PERFORMANCE INVESTIGATION OF CI ENGINE RUN BY BIODIESEL WITH NANOPARTICLES (NiO_2)

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Abstract*— The main reason for using alternative fuels in compression ignition engine is that the consumption and demand of petroleum products are increasing every year due to urbanization, increase in vehicular density and power requirement is going up and to reduce emission produced by today's diesel engine, which in turns require a clean burning fuel that perform well under the variety of operating conditions. Using an emulsion of diesel in water as a fuel has been a recent field of study in this field. Biodiesel/diesel emulsified formulations are reported to reduce the emissions without compensating the engine's performance. Conventional fuels have been found rather inadequate in improving emission characteristics which is the very first need of impeding emission regulation. Nanoparticles could decrease the emission parameter and can improve combustion efficiency by improving the ignition delay and fuel properties. Nanoparticles had the potential as the next generation fuel for to increase the B.P./B.T.E./reduction in emission; also it will have potential to enhance the diesel engine performance, working efficiency of D-engine under different condition of load, lowering emission and combustion efficiency improvement. Although Nanoparticles have displayed enormously exciting potential applications, some vital hinders also exist before commercialization of Nanoparticles.

***Index Terms*— Biodiesel, Pumpkin Seed Biodiesel, Nanoparticle, BTHE, BSFC, NiO_2,**

I. INTRODUCTION

1.1 Biodiesel

Biodiesel is a clean burning alternative fuel produced from domestic, renewable resources. The fuel is a mixture of fatty acid alkyl esters made from vegetable oils, animal fats or recycled greases. Where available, biodiesel can be used in compression-ignition (diesel) engines in its pure form with little or no modifications.

Biodiesel is simple to use, biodegradable, nontoxic, and essentially free of sulphur and aromatics. It is usually used as a petroleum diesel additive to reduce levels of particulates, carbon monoxide, hydrocarbons and toxics from diesel-powered vehicles. When used as an additive, the resulting diesel fuel may be called B5, B10 or B20, representing the percentage of the biodiesel that is blended with petroleum diesel.

Biodiesel is produced through a process in which organically derived oils are combined with alcohol (ethanol or methanol) in the presence of a catalyst to form ethyl or methyl ester. The biomass-derived ethyl or methyl esters can be blended with conventional diesel fuel or used as a neat fuel (100% biodiesel). Biodiesel can be made from any vegetable oil, animal fats, waste vegetable oils, or microalgae oils. There are three basic routes to biodiesel production from oils and fats:

- Base catalyzed trans-esterification of the oil
- Direct acid catalyzed trans-esterification of the oil
- Conversion of the oil to its fatty acids and then to biodiesel.

There are a variety of oils that are used to produce biodiesel, the most common ones being soybean, rapeseed, and palm oil which make up the majority of worldwide biodiesel production. Other feedstock can come from waste vegetable oil, jatropha, mustard, flax, sunflower, palm oil or hemp. Animal fats including tallow, lard, yellow grease, chicken fat and fish oil by-products may contribute a small percentage to biodiesel production in the future, but it is limited in supply and inefficient to raise animals for their fat. Jatropha is a small pest- and drought -resistant shrub that is capable of being grown on marginal/degraded land and produces seeds that yield several times more oil per acre than soybeans.

1.1.1 Cetane number

Cetane number or CN is a measure of the combustion quality of diesel fuel via the compression ignition process. Cetane number is a significant expression of diesel fuel quality among a number of other measurements that determine overall diesel fuel quality. Cetane number is actually a measure of a fuel's ignition delay; the time period between the start of injection and start of combustion (ignition) of the fuel.

1.1.2 History of Biodiesel

One of the first inventors to convince the people of the use of ethanol was a German named Nikolaus August Otto. Rudolf Diesel is the German inventor of the diesel engine. He designed his diesel engine to run in peanut oil and later Henry Ford designed the Model T car which was produced from 1903 to 1926. This car was completely designed to use hemp derived biofuel as fuel.

It was a Belgian inventor in 1937 who first proposed using transesterification to convert vegetable oils into fatty acid alkyl esters and use them as a diesel fuel replacement.

1.2 History of Nanoparticle

Nanoparticles are particles between 1 and 100 nanometers in size. In nanotechnology, a particle is defined as a small object that behaves as a whole unit with respect to its transport and properties. Particles are further classified according to diameter. Ultrafine particles are the same as nanoparticles and between 1 and 100 nanometers in size, fine particles are sized between 100 and 2,500 nanometers, and coarse particles cover a range between 2,500 and 10,000 nanometers. Nanoparticle research is currently an area of intense scientific interest due to a wide variety of potential applications in biomedical, optical and electronic field

Although, in general, nanoparticles are considered a discovery of modern science, they actually have a long history. Nanoparticles were used by artisans as far back as the ninth century in Mesopotamia for generating a glittering effect on the surface of pots. Even these days, pottery from the middle Ages and Renaissance often retains a distinct gold- or copper-colored metallic glitter. This luster is caused by a metallic film that was applied to the transparent surface of a glazing. The luster can still be visible if the film has resisted atmospheric oxidation and other weathering. The luster originated within the film itself, which contained silver and copper nanoparticles dispersed homogeneously in the glassy matrix of the ceramic glaze. These nanoparticles were created by the artisans by adding copper and silver salts and oxides together with vinegar, ochre, and clay on the surface of previously-glazed pottery. The object was then placed into a kiln and heated to about 600 °C in a reducing atmosphere. In the heat the glaze would soften, causing the copper and silver ions to migrate into the outer layers of the glaze. There the reducing atmosphere reduced the ions back to metals, which then came together forming the nanoparticles that give the colour and optical effects

Luster technique showed that ancient craftsmen had a rather sophisticated empirical knowledge of materials. The technique originated in the Muslim world. As Muslims were not allowed to use gold in artistic representations, they sought a way to create a similar effect without using real gold. The solution they found was using luster.

Michael Faraday provided the first description, in scientific terms, of the optical properties of nanometer-scale metals in his classic 1857 paper. In a subsequent paper, the author (Turner) points out that: "It is well known that when thin leaves of gold or silver are mounted upon glass and heated to a temperature that is well below a red heat (~500 °C), a remarkable change of properties takes place, whereby the continuity of the metallic film is destroyed. The result is that white light is now freely transmitted, reflection is correspondingly diminished, while the electrical resistivity is enormously increased."

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Uncontrolled agglomeration of powders due to attractive Vander Waals forces can also give rise to in micro structural heterogeneity. Differential stresses that develop as a result of non-uniform drying shrinkage are directly related to the rate at which the solvent can be removed, and thus highly dependent upon the distribution of porosity –

II. PROBLEM STATEMENT

The study of Biodiesel fuel is very timely because of arising problems such as the rising cost of fuel in the market, global warming phenomenon, and health problems such as respiratory diseases caused by the harmful byproducts of burning petroleum-based fuels. Another problem concerning the use of diesel is the deteriorating effects of the increased amount of Greenhouse Gases in the atmosphere. This is due to the high emission of carbon dioxide coming from incomplete combustion of diesel fuel in vehicles. Last of all, the emission of pollutants such as nitrogen oxide caused also by incomplete combustion of diesel fuel is one of the leading contributors of smog and can trigger serious respiratory problems

III. LITERATURE REVIEW

In this chapter many research papers were studied to formulate the problem. Research topic is related to the Nano fuels. The Nano fuels were prepared by adding nanoparticles to the diesel-biodiesel blends. The experiments were performed At variable compression engine. In this chapter lot of research papers were studied which are related to synthesis of nanoparticles, addition of nanoparticles to the biodiesel blends, effect of nanoparticles on fuel properties, effect on combustion performance and emission characteristics. Some papers were reviewed related to the biodiesel manufacturing, performance and emission characteristics.

A. Selvaganapthy et al. [1] evaluated the performance and emission characteristic of single cylinder four stroke vertical water cooled diesel engine using diesel fuel and the zinc oxide Nano particles which were mixed with the diesel fuel At the rate of 250 ppm and 500 ppm. The obtained particle size range was from 24-71 nm. A magnetic stirrer was used to disperse the Nano particles into the diesel and laser spectrometer was used to measure the dispersion. The higher cylinder peak pressure was observed for blend of Nano particles with diesel. The 69 bar cylinder peak pressure for diesel fuel was Attained At a crank angle of 5° after TDC, 75.6 bar was obtained for diesel fuel blended with 250 ppm of Zinc Oxide At crank angle of 2° after TDC and 78 bars was achieved At crank angle of 2° after TDC for diesel fuel blended with 500ppm of Zinc Oxide. The addition of zinc oxide further increased the heat release rate by 12.8% for 250ppm concentration of zinc oxide and20% for 500ppm of Zinc Oxide. The NOx emission was lower for the neat diesel compared to all the fuel blends. Least smoke opacity was observed for diesel fuel which was 5.2% At low load and 27.2% At full load while compared to the blended fuel. The brake thermal efficiency was found to improve by 2.71% with 250ppm No and 4.53% for 500ppm No.

Jain C. Sanjeevan et al. [2] had conducted an experiment on a naturallyaspirated four stroke single cylinder water-cooled compression ignition engine operatingAtrated speed of 1500 RPM to investigate the catalytic activity of cerium oxide. The performance and emission were compared with diesel and diesel having cerium oxide Nano particle with 5, 15, 25 and 35PPM concentration. Characterization technique such as EDS, XRD and TEM were used for studying the properties of cerium oxide Nano particle prepared by precipitation method and surfactant dodecanal succinic anhydride was added in diesel to obtain a stable suspension which had HLB Value 1.34. It was seen that the viscosity, flash and fire point increases with addition of Nano particle. The load tests were conducted by varying the dosing levels of cerium oxide Nano particle in diesel, the brake thermal efficiency was found to be increase At the dosing level of 35 ppm of cerium oxide with 2% DDSA. The hydrocarbon emission decreased on addition of catalyticNano particle by about 40 to 45%, especially At higher load. The NOx emission was found to decrease by a maximum of 30% on the addition of cerium oxide Nano particle in diesel especially At higher loads and further reduction up to 50% with the addition of 5% volume fraction of surfactant treatedNano particle.

V. Arul MozhiSelvan et al. [3] investigated the performance and emission characteristics of neat diesel and diesel-biodiesel-ethanol blends with 25 PPM and 32 nm size cerium oxide as fuel borne additive on a single cylinder four stroke variable compression water cooled engine At the compression ratio of 19. The phase separation between diesel and ethanol was prevented by adding biodiesel. The turbidity procedure was used to assess the stability of the resulting suspension. All the results were plotted against brake mean effective pressure (BMEP). The lower BSFC was observed for Cerium oxide blend of neat diesel. The higher brake thermal efficiency was observed for neat diesel. The highest peak pressure 10.2Mpa was found for neat diesel blends with cerium oxide. The addition of cerium oxide further decreased the CO, HC emission when compared to neat diesel. The NOx emission was lower for the neat diesel as compared to all the fuel blends. The least smoke absorption coefficient was observed as 1.273 for cerium oxide blended diesel-biodiesel-ethanol blends At BMEP of 0.44MPa.

V. Sanity et al. [4] had studied the influence of dosing level ranging from 20 to 80 PPM of cerium oxide Nano particles in biodiesel derived from atrophy, on a single cylinder water-cooled direct injection diesel engine operatingAt 1500 RPM. The physiochemical properties, performance and emission characteristics were measured. The size of Nano particle was 10 to 20 nm and density was 7.13g/ml. The results so obtained were plotted against the load on test engine. Increasing trend was seen in the physiochemical properties of fuel like flash point, viscosity and volatility with addition of Nano particle. The results concluded that an average reduction of 25% to 40% in the hydrocarbon emission was obtained for the additive dosing level ranging from 40 to 80 PPM of the additive. The NOx emission was found to be generally reduced by 30% on the addition of cerium oxide Nano particle to biodiesel with dosing level of 80 PPM. The reduction influence of the fuel additive on carbon monoxide emission was not so prominent.

Rachis N. Mehta et al. [5] Investigated the burning characteristics, engine performance and emission parameters of a single-cylinder Compression Ignition engine using Nano fuels which were formulated by sonicatingNano particles of aluminum (Al) having 30-60nm, iron (Fe) 5-150 nm and boron (Bo) 80-100 nm in size in base diesel with 0.5wt% and 0.1wt% Span80 as a surfactant for stable suspension. The Nano fuels reduced ignition delay, longer flame sustenance and agglomerate ignition by droplet combustion mechanism test. Peak cylinder pressures decreased At higher load conditions and were registered as 55 ,59, 60 and 62 bars for A1, Bo, Fe and diesel respectively. Specific fuel consumption was reduced by 7% with A1 in comparison to diesel. Exhaust gas temperatures of A1, Fe, and Bo rose by 9%, 7% and 5% respectively, resulting into increase in brake thermal efficiencies by 9%, 4%, and 2% as compared to diesel At higher loads. A wet What man filter paper was adopted to collect the soot particles and increase in weight by 12%, 9%, and 8% was observed for Fe, Bo and A1 Nano fuels, respectively as compared to diesel. At higher loads, the emission study showed a decline of 25–40% in CO (vol.%), along with a drop of 8% and 4% in hydrocarbon emissions for A1 and Fe Nano fuels respectively. Due to elevatedtemperatures a hike of 5% and 3% was observed in NOx emission with A1 and Fe.

IV. METHODOLOGY

- Preparation of Nanoparticle
- Characterization of Nanoparticle
- Purchase of Pumpkin seed oil
- Determination of Thermo-physical properties using standard
- Doping of Nanoparticle in B50 blend in 25, 50, 75 and 100 ppm using Isopropyl Alcohol as solvent
- Experimentation performed for B50 (25, 50, 75 and 100 ppm) Biodiesel on CI Engine at varying load
- Plotting of results and comparison
- Varying parameters are
    1. Static Injection Pressure
    2. Breaking Torque
    3. Nanopaticle concentration in B50

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Preperation of Nanoparticle(NiO_2)

Materials required for production of nanoparticles

Nickel Chloride – 1 molar

Potassium Hydroxide - .27 molar

- Take the chemicals the mortor pestle.
- Grind the mixture manually for about 30 minutes.
- The mixture is then added in the water & it is stirred for about 30 minutes.
- The mixture is allowed to filter with the help of filter paper & kept for drying in open atmosphere.
- Dry mixture is kept for heating at 300^0C, 600^0C and 900^0C in furnace.

Parameters of Nanoparticle

Parameters	Pure	With dopent
Lattice constant (c)	2.94	4.94
Crystalline size	10-12	50-60
Theoretical Density	2.91	2.91
Axial Ratio (C/A)	2.44	2.44
Particle Size	7-8 nm (approx…)	50-60 nm (approx..)

Preparation of biodiesel blends

Pumpkin Seed Biodiesel blend was prepared with pure diesel on volume basis. Three different blends B50 of biodiesel were prepared. B50: 500ml of Biodiesel and 500ml of regular diesel is used.

Equipment used for the evaluation of engine performance

A four stroke, single cylinder diesel engine was used for the performance study. The performance of various blends with and without the presence of nano particle were evaluated on the diesel engine. The experiments were conducted at the constant speed of 1500rpm at various loads. The test setup had a facility for measurement of fuel flow, temperatures and torque. The flow of cooling water and calorimeter was controlled with rotameter. Load cell sensor was used to vary the load on eddy current dynamometer which is coupled to the engine.

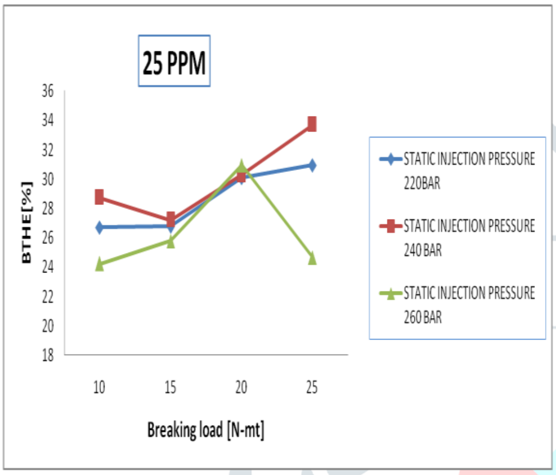
Experimental Procedure

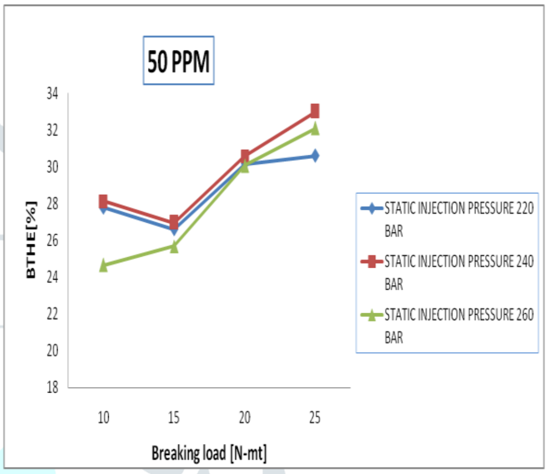
1. Fill the fuel tank by sufficient bio diesel blends.
2. Give 230V A.C supply to the trainer by connecting the three pin top provided with the trainer to the distribution board in your laboratory. Switch on the supply.
3. Provide cooling water to exhaust gas calorimeter and engine.

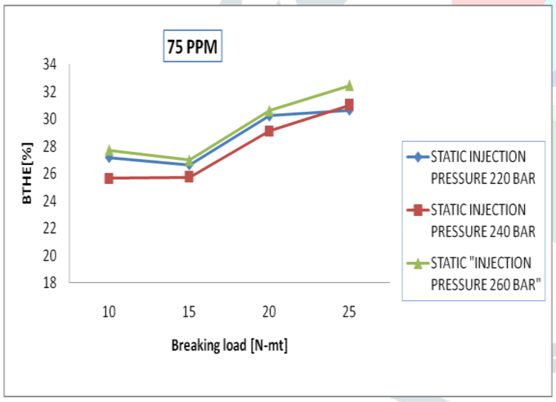
5. Switch ON mains switch mounted on the front panel. Ensure that all indicators are displaying readings.
6. Open the fuel supply valve of engine.
7. Start the engine by hand start.
8. Run the engine under no load condition. Let the engine stabilize.
9. Note down the parameters like speed, manometer difference, temperatures etc. at no load in to observation table.
10. Close the 2 way valve in fuel line and measure time required for consumption of 10 ml fuel, note the same in observation table.
11. Switch on the load ON/OFF switch. Increase the torque by the incremental of 5N- meter.
12. Repeat steps 9-10 for this torque.
13. Note down reading at different torque setting up to 25N-mtr.
14. Unload the engine by gradually reducing the torque to zero.
15. Wait for 2-3 minutes, keep engine running at no load.
16. Stop the engine.

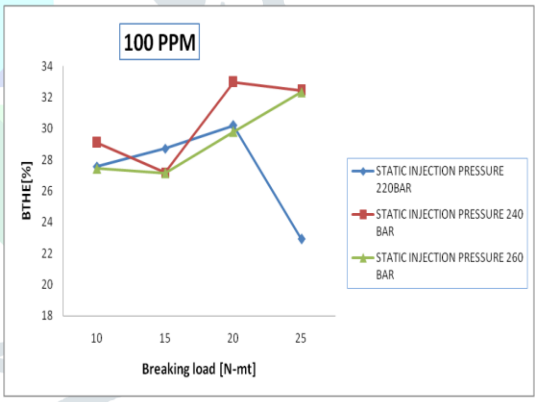
RESULT & DISCUSSION

Effect of blend and load on Break Thermal Efficiency at 25, 50, 75 and 100 ppm









From the above graphs we can say that

The BTHE is increases as the load increases; For SIT 240 bar the BTH efficiency increases constantly and; from 22% to 34% load increases as , For SIT 220 bar and SIT 260 bar BTHE increases but there is no consistent.

V. CONCLUSION

- The variation of biodiesel blend can be varied for a better result.
- Variation of Engine parameter like Compression Ratio, Static Injection Pressure and Injection opening pressure can be pulsated.
- The Heat Release Rate and P-Theta can be observed on variable Compression Ratio Engine. Also smoke opacity to observed using hartridge /AVL make using smoke meter.
- The experimentation can be also performed on current technologies like DDiS and CRDI type Engine. Also we can do experimentation on multicylinder engine.
- Hence we can say that from observation and Result. The BTE increases with reduction in BSFC but emission are slightly increases.
- As thermal efficiency increases the BSFC decreases.

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VI. ACKNOWLEDGMENT

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REFERENCES

[1] Selvaganapthy, A., Sunder A., Kumaragurubaran, B., & Gopal, P. (2013). An experimental investigation to study the effects of various nanoparticles with diesel on DI diesel engine. ARPN J. Sci. Technol, 3(1).

[2] Sajeevan, A. C., &Sajith, V. (2013). Diesel Engine Emission Reduction Using Catalytic Nanoparticles: An Experimental Investigation. Journal of Engineering.

[3] Selvan, V. A. M., Anand, R. B., &Udayakumar, M. (2009). Effects of cerium oxide nanoparticle addition in diesel and diesel–biodiesel–ethanol blends on the performance and emission characteristics of a CI engine. J EngApplSci, 4(7), 1819-6608.

[4] Sajith, V., Sobhan, C. B., & Peterson, G. P. (2010). Experimental investigations on the effects of cerium oxide nanoparticle fuel additives on biodiesel. Advancesin Mechanical Engineering, 2, 581407.

[5] Mehta, R. N., Chakraborty, M., & Parikh, P. A. (2014). Nano fuels: Combustion, engine performance and emissions. Fuel, 120, 91-97.

[6] Karthikeyana, S., Elangob, A., &PrAthimac, A. (2014). Performance and Emission Study on Zinc Oxide Particles Addition with Promolion Stearin Wax Biodiesel of Engine. Journal of Science and Industrial Research, 73.

[7] Lenin, M. A., SwaminAthan, M. R., &Kumaresan, G. (2013). Performance and emission characteristics of a DI diesel engine with a nanofuel additive. Fuel, 109, 362-365.

[8] Karoonfangsuwannarak.,TriAtanasirichai,K., (2013). Effect of metalloid compound and bio-solution additives on biodiesel engine performance and exhaust emissions. American Journal of Applied Sciences, 10(10), 1201-1213.

[9] Shafii, M. B., Daneshvar, F., Jahani, N., &Mobini, K. (2011). Effect of Ferro fluid on the performance and emission pAtterns of a four-stroke diesel engine. Advances in Mechanical Engineering, 3, 529049.

[10] Tewari, P., Doijode, E., BanapurmAth, N. R., &Yaliwa, V. S. (2013). Experimental investigations on a diesel engine fueled with multi-walled carbon nanotubes blended biodiesel fuels. Int J Energy TechnolAdvEng, 3, 72-6.

[11] Karthikeyana, S., Elangob, A., &PrAthimac, A. (2014). Diesel engine performance and emission analysis using canola oil methyl ester with the Nano sized zinc oxide particles. Indian journal of engineering and material sciences.

[12] Kannan, G. R., Karvembu, R., &Anand, R. (2011). Effect of metal based additive on performance emission and combustion characteristics of diesel engine fueled with biodiesel. Applied Energy, 88(11), 3694-3703.

[13] Keskin, A., Gürü, M., &Altıparmak, D. (2008). Influence of tall oil biodiesel with Mg and Mo based fuel additives on diesel engine performance and emission.Bioresource technology, 99(14), 6434-6438.

[14] Gürü, M., Koca, A., Can, O., Çınar, C., &Şahin, F. (2010). Biodiesel production from waste chicken fat based sources and evaluation with Mg based additive in a diesel engine. Renewable Energy, 35(3), 637-643.

[15] Keskin, A., Guru, M., &Altiparmak, D. (2010). The investigation of performance and emissions characteristics of tall oil biodiesel with a co-based additive. EnergySources, Part A: Recovery, Utilization, and Environmental Effects, 32(20), 1899-1907.

[16] Ranaware, A. A., &SAtpute, S. T. (2013). CorrelAtion between effects of cerium oxide nanoparticles and Ferro fluid on the performance and emission characteristics of a CI Engine. Journal of Mechanical and Civil Engineering.

[17] Bagri, S., &Chaube, A. (2013). Effect of SC5D Additive on the Performance and Emission Characteristics of CI Engine. International Journal of Modern EngineeringResearch , 4(3).

[18] Xing-cai, L., Jian-Guang, Y., Wu-Gao, Z., & Zhen, H. (2004). Effect of cetin number improver on heat release rate and emissions of high speed diesel engine fueled with ethanol–diesel blend fuel. Fuel, 83(14), 2013-2020.

[19] Selvan, V. A. M., Anand, R. B., &Udayakumar, M. (2014). Effect of Cerium Oxide Nanoparticles and Carbon Nanotubes as fuel-borne additives in Die sterol blends on the performance, combustion and emission characteristics of a variable compression ratio engine. Fuel, 130, 160-167.