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Diesel engine combustion parameters adopting biodiesel blended nano-particles.

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Abstract:
In order to enhance the ambient air quality, emission standards for internal combustion engines are more demanding. The focus of today's diesel emissions control technology is on particulate matter emissions and nitrogen oxides. The additions of nanometal oxides in the decrease of diesel emissions are reportedly beneficial. The composition of diesel fuel and the development of engines can ensure clean combustion of diesel fuel. Experimental results showed that by adding nanoprodits to gasoline-biodiesel blends, peak in cylinder gas pressure, and high pressures increase compared to neat diesel fuel because of the shorter ignition time leading to earlier combustion and higher cylinder pressures. It can be observed that the heat release rate of the diffusion phase is highest when compared with the greater oxygen contents of the mixed fuels that have enhanced the diffusion phase combustion process and reduced the length of combustion for nanoadditives in respect of biodiesel and biodiesel. In BD+CNT120 (Biodiesel+120 ppm Nano Carbon Tubes nano additive), peak stress was increased to 15.38 percent. The innovative combustion improves the rate of peak pressure and thermal release by 23.33%, respectively, and 28%. The delay in Ignition decreased by 8.98% compared to the neat diesel fuel in BD+CNT120.

Keywords: Combustion characteristics, nanoparticle, Biodiesel blended, diesel.

1. Introduction:

The growing need to reduce the environmental impact of the modern life style imposes a continuous development of novel technologies aimed at severe reduction of pollutant emissions. Diesterol blends are formulated in the recent years, which not only serve for the utilization of ethanol in CI engines, also to reduce the harmful pollutant emissions when comparing with the neat diesel [1]. In light of the use of ethanol in the pressure ignition engines Lapuerta et al.[2] have examined the stability of diesel–biodiesel-ethanol mixtures at various temperatures, and have found that biodiesel acts as a stabilizing component in e-diesel mixtures except at low temperatures, where it favours gelatin phase formation. The findings of engine testing for diesel-biodiesel-ethanol mix indicated an increased emission of hydrocarbon, higher concentration of ethanol and substantial emission reductions of smoke and particulate matter compared to neat diesels. Emissions such as nitrogen oxides, carbon monoxides, hydrocarbon und smoke have been decreased, with a further increase in Diesterol's bio-fuel content across the whole spectrum of motor operations. The technique for variable compression engines can handle gasoline with a wide variety of fuel characteristics. Arul Mozhi Selvan et al. [3–6] conducted experimental research on the performance, combustion and emission properties of a Diesterol fuel mix in a compression engine of 15: 1, 17:1, and 19:1 at an engine with a constant speed of 1500 r/min. The usage of fuel transmission catalysts is now focused on the benefit of fuel economy while decreasing the harmful emissions of greenhouse gases, nitrogen oxide and particulates among the numerous approaches that may be utilised to minimise harmful emissions of exhaust gases. Cerium oxide Nanoparticles acts as a catalyst for hazardous gases in hydrocarbon fuel combustion and enhances fuel savings. Oxygen storage capability (OSC) for CERIA and the presence of CERIA in fuel aid to replenish the diesel particular filter[7] is called the quantity of oxygen reversibly given during and withdrawn from the gas phase. [8]. Electronic, mechanical, optical and chemical properties of the nanotubes are the most attractive aspects that have opened the door to future uses.

Carbon Nanotubes are employed in the current study as a fuel-driven supplement to improve fuel combustion properties and lower exhaust emission levels by hazardous contaminants. The Carbon Nanotubes are capable of trapping free radicals and carbon fibrils can act as an anti-knock agent. The fibrils of carbohydrate can be utilised as a sequestration agent to minimise intraocular contaminants for tramp metals/tramp ions in motor fuel. Additionally, the inclusion of carbon nanotubes in diesel increases the amount of cetane combined and is a catalyst for speeding up combustion rates[9]. As diesel soot may be recycled as the carbon source for SWNTs, the resulting SWNTs give economic benefits and contribute to a cleaner environment[10]. As ethanol and diesel are immiscible, an additive called the "Diesterol" fuel blend with 70 percent diesel is utilised to produce the E-20. The present investigation, taking an initiative from previous studies, aims to combine CERIA and CNT's carbon reduction potential as fuel additives and to investigate their impact on the Diesterol mix; alternative fuel has diesel, ethanol and biodiesel advantage over the operating features of a variable compression engine.

2. Experimental Result and Procedure

The nanoparticles mix Diesterol fuels for experimenting with the variable compression ratio engine are created. Cerium oxide nanoparticles (CERIA) and Carbon nanotubes (CNT) are mixed with diesterol fuel mixtures, each at a concentration of 25, 50 and 100 ppm. The diesterol mixtures are maintained for half an hour in an ultrasonic bath to increase the fuel mixing stability. The turbidity process is used to test the suspension stability. The characteristics of the stable diesel-biodiesel-ethanol fuel mixtures are evaluated by ASTM and shown in Table 1. Figures 1 and 2, show the results on relative density fluctuations for two-theta, respectively, and the tests for X-ray diffraction (XRD) are carried out at CERIA and CNT. The XRD data will be examined with the JCPDS data base, and XRD tests indicate that cerium-oxide nanoparticles are pure, and that the cerium-oxide nanoparticles are 33 nm large by Scherrer. The XRD data will be evaluated with the XRD data.

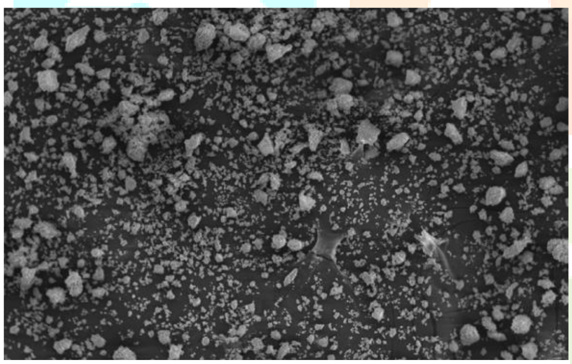

Figure 1 SEM image of Cerium Oxide Nanoparticles

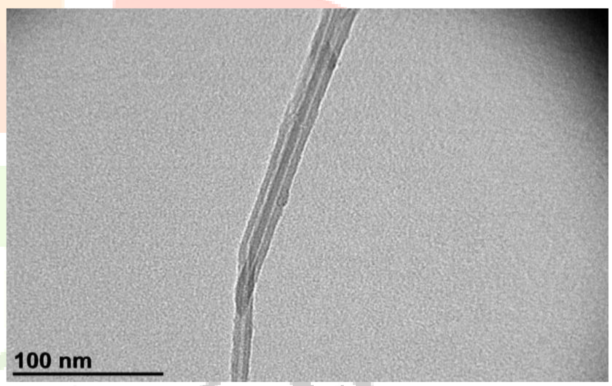

Figure 2 TEM image of single walled Carbon Nanotube

$$\tau = \frac{k\gamma}{\beta \cos\theta} \quad \text{……………………} (1)$$

where s is the mean size of the ordered domains, K is the shape factor, k is the X-ray wavelength, b is the line broadening at half the maximum intensity in radians and h is the Bragg angle. A common value of around 0.9 is the dimensional form factor. The photographic pictures acquired from CERIA and CNT are presented in Fig. 1and 2 using the scanning electron microscope (SEM) to examine their morphology. The Carbon Nanotubes TEM picture verified the CNT as a single carbon nanotube walled.

Diesel delivered by M/s Indian Oil Corporation Limited through the trade dealer in Tiruchirappalli, India and the M/s Changshu Yangyuan Chemical in China supplied with 99.9% purity, and 99.9% of Castor oil purchased at the Tiruchirappalli, India is used for the Castor methyl ester (Biodiesel) preparation by means of an institute transesterification process. Diesterol fuel mixtures are created by differing diesel, biodiesel and ethanol concentrations. Due to the immiscibility of Diesel and Ethanol, Castor oil biodiesel is employed as an addition to avoid the breaking up of the phase. The stability of the mixture has been observed for more than a month without a phase-separation; the combined fuel may thus be confidently utilised in motor testing. The fuel characteristics of the

Table 1
Properties of diesel-biodiesel-ethanol fuel blends.

Properties	Diesel	Biodiesel	Ethanol	E20	ASTM standards
Kinematic viscosity @ 40 °C, (mm^2/s)	2	5.98	1.1314	2.35	ASTM D445
Density @ 15 °C, (kg/m^3)	830	893	790	827	ASTM D1298
Flash point, (°C)	50	88	13.5	11	ASTM D93
Fire point, (°C)	56	106	-	14	ASTM D93
Pour point, (°C)	6	−7	−117.3	−14	ASTM D5985-02
Copper strip corrosion	-	1	-	1	ASTM D130
Cetane number	46	55.4	6	45.25	ASTM D 613
Calorific value, (MJ/kg)	42.30	38.71	25.18	40.10	ASTM D240

diesel–biodiesel–ethanol blending are determined by using ASTM test standards and the findings are The fuel blends in Diesterol (E20), which are used to study the impact of fuelborne nanoparticles upon the potentials of reduction of emissions and improvement in the performance of The Diesterol fuel blend, are supplemented with th e Cerium Oxide Nanoparticles (CERIA) and the CNT, each 25, 50, 100 ppm is shown in table 1.In order to create a stable homogenous blend, the Nano Diesterol mixes undergo high-speed mechanical turmoil followed by ultrasonic bath stabilisation. For experimental investigations, the stable Nano-Diesterol mixes (E20 + CERIA 25 + CNT 25, E20 + CERIA 50 + CNT 50, E20 + CERIA 100 + CNT 100) are used to determine performance, combustion and emission characteristics of the nano-diesterol blend on the variable compression engine. Comparison with E20 blend is possible. The compression ratio of the engine is adjusted to 19:1 and operates at a constant speed from 1,500 rpm under different loading situations, at 0–0.55 MPa average braking effect pressure, which is between 0 and 10% load conditions. The engine is charged with a dynamometer of eddy current and a loading cell type of tension indicator is used to measure load. For measurement of in-cylinder pressure, the piezo-electrical pressure transducer Kistler is utilised to measure the curb angle with a crank corner encoder Kistler. The temperature of air, water and exhaust gas is detected using the thermocouple type 'K' and the fuel flow rate is measured using an optical infrarot capable. With pressure change across the aperture plate, air intake was monitored for the engine. The data collection system is fed through a signal conditioning unit and DICI-V5.73 to all the signal gathered from the sensors.

Table : 2

Specification of the engine.

Rated power	3.7 kW
Compression ratio	5:1–20:1(Variable)
Stroke	110 mm
Type of fuel injection	Direct injection
Fuel injection pressure	20 MPa
Fuel injection timing	23_ BTDC
Fuel injection pressure	20 MPa
Cooling	Water cooled
Ignition System	Compression Ignition
Bore	80mm
Engine Speed	1500 r/min-Constant
Loading system	Eddy current dynamometer

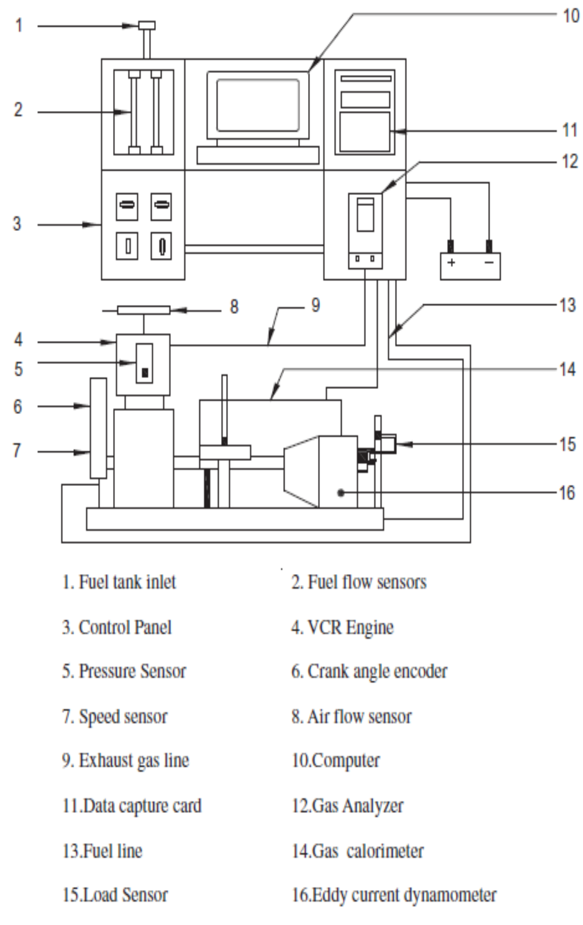

Fig. 3. Schematic diagram of the experimental setup.

The exhaust gas emissions such as CO, HC and NO are measured by AVL Five gas analyzer and the Smoke is measured using the AVL Smoke meter. All the experiments are conducted and the corresponding readings are recorded after reaching the steady state conditions. The uncertainty analysis of the experimental data has been performed based on the procedures suggested by Kline [11], Moffat et al. [12] and Holman [13] and the estimated uncertainty for the measured and the evaluated quantities are shown in table 3.

3. Results and discussion

The following are the results from an experiment on how the compression ignition engine performs, combustion and emits, with Diesterol/CERIA+CNT mixtures with different concentrations of cerium oxides and carbon nanoparticles, of the25, 50 and 100 ppm in the diesterols mixtures (D70B10E20). In this section the experiment is presented.

3.1 Combustion parameters of Diesterol CERIA–CNT blends

The variation of cylinder gas pressure with the crank angle for the Diesterol + CERIA + CNT blend is shown in Fig. 4.The peak pressure for the Diesterol + CERIA + CNT blend is higher than that of the E20 blend due to the addition of CERIA and CNT, which accelerates the complete combustion and cause for the higher cylinder gas pressure. However, the variation between the CERIA and CNT concentrations of each 25, 50 and 100 ppm is marginal. The peak pressure for the E20 + CERIA 50 + CNT 50 is found as 10.7 MPa at the crank angle of 367°c, whereas for the E20 blend it is 7.9 MPa at the crank angle of 377°C. It is observed that the occurrence of peak pressure is advanced with the addition of CERIA and CNT in E20 blend due to the shorter ignition delay due to the addition of CNT which accelerates the combustion and the addition of CERIA, which supplies oxygen and promotes the complete combustion. The addition of CERIA and CNT in E20 blend advances the occurrence of the peak heat release rate when comparing with the E20 blend and the variation of heat release rate with the crank angle. for the Diesterol + CERIA + CNT blend. The heat release rate is negative at the start of combustion for all the biodiesel blends and neat diesel. This is due to the vaporization of the fuel accumulated in the ignition delay period. The fuel has taken the heat form the combustion chamber walls to vaporize the fuel and the hot air in the compression process. After the ignition starts, the rate of heat release increases rapidly and reaches to the maximum value. When the ignition delay is more, the quantity of the fuel accumulated in the combustion chamber is also more and cause for the rapid burning in the premixed combustion process. The heat release rate calculation adopted by the same author Arul Mozhi Selvan et al. [14] is used in this present investigation. The addition of Cerium Oxide Nanoparticles and Carbon Nanotubes decreases the ignition delay and accelerates earlier initiation of combustion, which results in the lower heat release rate and advancement of the peak heat release rate. The maximum heat release rate is observed as 67 J/CA at the crank angle of 370_ for the E20 + CERIA 25 + CNT 25 blend, whereas it is 85 J/CA at the crank angle of 376 for the E20 blend.

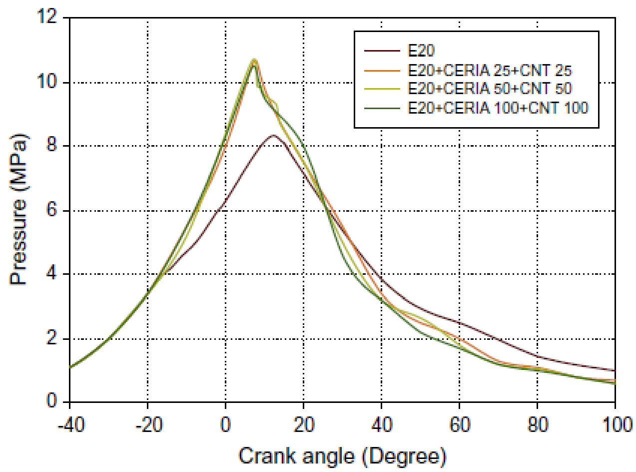

Figure 4 Variation of cylinder gas pressure with crank angle for Diesterol–CERIA–CNT

4. Conclusion

The impacts of Carbon Nanotubes and Cerium Oxide Nanoparticles as a fuel-borne nanoparticle addition of a diesel-biodiesel–ethanol mixture are examined by the performance, combustion and emissions characteristics of a VCR at different concentrations of Ceria–CNT in Diesterol fuel mixes. The following key findings have been drawn from the experimental research..

1. With the addition of CERIA and CNT, the thermal brake effectiveness rises to 7.5% compared with The Diesterol mixture 1. 1. (E20).
2. The addition of CERIA and CNT in the Diesterol blend advances the occurrence of the peak heat release rate when comparing with the Diesterol blends. The addition of Cerium Oxide Nanoparticles and Carbon Nanotubes decreases the ignition delay and accelerates earlier initiation of combustion, which results in the lower heat release rate and advancement of the peak heat release rate.

3. Increasing carbon monoxide emission to 22,2 percent as compared with the E20 mix is included in Diesterol blend (E20 + CERIA 50 + CNT 50). 1. 1. 1. 1. The adding of CERIA and CNT to the E20 mix increases combustion and decreases the emission of hydrocarbon and smoke to 7,2% and 47,6% respectively compared to the E20 blend. Adding to the fuel blend E20 CNT and CERIA does not reduce the nitrogen oxide output much.

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