano particle

INTRODUCTION:

In any sector energy will plays a key role for economy development in any country. In energy field fossil-based fuels like Coal, Diesel, Petroleum are major sources. The world is facing lot of problems by the usage of fossil-based diesel fuel [1].industrial development and population growth exploited the natural resources aggressively. Petroleum resources are depleting rapidly due to ever increasing demand of energy to maintain the human growth pace [2]. The transportation sector plays an integral role in today's global economy, which is strongly affected by changes in fuel economy, conversion efficiency, fuel supply, and costs. Since its invention in the late nineteenth century, the diesel engine has quickly capitalized on its advantages and maintained its role as a leading choice of the engine due to its superior performance [3]. In recent years, a growth in the number of vehicles has resulted in increased demand for petroleum oil, resulting in an increase in the price and demand for fossil fuels in the economy. Due to continuous growth in industrial developments and population, the demand for energy from fossil fuels increases. Nearly about 75% of the fossil fuels are used in the transport and industrial sector and the remaining 25% in agricultural development and domestic. Also, the burning of fossil fuels leads to the greenhouse effect, which affects the natural cycle.[4]

Transport vehicles greatly pollute the environment through emissions such as CO, CO2, NOx, SOx, unburnt or partially burnt HC and particulate emissions. Fossil fuels are the chief contributors to urban air pollution and major source of greenhouse gases (GHGs) and considered to be the prime cause behind the global climate change [6]. To date, great efforts have been made to reduce emissions from diesel engines by three main approaches: (1) internal engine modification, (2) exhaust after-treatment, and (3) fuel adulteration. In this research, the fuel adulteration approach is adopted for convenience because it does not require any engine structure modification [7]. Among the various techniques available to reduce exhaust emissions, the use of fuel-borne catalyst is currently focused due to the advantage of increase in fuel efficiency while reducing harmful greenhouse gas emissions and the health-threatening chemicals such as NOx and particulate matter. [8] Thus, it reduces the amount of pollution and also reduces the amount of fuel consumption. It also noted that cerium oxide will increase pressure and heat release rate in the combustion chamber which reduces HC, CO and increases the thermal efficiency [9]. The nanoparticles dispersed test fuels shows better thermo physical properties due to its higher surface to volume ratio and acts as an oxygen buffer with respect to NO emission.[10]

.Biodiesels are produced from variety of natural feedstock sources and globally around 350 crops are recognized as the possible feedstock for biodiesel production. Several varieties of seed from the plants such as jatropha, castor, mahua, pongamia, are utilized to obtain the biodiesels. These non-edible oil plants are noted as second generation feedstock which are economically cheap and are cultivated in many parts of the world. Such type of oils have high free fatty acid (FFA) content and needs to undergo a process called transesterification with a catalyst to remove the glycerol from the oil before it is been used in an engine.[16] . Biodiesel have some unfavourable parameters like higher density, high viscosity and lesser heating values etc. To overcome these inauspicious parameters additives are added. These additives will boost the quality of the biodiesel to meet the international pollution norms.[17]. The addition of nanoparticle in biodiesel, reduces the viscosity and density of the blend and becomes similar to diesel. Biodiesel-diesel-ethanol blends produce lesser emissions of smoke and NOx emissions compared to diesel, due to addition of nanoparticles. [18].The proportion of biodiesel and nano additives plays a significant role in improving the engine performance and emission characteristics. However there is no proper relation to find out the appropriate nano additive quantity to characterize the behavior. So far the researchers had tried by trial and error based approach to fix the proportions. The experimental cost and time rapidly goes on increase by testing the engine with wide range of the proportions. So, an appropriate prediction methodology is required to establish a correlation between fuel, nano additive proportions to engine performance characteristics in order to reduce the experimental cost and time [19]. Nanoparticles can overcome the density difference because of its better interaction between particles caused by its high surface to volume ratio [14 to 16].[20]

BTE:

From Figure -1(a) we conclude that Kumar and rao conducted an experiment with Hazantus(ALGE) Bio Diesel with addition of Cerium oxide of 25mg into it and conclude that 32.54% of BTE is observed with ALGE+CeO2 25mg but ALGE biodiesel engine is produced 28.61% efficiency only[1]. Sadia Akram et al experimented with waste cooking oil added with CeO2 100ppm deduce there is increase in the BTE by 2% when it compared with Waste cooking oil without CeO2 diesel[2]. Hoang et al concluded that 1.5% increase in BTE when B20+CeO2 100ppm compared with B20 diesel (ie B20 diesel 28% and B20+CeO2 100ppm is 29.5%)[3].Muruganantam et al conducted an experiment with corn oil methyl ester diesel with 50 ppm of CeO2 added to it concluded that for COB10+50ppm of CeO2 it found 34.7% BTE is recorded at full load and for COB10 it is 34%[4]. seela et al conducted an experiment with Mahua Methyl ester with 100 ppm of CeO2 conclude that there is 1.8%BTE increase compared to neat diesel[5]. Suresh et al with PPME(pongamia pinnata methyl ester) with 50ppm and gives there is 2%BTE increases compared to PPME diesel engine(35% diesel and 37% for PMME+50ppm of CeO2[6]. Deqoing et al with CTAB (cetyl tri methyl ammonium bromide) with 50ppm of CeO2 added to it and conclude 1.7% BTE increases at full load[7]. Arul conducted with Diesel ethanol blends of 25ppm of CeO2 added to it and gives BTE of ethanol blends with 25ppm gives 25.66% but a Diesel ethanol blende engine gives only 23.63% [8]. syed with diesel fuel blend with CeO2 50ppm and deduce that there is 1.3% increase of BTE when compared with diesel fuel blende[9] . Prabhu conducted an experiment with B20 and by adding 30ppm of CeO2 added to it and conclude that 12% BTE increases when compared B20 with B20A30C30 fuel [10].

From Figure 1(b) and 1(c)we get Ahmed et al. conducted and give increase in 4.1% with 50, 100 and 150 mg/l of graphite nanoparticles respectively.when compared with neat diesel.[11]. Vikas et al studies waste cooking oil .B40NCP1 and B40C1 showed an increment in BTE by 8–10% at full engine load compared to D100 and W100 fuels.[13]. Jiangjun Wei et al stated the alumina nanoparticles methanol in mass proportions of 25, 50 and 100 ppm. Hosseini.et.al.conducted.experiment.with.waste.cooking.oil.with.Alumina.nanoparticle.10.63%.BTE.increases.[14]Kumar.et.al.worked..on..cotton..seed..oil(CSME)..BTE..for..Diesel,B20CSME,B20CSME+40ZNO,B20CSME+80ZNO,B20CSME+120ZnO.are.28.6%,33.5%,38.1%,39.04% and 35.15% respectively[17]. Prabakaran et al. investigated At full load condition the BTE found for the Diesel,C 6 and nano C6 is 36.9% ,29.9% and 33.4% respectively [18]. C.R.Seela et al. investigated the effect of ZnO and gives BTE of diesel,B20 and B20+ZnO(50ppm) is 27.2%,28.1% and 29.4% respectively. [19]. Lobo et al. worked in the Biodiesel derived from Waste cooking oil-Waste cooking oil methyl ester (WCOME) The BTE for the diesel, B20WCO and B20WCO+ZnO(80ppm) fuels are 33%,35.3%,and 37.2%.[20].Dhanarasu.et.al.worked.on.the.sunflower.oil.methyl.ester(SOME).The.BTE.for.the.fuels.diesel,B20,B20+ZnO(10ppm),B20+ZnO(20ppm) and B20+ZnO(30ppm) are 34%,32.3%,31.9%,32.0% and 32.5% respectively. [21]. Javed et al. investigated JME biodiesel blends. The results show that BTE increased from 32.5 to 35.4% for B30-ZnO40nm [22]. Soudagar et al. investigated The BTE increases with the addition of ZnO nanoparticles by 9.6% and 16.4% for D10030 and MOME2030 [25]. Vigneswaran.While at low loads, the percentage of rise of BTE is up to 0.78%, 0.86%, 0.94%, 1.01%.[26]. Karthikeyan,a Illustrates the change in engine brake thermal efficiency (BTE) at various engine loads and tested fuels.[27]. Sunil, presents the variation of BTE with load for tested fuel samples. It is observed that maximum thermal efficiency is obtained at 20% biodiesel blend (31.21% at 100% load). [28]. Sarıkoç, et al. brake engine torque and power for all tested fuel blends at various engine speeds and full load condition. The maximum torque values of 34.72 Nm, 28.87 Nm, 32.48 Nm, 35.57 Nm, 30.88 Nm and 33.98 Nm, respectively were recorded at 1400 rpm 29]. The brake thermal efficiency (BTE), combustion stability, number concentration, and size distribution of the ultrafine particulate (UFP) emission of the three nano-emulsion fuels were investigated on a turbocharged heavy-duty diesel engine.[30].

Reason for increasing in BTE is nanoparticle enhances the combustion process and producing enough heat to get complete combustion.[1-3] and , the BTE increases, which is due to higher in-cylinder pressure and temperature for enhanced vaporization of the fuel.[4]The oxides of metal nano particles present in the biodiesel blend promote the complete combustion[5-10],The addition of nanoparticles decreases the period of ignition delay and fuel consumption, significantly enhancing the combustion process.[11-13][21-23].Because of the improper atomisation of biodiesel droplets as well as higher viscosity of the blend. the maximum efficiency was improved with the addition of GNPs to some extent[14-18],The addition of TiO2 nanoparticles to J50D10Bu blend enhances the engine performance.[22-24]

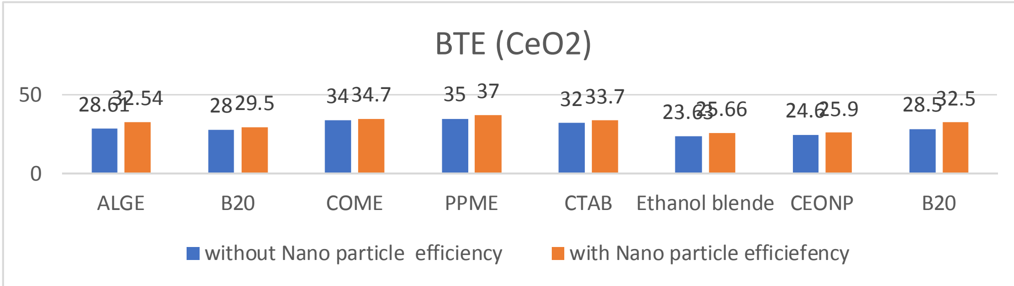


Figure-1(a)

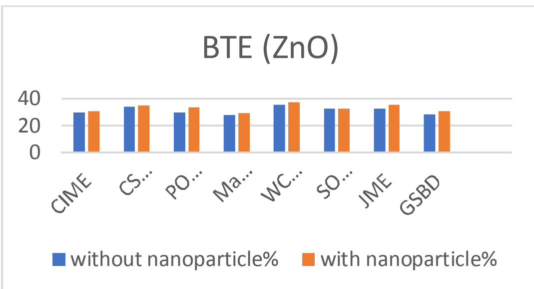


Figure-(b)

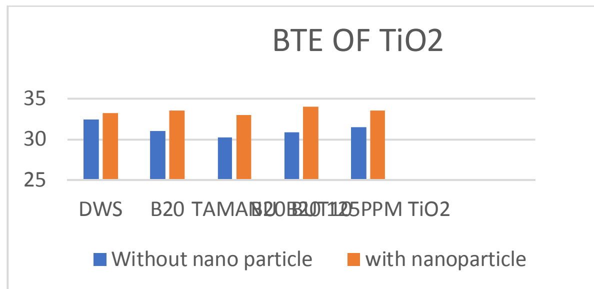


Figure-(c)

BSFC:

The Blende ALME10+CeO2 is producing a lowest BSFC of 0.26kg/kw-h and the ALME10 diesel engine consumes 0.3kg/kw-h. [1]. Akram said that the BSFC is lowered compared to Waste cooking oil with nanoparticle added to it[2]. Hoang said that the lowest BSFC value is 0.29kg/kw-h is recorded for B20+CeO2 (100) ppm which is only 1%more than B20 diesel[3]. Muruganantham et al gives COB diesel BSFC of 0.249kg/kw-h but COB10+25ppm COB10+50ppm COB10+75ppm of CeO2 is 0.248,0.242,0.243kg/kw-h. That is BSFC decreases [4]. Seela et al conclude that 1% betterment in BSFC compared to Mahua Methyl ester diesel when Nanoparticle added to it [5]. Suresh et al observed that for B100 diesel BSFC at 50% load it is 0.3kg/kw-h for B100of CeO2 it is 0.4kg/kw-h so BSFC increases [6]. Deqing et al said at bmep of 0.46 bar the BSFC for D50 diesel is 0.270kg/kw-h but for D50Ce and D100 Ce it is 0.255, 0.260kg/kw-h so BSFC decreases[7]. Arul said that for Diesel ethanol diesel it is 0.3931kg/kw-h at bmep of 0.44 mpa but Diesel ethanol with CeO2 nanoparticle it is 0.3586kg/kw-h.so BSFC decreases[8]. Syed said that BSFC of CEONP diesel is higher of 9% when compared to CEONP50 of CeO2 nano particle 9].Prabhu concluded that the BSFC for B100A30C30 is 13.2MJ/kwh and for B100 bio diesel it is 14.8Mj/kwh[10].The reduction in bsfc was observed to be 2.1%, 2.3% and 2.6% with 50, 100 and 150 mg/l of graphite particles respectively.[11].Qibai Wu et al gives There is a remarkable decrease in BSFC for B10E4N30 at the average of 10%,the inertial effect of fuel system lead to higher fuel injection in the beginning [12]. BSFC for biodiesel and fuel blends were higher than fossil diesel. However, B40NCP1 and B40C1 blends gave 8–8.5% lower BSFC than W100 due to their higher heating values.[13]. waste cooking oil with Alumina nanoparticle at 30, 60, and 90 ppm 14.66% BSFC increases[14]. An average reduction in percentages 4.5% and 5.0% BSFC for addition of aluminium NPs, concentration of 25 mg/l and 50 mg/l, respectively[15].

The BSFC for Emulsified fuels CIME ZnO50 and CIME ZnO100 are 0.287 and 0.273 Kg/ Kwh respectively [16].At full load condition BSFE for Diesel,B20CSME,B20CSME + 40ZnO,B20CSME + 80ZnO,B20CSME + 120ZnO are 0.818,0.693,0.57,0.52and 0.667Kg/Kw -hr [17]. BSFC for the fuels diesel C6 and nano C6 at full load condition are 0.24, 0.35 and0.28 kg/KWh respectively .[18]. The BSFC for diesel B20 and B20+ZnO (50ppm) is 0.30,0.301and 0.31Kg/Kw-hr respectively.[19]. There is reduction of 10% for the BSFC of B20 and 12% for B20+ZnO (80ppm) compared to 100% diesel at full load condition [20]. The BSFC of B20+ZnO (10 ppm), B20+ZnO (20 ppm) and B20+ZnO (30 ppm) was 0.28 kg/kW-hr, 0.27 kg/kW-hr and 0.26 kg/kW-hr, respectively.Which are 3.44%, 6.89% and 10.34% lower than that of B20 at full-load condition. [21]. That B20-ZnO20nm has low BSFC compared with B30-ZnO20nm because the lower calorific value of JME than neat diesel [22]. The oxidation rates are higher in case of GSBD Zn10% blend the BSFC is 331 kg/kWh,and hence they instigate lower fuel consumption[24]. The BSFC of fuel blends, D10030 and MOME2030, demonstrated 11.7% and 12.2% reduction, respectively in fuel consumption as compared to diesel and MOME20.The reduction in fuel consumption is attributed to the enhanced squish in TRCC that facilitates improvement in the swirl rate [25].Vigneswaran conclude the BSFC. The deviations of BSEC between diesel and DWS, DWT1, DWT2, and DWT3 fuels at low loads are 5.60%, 4.47%, 4.40%, 2.74%. At partial loads, the deviations are 13.04%, 11.35%, 9.09%, 6.2%, respectively. [26]. Sunil,shows Between 50% and 90% loads it can be noticed that B10 and B20 biodiesel blends has lesser brake specific consumption in comparision to petro diesel[28]. Sarıkoç et al. Conversely, the addition of TiO2 decreased the BSFC of B20 + TiO2 and B20But10 + TiO2 for 24.52% and 17.78%. Compared to B20 and B20But10, the average reduction in BSFC for B20 +

TiO2 and B20But10 + TiO2 were 27.73%, 28.37% respectively [29]. At a low load,the in-cylinder temperature and pressure were relatively lower, and the inferior spray quality and incomplete combustion resulted in higher BSFC and lower BTE[30]

The reason is nanoparticle added with diesel engine enhances the BTE because additive fuels improves combustion and atomization and reduce BSFC [1-4&30] and the reason for decreasing of BSFC is SFC is higher for diesel ethanol blends than neat diesel at all the bmep. This is due to low calorific value of dieseal ethanol blends than neat diesel [7-8] and BSFC decreases due to fine automization proprety of nanoparticles results in better combustion [10-12].ZnO acts as an oxidizing agent which boosts the combustion process and improves the A/F Ratio reducing the BSFC Shorter ignition delay caused by Zinc Oxide leads to better combustion and thus more work is gotten for the same amount of fuel thus lowering the BSFC.[13-15] One of the causes for reduction of BSFC can be better combustion caused by shorter delay of ignition as a result of addition of a nanoparticle like ZnO.

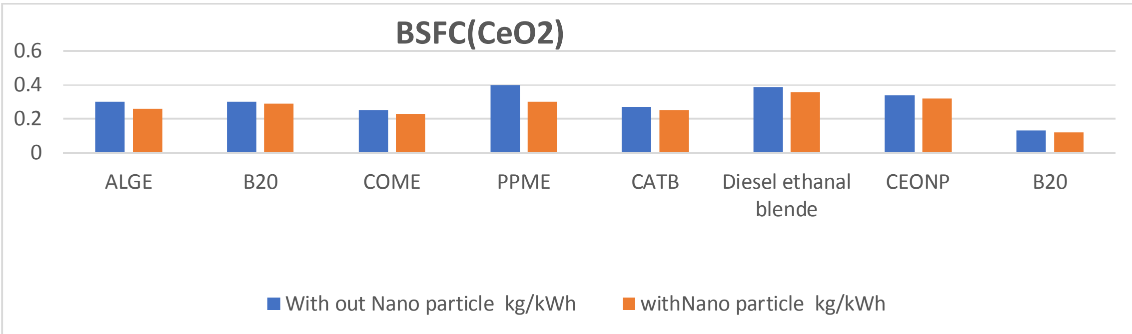


Figure-2(a)

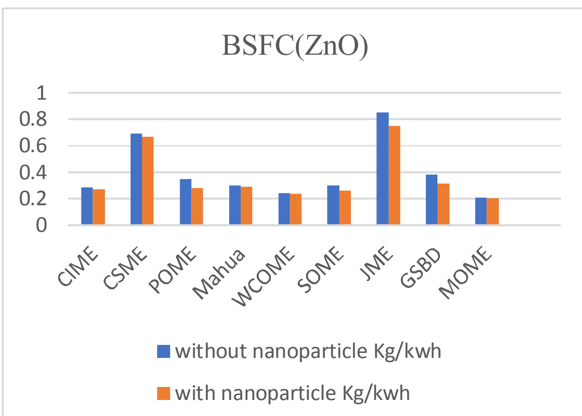


Figure-2(b)

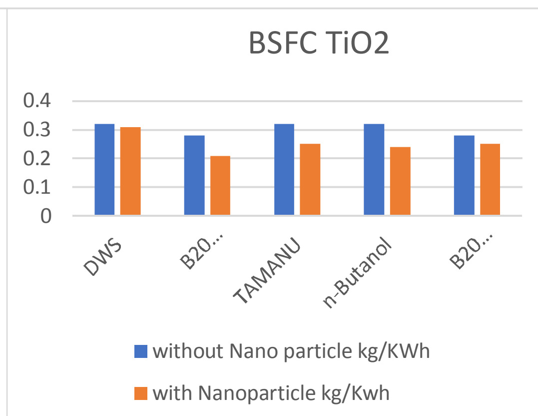


Figure-2(c)

EMISSIONS:

NOx:

From Figure3(a) and 3(b) NOx emission in ALME10+CeO2 50mg produces 1458ppm and the ALME diesel fuel engine produces only 835ppm. [1]. B20 blend compared with B20+ CeO2 100ppm that NOx emission reduced by 18.27%.[2]. Nox decreases due to high thermal stability after initial interaction between CeO2 and Hydrocarbons [3].Muruganantham et al deduce that the NO emission for COB10 is 1925 but for COB10+25ppm it is 1837 only. So NOx emission decreases [4]. NOx emission decreases of 0.039/kw-h compared PME with PME50CeO2 [6]. NO emissions are for CATBD is5.4% but for CTABD50CeO2 it is only 2.4%.so that NO emission decreases [7]. NOx emission for D70C10E20 is 280ppm at 0.44Mpa and for D70C10E20+25 CeO2 ppm it is 310ppm[8]. NO emission for CEONP50+25ppm is 948ppm but for CEONP it is 850ppm so NOx emissions increases[9]. NO emission for B20A30C30 ppm is 978 and The NO emission for B20 is 1300.[10].The increase in NOx was observed to be 4.5%, 17.6% and 24.5% with 50, 100 and 150 mg/l of graphite respectively. Due to an indication of improved combustion and elevated exhaust gas temperature.[11]. The value of the NOx decline on B10E4N30 compared with B10 and B10E4, is 9.9% and 8.8%, respectively.[12]. NO was reduced slightly in the case of NP additive. NO emissions for B40NcP01 and B40C1 were found 5% and 0.3% lower at full engine load than D100 respectively.[13]. NOx emissions significantly increases, according to the peak -Rd value of 134.4%, 464.5% and 971.4% for NMFs based on M10, M30 and M50 respectively[14].

The addition of alumina NPs to B30 leads to an average increase in NOx emissions by 0.5%, 3.7%, 4.7% and 16.25% for 25, 50, 75 and 100 mg/l, respectively. This could be attributed to the excess oxygen existing in biodiesel that enhances the NOX formation [15]. The addition of 100ppm and 50ppm of ZnO nanoparticle to CIME in the form of nanofluid was able to achieve a reduction of 12.6% and 9.8% in NOx emission[16]. The fuel samples Diesel, B20CSME, B20CSME+40ZNO, B20CSME+80ZNO, B20CSME+120ZnO exhibited 669.2ppm, 818.4 ppm, 566.2ppm, 527.5ppm and 497.8ppm reduce in NO emission except B20CSME fuel blend compared to remaining four fuels.[17]. The NOx emissions for the fuels diesel, C6 and nano C6 at full load condition are 1800ppm 1170ppm and 1570ppm respectively. [18]. For the blend nano C6 the presence of ZnO increases the calorific value and increases the average combustion chamber temperature, leading to higher NOx emissions compared to C6 and lower than diesel [2,3].[19]. The NOx emissions is reduced by 14% for B20 blend and 16% for B20+ZnO (80ppm) compared to the pure 100% diesel is increased leading to greater amount of oxygen to react and lowering the NOx emissions [20]. The NOx emissions of B20, B20+ZnO (10 ppm), B20+ZnO (20 ppm) and B20+ZnO (30 ppm) were 12.66%, 4.01%, 7.41% and 7.47% higher than diesel at full-load condition [21]. The NOx emissions are reduced from 450 to 320 ppm when the engine is run with JME blends with ZnO nanoparticles [22]. The average reduction of NOx emission for emulsified fuel is recorded as 22.1% and 37.5% for SB10W and SB20W emulsified fuels compared to SB [23]. The BSNO emission values of diesel, GSBD and GSBD ZnO 10% TCC blends are 7.6, 9.2 and 8.07 g/kWh respectively. [24]. The higher NOx emission from the MOME20 blend compared to diesel at all pressures is due to the intense combustion reaction [25]. From figure 3(c) Vigneswaran investigated the colloidal state of emulsions prepared with water, TiO2 and its blend with plastic diesel oil (PDO). The outcomes from the test results were reduced EGT, [26]. Karthikeyan gies The temperature, local concentration of oxygen and duration of combustion are considered the main factors that affect the NOx formation Consequently, NOx .[27]. Sunil, it is observed that the NOx outflow of biodiesel mixes are marginally higher in comparision with petro diesel. At maximum loading B20 blend produces approximately 5% higher NOx in compared with neat diesel. [28]. Sarıkoç et al. increased the emissions of NOx. At high temperatures nitrogen is more oxidized increasing the nitric oxide and this augments the NOx formations [29]. First, the brake specific emissions of NOx decreased as the engine loads increased. Although the in-cylinder temperature and NOx concentration increased with increasing engine load, the increasing rate of the output power was greater than that of the NOx concentration when the NOx emission in terms of ppm was converted into g/kW h resulting in a reduction in the brake specific emission of NOX as the engine load increased.[30]

NO emission is decreases. The additional oxygen content in the manifold fuel blends increases in cylinder combustion temperature which it turns increases NO emissions[2-10,13-17,25-30] The NOx emission increased due to at high temperature the oxygen reacts with the nitrogen and causes the production NOx[1,11-12,18-24].

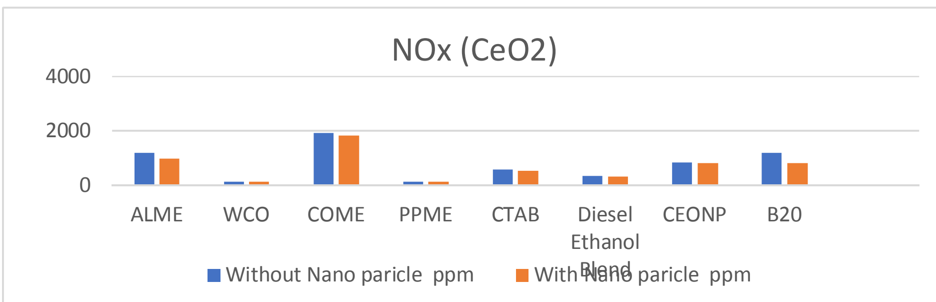


Figure-3(a)

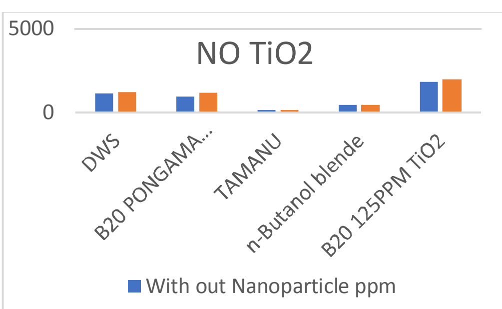


Figure-3(b)

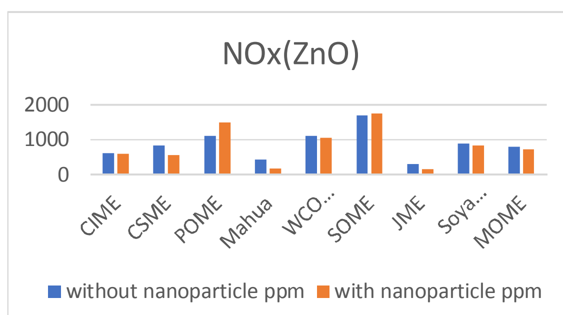


Figure-3(c)

COx:

The blende ALME10+50mg CeO2 0.48ppm of CO and ALME10+25mg of CeO2 produces a 0.048ppm of CO .the addition of CeO2 nanoparticle increases the oxygen content and reaction rate[1].waste cooking oil biodiesel +CeO2 at 100 ppm reduced CO by 34.32% when compared with pure diesel[2].for B20 diesel the CO emission is 0.22% but B20 with 50ppm CeO2nanoparticle it is 0.10% emission only [3].CO emissions for COB10 fuel is higher than COB10 with CeO2 content. Availability of oxygen is more so it improves ignition delay which reduces CO. At engine peak load the CO emission are reduced by 36,44,83.3&85 for COB10,COB10+25 ppm,COB10+50ppm,COB10+75ppm of CeO2 additive fuel[4].Seela concluded that co emission are decreases due to proper combustion[5].2.6% of CO emission decreases compared PME with PME50 CeO_2 [6].There is 18.4% decrease in CO emissions on compared D50 diesel with D50CeO_2 fuel [7].CO emissions decreases with addition of CeO_2.The CO emissions are decreases by 21% when compared with neat diesel [8]. Syed deduce that CO emission reduces up to 21% for CEONP50ppm fuel compared to D70C10E20 fuel with D70C10E20+CE25ppm [9].The CO emissions for B20 is 0.03 whereas for B20A30C30 it is 0.02[10].The CO emissions decreases due to the addition of CeO_2 with the diesel fuel. Generally CO emissions caused due to poor mixing of air and fuel,and incomplete combustion fuel[1-10]. CO emissions for B40NCP1 and B40C1 were higher 11% and 0.1% at full engine load than W100, respectively [11]. AlC nanoparticles as an oxidation catalyst leads to higher carbon combustion activation and heat transfer rate, and hence promoting complete combustion that reduce the emission levels of NOx and CO.[12]. CO emissions for B40NCP1 and B40C1 were higher 11% and 0.1% at full engine load than W100, respectively [13].

Among the tested fuel samples, CIME ZnO50 and CIME ZnO100 were able to achieve a maximum reduction of 15% and 18.4% respectively in CO emission at full load when compared to pure CIME. The additional oxygen supplied by nanoparticle and improved oxidation of fuel due to the presence of nanoparticle are the reasons for lower CO emission [16].At full load condition CO emisions are for the five fuels namely Diesel, B20CSME, B20CSME+40ZNO,B20CSME+ 80ZNO,B20CSME + 120ZnO are 0.048%,0.042%,0.04%,0.037% and 0.05%. [17].The CO emission for the fuels diesel C6 and nano C6 at full load condition are 0.082, 0.028 and 0.006 (% vol). [18]. The CO emissions are 0.13%, 0.16% and 0.1% of the fuels respectively. At higher loads the dominance of the heat of vaporization reduces and better complete combustion occurred, leading to lesser CO emissions [19].For full load the CO (% volume) emissions decrease by nearly 30% for both the blends B20 and B20+ZnO. [20]. The CO emission of B20, B20+ZnO (10 ppm), B20+ZnO (20 ppm), and B20+ZnO (30 ppm) records 10.6%,13.63%,17.4% and 20% lower than diesel fuel at full-load condition. [21].With the induction of H_2, higher CO emissions were observed for B30- ZnO20nm compared with B10-ZnO20nm and B20-ZnO20nm. There is an average increase of 35% of CO at a partial load and 50% at a full load [22]. Suresh et al. investigated the effect of water emulsion and ZnO nanoparticle on the emissions pattern of a diesel engine running with Soybean biodiesel (SB). At 75% load condition, SB10W emulsified biodiesel exhibits 33.3% lower CO emission compared to SB [23]. The BSCO emissions for diesel, GSBD and GSBD ZnO10% TCC blends are 5.5 g/kWh, 4.3 g/kWh and 4.21 g/kWh respectively.GSBD being a moderately unsaturated fuel [24]. For the fuel blend MOME20, the addition of ZnO nanoparticles at all injection pressure has illustrated 2.3% reduction in CO emission.Due to the small fuel droplet size resulted in reduced CO emissions[25].

Vigneswaran.conclude the divergent fuels, viz., DWS, DWT1, DWT2, and DWT3. CO emission for emulsion fuel (DWS) is higher on a par with all the other test fuels in the cycle at all load conditions and the maximum rise in percentage is 11.11%. [26] Karthikeyan, conducted an exprement and show that the variation of CO and UHC exhaust emissions with respect to the engine loads and tested fuels. Generally, the CO emission is diminished slightly with the increase in the applied engine loads, except at the higher load of 13.5 N·m. [27]. Sunil, Co emissions may be attributed to higher viscosity, lower calorific value, low flash point, and fire point; it takes more time to mix with air and get ignited than other fuels [28]. Sarıkoç, et al. CO emission results for all test fuels at full load and various engine speeds. For all fuel blends, the maximum values were recorded at 1000 rpm. Compared to euro diesel, the average CO emission of B100, B20, B20 + TiO_2, B20But10 and B20But10 + TiO_2 test fuels decreased for 44.83%, 16.51%, 25.56, %27.44% and 38.09%, respectively. The lowest CO emission values are obtained for B100 fuel compared to other fuel blends [29]. The nano-emulsion fuels had higher peak cylinder pressure and peak heat release rate owing to the faster combustion rate caused by the micro-explosion of fuel droplets and higher thermal conductivity caused by the high surface-to-volume ratio of TiO_2 nanoparticles[11-15,18-22]

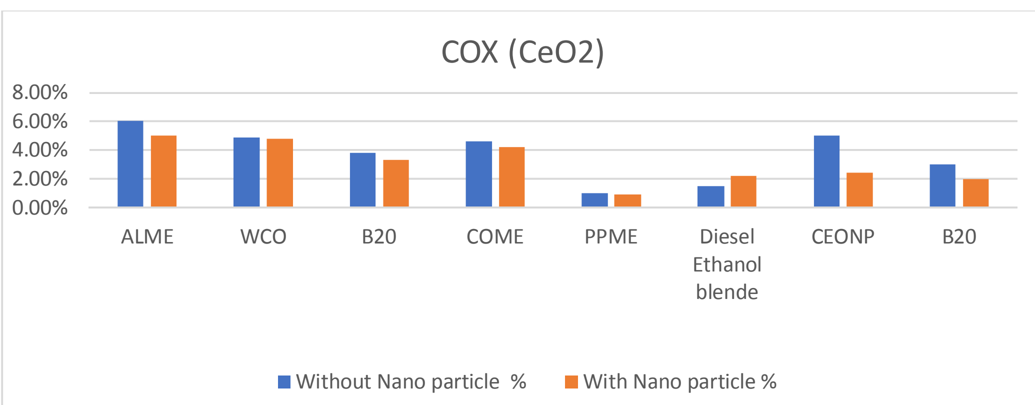


Figure-4(a)

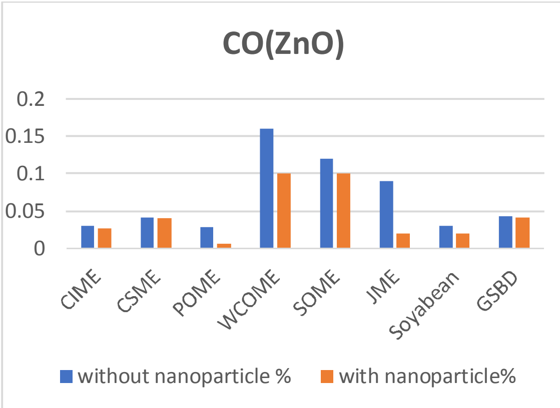


Figure-4(b)

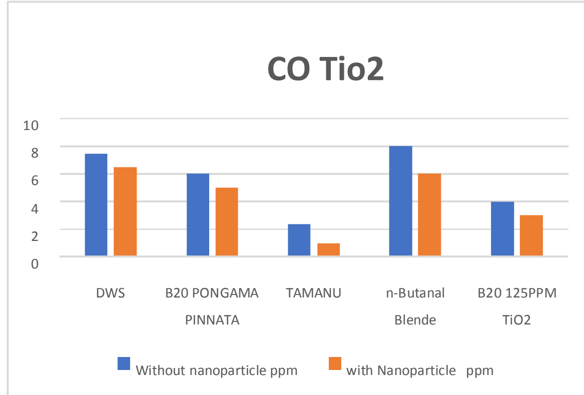


Figure-4(c)

HC:

The fossil based diesel is releases the high unburnt hydrocarbons [ALME] of 50ppm. the blend ALME10CeO2 50mg releases lowest hydrocarbons of 38ppm.HC emission decreases.[1] The maximum UBHC is B20 is 27.67% but UBHC observed for B20 blend+CeO2 100 ppm is 23.46% .The HC emissions decreases[2].for 1bar BMEP the HC of diesel is observed that 0.28% emission but HC of diesel with 100 ppmCeO2 is 0.26% .There is 0.02% reduction [3].for diesel the HC emission for COB10 is 12% whereas for COB10+25ppmof Ceo2 it is 10%. So HC emission reduced due to lower availability of Oxygen content [4]. HC decreased due to proper combustion [5].There is 0.049/kw-h decreases of HC emission compared PME withPME50 CeO2 nano particle [6].There is 15.1% decreases in HC emission on compared with D50 diesel with D50CeO2 nanoparticle blend [7]. Arul et al deduce that the least HC emission is observed is 48ppm for CEONP50 compared with CEONP diesel its emission is 100ppm. This is due to high oxygen content [8].Least HC observed is 48ppm for CEONP50 at bp5.2Kw and for CEONP diesel it is nearly 100ppm so that HC emission drastically decreased [9].HC emission for B20 is 13ppm and HC emission for B20A30C30 it is 10ppm the emission decreases [10]**.** For M30 fuel, the peak Rd in HC emissions is 97.1% for the alumina. As the alumina nanoparticle mixed into M50, the peak Rd in HC emissions presents higher levels [14].

Vigneswaran conclude the HC and smoke were drastically reduced to a maximum of 22.2%, 19.1% and 32.9% for nano blended fuels on par with diesel fuel. While comparing to DWS fuel the parameters such as BSEC, CO, HC and smoke were decreases up to 9.66%, 33.36%, 32.53%, 7.74% At full load condition, fuel samples containing 100ppm of ZnO showed 13% reduction in HC emission while for the sample containing 50ppm of ZnO, a reduction of 6.7% was observed [16]. The presence of nano additives acts as a binder and evades the undesirable fuel buildup and crevice area penetration thus decreasing the HC emissions [17]. The HC emissions of C6 and nano C6 are 42ppm and 32ppm respectively. The reduction of HC emissions is due to the presence of the nano particles reacting to improve the combustion. Also, as the temperature of the cylinder is very high at full load more complete combustion[18] .The HC emissions of biodiesel and nano B20(100ppm) are similarly equal to 58ppm at full load condition[19].The B20 and B20+ZnO are 42ppm and 47ppm at full condition. It is seen that ZnO is highly operative in tackling HC emissions at 80-100% loads possibly because of the supply of extra oxygen and also by ZnO acting as an oxygen buffer [20].The HC emissions of B20 and B20+ZnO (30ppm) are 65ppm and 55ppm.ZnO nanoparticles with the concentration of 30 ppm added with B20 generates lower UHC than all other fuels. [21].39ppm and 15ppm are the HC emissions of the B100 and B20 with 40ppm of nanoparticles. The ZnO-blended JME fuels with H2 induction reduced the HC emissions, and with increasing induction rate of H2 [22].15ppm and 9ppm are the HC emissions of SB20W and SB20W100ZnO. The inclusion of ZnO nanoparticle in SB20W emulsified biodiesel reduces the HC emission at all loading conditions. An increase in mass fraction of ZnO nanoparticle is directly proportional to drop in HC emission [23].

The inherent oxygen content of biodiesel helps in attaining near complete combustion. It is noticed that addition of ZnO nano emulsions to GSBD fuel, has resulted in microlevel explosion that improves vaporization, atomization and mixing with air. EGR at low rates of about 5% causes less significant effect on HC emissions[24].The HC emissions are 42ppm and 40ppm of MOME20 and MOME2030[25]**.** [26]. HC and soot emissions relying on the comparative percentage of butanol used as well as the engine working situations. The performance and emissions parameters of a diesel engine fueled by different mixture of n-butanol-di-methyl ether and n-butanol-diesel fuels were studied by Karthikeyan, [27]. Sunil, TiO2 nanoparticles promote complete combustion which reduces the HC emissions. Hydrocarbon emission is obtained for B20 125 PPM and 250PPM blends are 41 PPM and 49 PPM respectively, whereas B20 is 76 PPM at maximum load.[28]. Sarıkoç, et al.The maximum HC emission values were recorded at 1000 rpm while the minimum values were obtained at 3000 rpm for all fuel blends except for euro diesel. The average decrease in HC emission for B100, B20, B20 + TiO2, B20But10 and B20But10 + TiO2 test fuels were about 45.14%, 29.58%, 34.12%, 15.87% and 34.39%, respectively. [29] . Compared with petro-diesel, the soot emission of the F–T diesel was reduced by an average of 27.32 % at various loads, whereas that of the optimal T50 decreased by an average of 43.61 %. Additionally, the number concentration of UFPs of T50 was reduced by an average of 21.2 % compared to the F–T diesel. [30] The main reason for decreases in HC emission is the present of High Cetane number present in CEONP blended diesel. The reason for decreasing of HC is due to Oxygenated additives promote complete combustion [1-9] and HC emission decreases due to the ability if nanoparticles to convert CO toCO_2 and HC to H2O by its strong redox active property**.**

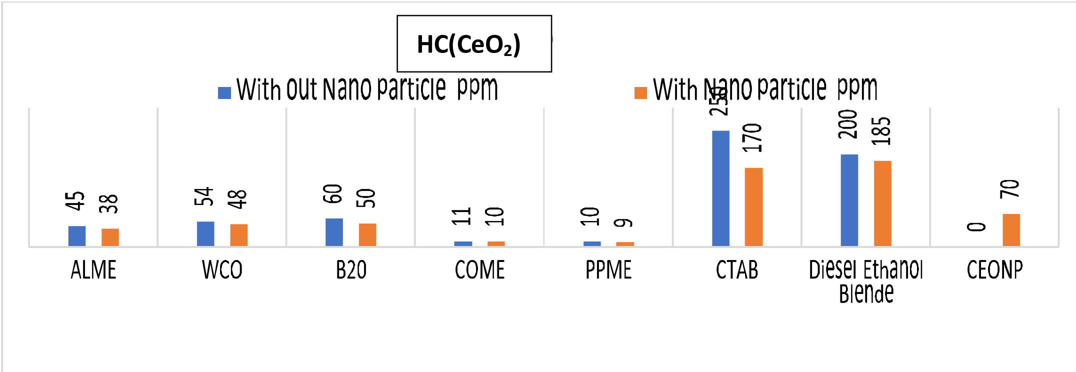
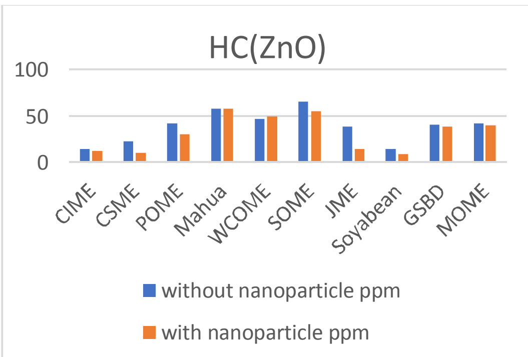


Figure-5(a)



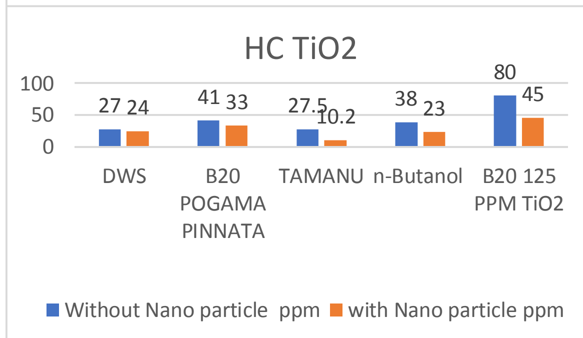


Figure-5(b) Figure-5(c)

Table:1

Researcher	Fuel used	Nano particle used	Nano particle concentration	BTE	BSFC	NO emission	CO emission	HC emission
Pawan Kumar and Rao [1]	Hazantus(ALGE)	CeO_2	25mg and 50mg	13.73%increases	13.33% decreases	17.01% high emission	0.48% decreases	18.5% decreases
Akram et al [2]	Waste cooking oil	CeO_2	100ppm	1-1.8%increases	0.8% decreases	18.27% reduced	6.57%reduced	23.46%reduced
Hoang et al [3]	Bio diesel	CeO_2	50ppm	1.5%increases	1% increases	6.37% decreases	55%decreases	7.14% decreases
Muruganantam et al [4]	Corn oil methyl ester	CeO_2	25,50,75ppm	34.7% increases	2.81%decreases	4.57% decreases	36% reduced	16.6%reduced
Chiranjeevi rao et al [5]	MahuaMethyl ester	CeO_2	50,100ppm	1.8%increases	1% decreases	50ppm increases	decreases	decreases
Sureshkumar et al [6]	PME	CeO_2	100ppm	2% increases	25%icrases	0.06% decreases	4.2% decreases	0.05% decreases
Deqing et al [7]	CTAB	CeO_2	50,100mg/l	1.7% improved	5.55%reduced	2.4%reduced	15.1% reduced	18.4%reduced
Arul et al[8]	Diesel ethanol blende	CeO_2	25ppm	7.99% increases	8.77%reduced	9.6%Reduced	0.15%Reduced	19.13%Reduced
Syed et al [9]	CEONP	CeO_2	25ppm	1%Increases	9% decreases	3.4%	5% reduces	28% reduces

						decreases		
Prabhu et al[10]	**B20 Biodiesel**	**CeO_2**	**30ppm**	**12% increases**	**11.76% decreases**	**32%reduced**	**0.01%reduced**	**23% reduced**
Qibai Wu et al.[11]	**palm oil methyl ester**	**Aluminum**	**30ppm**	**N/A**	**10%reduced**	**12% reduced**	**9% reduced**	**4.9%Reduced**
Ammar Ahmed et al. [12]	**homogeneous fuel blends.**	**Graphite**	**100ppm**	**2.9% increases**	**0.9%reduced**	**13.9% increases**	**5.5% reduced**	**N/A**
Vikas sharma et al.[13]	**WCO**	**Graphite**	**100 ppm**	**1.07% increases**	**5.8% decreases**	**3% decreases**	**15.2% decreases**	**N/A**
Jiangjun Wei et al[14]	**Methanol bio diesel**	**Aluminum**	**100 ppm**	**N/A**	**N/A**	**30% decreases**	**9% decreases**	**89.9% decreases**
A.E. Elwardany et al,[15]	**SOH**	**Aluminum**	**25ppm**	**N/A**	**2.2% reduced**	**28% reduced**	**N/A**	**N/A**
Ashok et al.[16]	**CIME**	**I. Zinc Oxide ii.Ethanox**	**50,100ppm**	**Increases by 1.2% Ii Increased by 0.3%**	**Decreases from 0.287 to 0.273 Kg/Kwhr**	**Decreases by 3.4% Increases by 13.2%**	**Decreases by 2.8% Decreases by 3.5%**	**increased by 9.7% and 12.3%**
Kumar et al.[17]	**CSME**	**Zinc Oxide**	**80 ppm**	**Increases by 0.96%**	**Decreases from 0.57 to 0.52Kg/Kwhr**	**Decreases by 0.003%**	**Decreases from 566.2ppm to527.5ppm**	**50% decreases**
Prabakaran et al.[18]	**POME**	**Zinc Oxide**	**250 ppm**	**Increases by 3.5%**	**decreases from 0.35 to 0.28 Kg/Kwhr**	**Decreases by 0.022%**	**Increases from 1170ppm to 1570ppm**	**20% decreases**
C.R.seela et al. [19]	**mahua**	**Zinc Oxide**	**50,100ppm**	**increases by 1.3%**	**Increases from 0.301 to 0.31Kg/Kw-hr**	**Decreases by 0.06%**	**Decreases from 487ppm to 324ppm**	**1.2%decreases**
Lobo et al.[20]	**WCOME**	**Zinc Oxide**	**80ppm**	**increases by 1.9%**	**Increases by 2%**	**Decreases by30%(vol)**	**Decreases by 30%(vol)**	**7%increases**
Dhanarasu et al.[21]	**SOME**	**Zinc Oxide**	**30ppm**	**Increases by 0.2%**	**Decreases by 10.34%**	**Decreases by 9.4%**	**Increases by 5.19%**	**9.23%decrease**
Javed et al.[22]	**JME**	**Zinc Oxide**	**100ppm**	**Increases by 2.9%**	**decreases**	**Increases 50%**	**Decreases from 450 to 320 ppm**	**reduced by 40 to 45%.**
Suresh et al. [23]	**Soyabean**	**Zinc Oxide**	**50ppm**	**N/A**	**N/A**	**Decreases 33.3%**	**Decreases 12.9%**	**20% lower HC emission**
Praveena et al. [24]	**GSBD**	**Zinc Oxide**	**10% ppm**	**N/A**	**N/A**	**Decreases from 4.3 to 4.21 g/kWh**	**Decreases from 9.2 to 8.07 g/kWh**	**20% reduced**
Soudagar et al [25].	**MOME**	**Zinc Oxide**	**30ppm**	**Increases 6.8%**	**decreases by 0.5%**	**Decreases 2.3%**	**Increases**	**N/A**
Vigneswaran et al. [26]	**Diesel fuel**	**TiO_2**	**30ppm**	**2.58%increases**	**3.125%decreases**	**16% reduced**	**13.33%decreases**	**11.11%decreases**
Karthikeyan et al. [27]	**Alcohol blend**	**TiO_2**	**25ppm**	**N/A**	**N/A**	**2.4% decreases**	**26% decreases**	**53% Reduced**
Sunil et al. [28]	**petro diesel**	**TiO_2**	**30ppm**	**3.9% increases**	**7.4%decreases**	**7.6% increases**	**37% reduced**	**44% reduced**

Sarıkoç, et al.[29]	**Euro diesel**	**TiO_2**	**100ppm**	**1.5% increases**	**9.3% increases**	**8.3% increases**	**13%decreases**	**26%decreases**
Dselva et al. [30]	**Fischer–Tropsch**	**TiO_2**	**100ppm**	**2% increases**	**6% reduction**	**17.4% increases**	**N/A**	**19% increases**

CONCLUSION:

Among the fuels corn oil methyl ester with CeO_2 nano particle produces better BTE and diesel ethanol blend also produces a 7.99% of increment in the BTE .Among the fuels PME biodiesel with Ceo_2 nanoparticle produces 11.76% decrement in fuel consumption and ALGE also produces 13.33% decreases in fuel consumption .Among the fuels soyabean biodiesel ZnO produces 33.3% decreases NOx emissions and also WCOME biodiesel produces 30% decreases in NOx emissions. Among the biodiesel corn oil methyl ester reduced CO emisions by 36% when CeO_2 is added to biodiesel. When petrol diesel reacts with TiO_2 the CO emissions reduced with 37%. When methanol bio diesel reacts with alumina it results to decrement in 80% HC emissions. when JME reacts with ZnO nano particle it reduces 45% of CO emissions.

ACKNOWLEDGMENT

We would like to express our sincere gratitude to Dr.A.Vijin Prabhu Professor of the Department of Mechanical Engineering, and Dr.Suresh Professor department of Mechanical engineering for providing all of the necessary resources that enabled us to complete our report successfully.

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