EXPERIMENTAL ANALYSIS ON DIESEL ENGINE USING Al_2O_3 NANO PARTICLES WITH HYBRID BIODIESEL

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Abstract - *In the context of fast depletion of fossil fuels and ever increasing diesel vehicle population, use of renewable fuels like vegetable oils has become more pertinent. Crude oil and petroleum products are going to become very scarce and costly to search and production. Although fuel economy of engines is greatly improved, increase in the number of automobiles alone dictates that there will be a great demand for fuel in the near future. The need of the development of alternative fuels for the IC-engine is concerned over the emission problems of gasoline engines. Combined with other air polluting systems, the large number of automobiles is a major contributor to the air quality problem of the world. A third reason for alternative fuel development is the fact that a large percentage of crude oil must be imported from other countries which control the larger oil fields. Bio-diesel is the essential fuel which have completed the health effects testing requirements of the US Clear Air Act. Bio-diesel provides reduction of unburnt hydrocarbons, carbon monoxide, and particulate matter used in a conventional diesel engine. It eliminates the sulphate fraction (as there is no sulphur in the fuel). There is no requirement engine modifications up to 20 percent blend. Bio-diesel could be made from crude/natural vegetable oils, crude/refined fats, high acidity oil/fats, recovered fried oils, animal fats and waste oils. Bio-diesel is a renewable fuel, biodegradable and non-toxic. Bio-diesel is produced by a simple chemical reaction between vegetable oil and alcohol in the presence of an acid or base as catalyst. It contains around 10% built-in oxygen by weight and has no sulphur and has excellent lubricity properties. Due to built-in-oxygen It is more efficient fuel than petro-diesel hence It contains higher cetane number than that of petro-dieselIt is defined as mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats. Bio Diesel confirm to ASTM D6751 specifications for use in diesel engines. The combustion behaviour of traditional liquid fuels with the addition of Nano scale energetic materials as fuel additives to enhance the performance and emissions in a diesel engine is an interesting concept. The addition of aluminium nanoparticles to diesel provides a large contact surface area with water and high activity for the decomposition of hydrogen from water during the combustion process. During combustion, alumina serves as a catalyst and the aluminium nanoparticles are denuded and decomposed the water to yield the hydrogen.The combustion of the diesel fuel mixed with aqueous aluminium . Nano metal oxide additives are reported to be successful in reducing diesel emissions. The metal based additives reduce diesel engine pollution emissions and fuel consumption values.*

Key Words: **Al_2O_3- Alumina, CO- Carbon mono oxide, CO_2- Carbod Di Oxide, HC- Hydro Carbon etc**

1. INTRODUCTION

When rudolf diesel first enunciated the concept of diesel engine, about a century back, the experimental evaluation was demonstrated on peanut oil indicating that the vegetable oils will be the prospective future fuels in diesel engines in the context of fast depletion of fossil fuels and ever increasing diesel vehicle population, use of renewable fuels like vegetable oils has become more pertinent. the various biomass based resources, which can be used as an extender, or a complete substitute of diesel fuel may have very significant role in the development of agriculture, industrial and transport sectors in the energy crisis situation. the role of diesel fuel in these sectors cannot be denied because of its ever-increasing use. in fact agricultural and industrial sectors are almost diesel dependent.

Probably in this century, it is believed that crude oil and petroleum products will become very scarce and costly to find and produce. Although fuel economy of engines is greatly improved, increase in the number of automobiles alone dictates that there will be a great demand for fuel in the near future. Alternative fuel technology, availability, and use must and will become more common in the coming decades. Another reason motivating the development of alternative fuels for the IC-engine is concerned over the emission problems of gasoline engines. Combined with other air polluting systems, the large number of automobiles is a major contributor to the air quality problem of the world. A third reason for alternative fuel development is the fact that a large percentage of crude oil must be imported from other countries which control the larger oil fields.

Bio-diesel is the first alternative fuel to have fully completed the health effects testing requirements of the US Clear Air Act. The use of bio-diesel in a conventional diesel engine results substantial reduction of unburnt hydrocarbons, carbon monoxide, and particulate matter. Emissions of nitrogen oxides are either slightly reduced or slightly increased depending on the duty cycle and testing methods. The use of bio-diesel decreases the solid carbon fraction of particulate matter (since the oxygen in bio-diesel enables more complete combustion to CO2), eliminates the sulphate fraction (as there is no sulphur in the fuel), while the soluble, or hydrocarbon, fraction stays the same or is increased. Biodiesel works well with new technologies such as catalysts, particulate traps, and exhaust gas recirculation. So bio-diesel reduces carbon dioxide by 78 percent on a life cycle basis. No engine modifications are required up to 20 percent blend.

1.1 ENERGY SCENARIO OF BIODIESEL IN INDIA

India's incremental energy demand for the next decade is projected to be among the highest in the world. With increasing growth rate of GDP, total primary commercial energy consumption has increased from 350 million metric tons of oil equivalent (MMToE) during 2003-04 to 380 MMToE at present. Consumption of petroleum has increased form 3.5 million metric tonnes (MMT) in 1950-51 to 17.9 MMT in 1970 and 843 MMT in 1997-98 and to more than 120 MMT at present. It is estimated that the demand for petroleum is 234 MMT in 2019-20. Domestic production of oil in 2004-05 is 33 MMT. Diesel consumption in 2004-05 for import of petroleum products and it is estimated to cost approximately Rs. 1, 75, 000 .00 crore in 2005 respectively. There is increase in the growth rate of expenditure on import of petroleum to the time of 46 percent from 2004-05 and 2005-06. More than 70 percent of India's total petroleum consumption is imported from international market, which itself has become more volatile than ever. International crude prices are soaring to new highs. Petroleum is predominately (46 percent) consumed in transport sector. The fuel-mix in transport sector shows that about 80 percent consumption in this sector is a High Speed Diesel (HSD). The projected demand for HSD in the country by 2005-07 is 52 MMT and on present indications, by 2011-12, it could increase to 67 MMT. Petroleum resources are finite and therefore search for alternative fuels is continuing all over the world. Bio-diesel is a renewable fuel and it can be made from any edible, non-edible vegetable oil including waste oil development of Bio-diesel as an alternative and renewable source of energy for transport sector has become important in the national effort towards self-reliance, an important component of the strategy for energy security.

1.2 BIODIESELS

Bio-diesel is a renewable fuel, biodegradable and non-toxic. It is an ester based oxygenated fuel made from any vegetable oil (edible or non-edible) or animal fat. Bio-diesel is produced by a simple chemical reaction between vegetable oil and alcohol in the presence of an acid or base as catalyst. It contains around 10% built-in oxygen by weight and has no sulphur and has excellent lubricity properties. Built-in-oxygen makes it more efficient fuel than petro-diesel hence its cetane number is higher than that of petro-diesel. It can be blended with petro-diesel in any proportion. Bio-diesel is the name of the clean burning alternative fuel, produced from domestic, renewable resources. Bio-diesel contains no petroleum, but it can be blended at any level with petroleum diesel to create a bio-diesel blend. It can be used in compression-ignition (diesel) engines with little or no modifications. Bio-diesel is simple to use, biodegradable, nontoxic, and essentially free of sulphur and aromatics. It is defined as mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats which confirm to ASTM D6751 specifications for use in diesel engines. Bio-diesel refers to the pure fuel before blending with diesel fuel.

Pure bio-diesel is not well-suited with natural rubber, sometimes found in pre 1994 vehicles. Because it is a solvent. It can degrade natural rubber hoses and gaskets. This is not a problem with B20 blends (20 percent biodiesel/80 percent diesel) and below. Bio-diesel does not require special storage. In fact, in its clean form or in blends, Bio-diesel can be store wherever petroleum diesel is stored, except in concrete-lined tanks. It is handled like diesel and uses the same transportation for transport, storage and use. At higher blend levels, bio-diesel may deteriorate natural rubber or polyurethane foam materials. Bio-diesel exhaust is less offensive. The apply of bio-diesel and bio-diesel blends results in a perceptible, less offensive change in exhaust odour, which can be a real benefit in confined spaces. In fact, equipment operators have compared it to the smell of French fries. Users also report having no eye irritation. Since bio-diesel is oxygenated, diesel engines have more complete combustion with bio-diesel than with petroleum. Bio-diesel is safer to use than petroleum diesel. The flash point (the point at which fuel ignites) for bio-diesel in its pure form is a minimum of 260 degrees versus about 125 degrees Fahrenheit for regular No.2 diesel. This makes bio-diesel one of the safest fuels to use, handle and store. Bio-diesel reduces emissions notably.

1.3 NANOFUELS

The recent advances in Nano science and nanotechnology paved the way to produce Nano scale energetic materials which have tremendous advantages over micron sized materials.The combustion behaviour of traditional liquid fuels with the addition of Nano scale energetic materials as fuel additives to enhance the performance and emissions in a diesel engine is an interesting concept.The addition of aluminium nanoparticles to diesel provides a large contact surface area with water and high activity for the decomposition of hydrogen from water during the combustion process. During combustion, alumina serves as a catalyst and the aluminium nanoparticles are denuded and decomposed the water to yield the hydrogen.The combustion of the diesel fuel mixed with aqueous aluminium Nano fluid shows the following phenomena: total combustion heat increases while the concentration of smoke and nitrous oxide in the exhaust emission from diesel engine decreases.Nano metal oxide additives are reported to be successful in reducing diesel emissions. The metal based additives reduce diesel engine pollution emissions and fuel consumption values. The reason for emission drop is that the metal reacting with water to create hydroxyl radicals, which improve soot oxidation, or by direct reaction with the carbon atoms in the soot, thereby lowering the oxidation temperature. Very few researchers worked, on the use of Nano additives to biodiesel for the enhancement of the performance and emission characteristics. The aluminium powder is a familiar ingredient for explosive formulations.

Latest technology allowed the production of aluminium particles of nanosize. These particles exhibit bizarre thermal behaviour that was thought to be connected with stored internal energy. Rudimentary aluminium is tempting as an enhancing agent in combustion applications due to its high heat of reaction.

2.0 LITERATURE REVIEW

Ali et al. [1] reported though biodiesel can replace diesel satisfactorily, problems related to fuel properties persist. In this study diethyl ether (DEE) was used as additive to the palm biodiesel-diesel blended fuel B30 and B40 in the ratios of 2% and 6% by volume and tested for their properties improvement according to ASTM D7467 standard procedures. The tested fuel samples were compared with diesel fuel (D) and palm biodiesel (B100). the results shows that the best properties was for B30DE6 where the presence of diethyl ether additive helps to reduce the viscosity by 35%, density by 3.6% and acid value by 57% compared to palm biodiesel. For Palm biodiesel there is reduction in amount of energy.

Ingle et al. [2] conducted tests on a four stroke, single cylinder, diesel engine with Diesel and various blends of Biodiesel at various preheating temperature. The outcomes of emission test are compared. The BSEC for Bldend 20 is minimum with 60^0C preheating and the gas temperature of exhaust gas is maximum where as pure diesel has minimum smoke density.

Liu et al. [3] studied transesterification of soybean oil to biodiesel using CaO as a solid base catalyst. The reaction mechanism was proposed and the separate effects of the molar ratio of methanol to oil, reaction temperature, mass ratio of catalyst to oil and water content were investigated. It shows that the ratio of 12:1 of methanol and oil, including 8% CaO as a catalyst, 65^0C temperature and 2.03% content of water is best for result, and the biodiesel yield exceeded 95% at 3 h. The catalyst lifetime was longer than that of calcined K_2CO_3/c-Al_2O_3 and KF/c- Al_2O_3 catalysts. CaO has property of activeness even after 20 rounds of cycle and the biodiesel yield after 1.5 h has not been affected due to repeatness of cycle.

Leung et al. [4] reviewed the different approaches of reducing free fatty acids in the Raw oil and refinement of crude biodiesel that are adopted in the industry. They also described other new processes of biodiesel production. The non catalytic methanol is best for small time reaction. This process is unable to control waste cooking oil and fat of animal.

Qi et al [5] produced biodiesel from soybean crude oil which was prepared by a method of alkaline catalysed Transesterification. The important properties of biodiesel were compared with those of diesel. Diesel and biodiesel were used as fuels in the compression ignition engine, and its performance, emissions and combustion characteristics of the engine were analysed. The combustion stages for biodiesl is similar even earlier combustion take place. At lower engine loads, the peak cylinder pressure, the peak rate of pressure rise and the peak of heat release rate during premixed combustion phase were higher for biodiesel than for diesel. For biodiesel the rate of peak pressure and heat release is minimum and peak pressure variation for cylinder at high load engine is similar. The power output of biodiesel was almost identical with that of diesel. The brake specific fuel consumption was lower for biodiesel. It has considerable reduction in harmful exhaust gases so it can be used as a substitute fuel.

Lin et al.[6] investigated the emissions of polycyclic aromatic hydrocarbons (PAHs), carcinogenic potencies (BaPeq) and particulate matter (PM), fuel consumption and energy efficiency from the generator under steady state for seven test fuels: P0 (Premium Diesel Fuel), P10 (10% palm biodiesel+90% P0), P20, P30, P50, P75 and P100. It is indicated the value of PAH reduces. The mean reduction fraction of total PAHs emission factor (P0 ¼ 1110 mgL_1) from the exhaust of diesel generator were 13.2%, 28.0%, 40.6%, 54.4%, 61.89% and 98.8% for P10, P20, P30, P50, P75 and P100, respectively, compared with P0. The mean reduction fraction of total BaPeq (P0 ¼ 1.65 mgL_1) from the exhaust of diesel generator were 15.2%, 29.1%, 43.3%, 56.4%, 58.2% and 97.6% for P10, P20, P30, P50, P75 and P100, respectively, compared with P0. The value of PM emission also reduces dure to increase in palm oil content up to 10% and increased as the palm-biodiesel blends increased from 10% to 100%. Palm-biodiesel seems to be the most feasible biodiesel. The best energy efficiency occurred between P10 and P20, close to P15. The curve dropped as the palm-biodiesel content rose above P20. By the results it is clear that Palm oil based bio diesel are best for use in CI eninges.

Agarwal et al [7] reviewed the production, characterization and current statuses of vegetable oil and biodiesel as well as the experimental research work carried out in various countries. Jatropha curcas (Ratanjyot), Pongamia pinnata (Karanj), Calophyllum inophyllum (Nagchampa), Hevca brasiliensis (Rubber) etc are non edible oil by which bio diesel is made. Biodiesel can be blend in any ratio such as diesel and there is no modification require up to some blend percentage.

Alkabbashi et al.[8] made a system to obtain crude oil based palm oil by esterification proesess. It is carried out by knowing temperatue of 60^0C and time 60 minute, 10:1 ratio of methanol and oil and amount of the catalyst by 1.4 (%wt). The test conducted are as: density of POB at room temperature, 0.8498 kg L^{-1}, surface tension at STP of 26.96 mN m^{-1}, with Huh-Mason correction of 0.1 and finally free fatty acid percentage of 0.12% (equivalent to acid value of 0.26 mg KOH g^{-1}).

Song et al. [9] investigated the soyabean based biodiesel performance in terms of power and fuel cost. The trade-off connection was plain among the NO_x and smoke density when the diesel engine fueled with different biodiesel percentage in the blends.

Dubey et al. [10] operated diesel engine with blends of Jatropha biodiesel and turpentine oil with a view to completely eliminate dependency on fossil fuel. Jatropha biodiesel (methyl ester) and turpentine oil is a high and low viscosity fuels combination with comparable heating values to that of diesel; this makes conducive for its use in a diesel engine. The experiments are carried out on Kirloskar diesel engine with Jathora to obtain various performance characteristics methyl ester with turpentine oil blends (dual fuel blends) and conventional diesel. Dual fuel blends are found to be the best substitute to conventional diesel fuel in all aspects such as performance and emissions. Then B50 Results in reduction of Brake Thermal efficiency or NOx, HC, CO and smoke respectively while CO2 emissions increase 10.7%.

Nalgundwar et al. [11] studied blend of two bio diesel is made and various tests are performed on Diesel engine. The results for lower blend of biodiesel D90PB5JB5 (i.e. 90% diesel & 10% biodiesel) with diesel showed 4.65% average increase in brake power than diesel. There was slight reduction seen in BSFC for lower blends. Higher biodiesel blend D20JB40PB40 (i.e. 20% diesel & 80% biodiesel) indicates increase in 15% of BTE . A notable decrease in exhaust gas temperature for most of biodiesel blends was observed. There were 7.1%, 17.7% and 14.5% average reductions in CO emissions with samples D90JB5PB5, D80JB10PB10 and D70JB15PB15 (biodiesel blends containing 10%, 20% & 30% biodiesel) respectively, when compared to diesel. Lower blends of biodiesel samples D90JB5PB5 and D80JB10PB10 showed 5.3% and 9.2% average increase in NOx emissions respectively, than diesel.

Silva et al. [12] evaluated how the variation of the feedstock, blend percentage and transesterification route. affects NOx emissions. By comparing the results with turkey's test the ethyl blend contain minimum NO_x exhaust emission and palm ethyl ester blends had the best results. Also when all factors are taken into account, B20 from soybean methyl ester has the lowest emisfsions of NOx.

Ghaly et al. [13] reported the devepoment of new biodiesel production processes has been increased due to need of nontoxic and recycled fuel.

Theansuwan and Triratanasirichai et al [14] reveals that biodiesel made by transesterfication process show alike properties.

Lawrence et al.[15] revealed that prickly poppy methyl ester (PPME) is used as a blend in CI engines .The results of test are enhancement in BTE, BP nd decrement of SFC for PPME and its blends with diesel.

Shaafi et al.[16] investigated the combustion, engine performance and emission characteristics of a single cylinder, naturally aspirated, air cooled, constant speed compression ignition engine, fuelled with two modified fuel blends, B20 (Diesel soybean biodiesel) and diesel soybean biodiesel ethanol blends, with alumina as a Nano additive and the results are compared with those of neat diesel. The nano particles mixes with bio diesel blend using ultra sonicator to obtain stable suspension. The properties of B20, D80SBD15E4S1 + alumina fuel blend are changed due to the mixing of soybean biodiesel and the incorporation of the alumina Nano additives. Some of the measured properties are compared with those of neat diesel, and presented. The cylinder pressure during the combustion and the heat release rate, are higher in the D80SBD15E4S1 + alumina fuel blend, compared to neat diesel. Further, the temperature of exhausted gases was decreased in the case of the D80SBD15E4S1 + alumina fuel blend, which indicates higher temperature during prevalling dure to which higher thermal efficiency is obtained. Dure to the more O_2 content in the soybean biodiesel, and due to better mixing of the nanoparticles, reduce the CO and UBHC appreciably, though there was a small increase in NOx at full load condition.

Basha et al. [17] prepared biodiesel emulsion fuel by emulsification technique comprising of 83% of jatropha biodiesel, 15% of water, and 2% of surfactants (Span80 and Tween80) with the aid of a mechanical agitator. The prepared biodiesel emulsion fuel was mixed with the alumina nanoparticles in the mass fractions of say 25, 50, and 100 ppm with the help of an ultrasonicator. The whole investigation was carried out in a constant speed diesel engine in three phasesusingjatropha biodiesel jatropha biodiesel emulsion f uelandalumina nano particle blended jatropha biodiesel emulsion fuels. The results indicate that there is enhancement in power and decrease in harmful gases. In addition, the incorporation of nanoparticles in the biodiesel emulsion fuel has also revealed an incremental better performance and reduced emissions than that of biodiesel emulsion fuel and biodiesel.

Sajith et al. [18] carried out an extensive investigation on a diesel engine fuelled with and without cerium oxide additives, to study the performance and emission characteristics. They found that the viscosity and volatility hold direct relations with the dosing level of 20-80 ppm. The emission levels of HC and NOx are appreciably reduced with the inclusion of CeO2. To reduce the NOx and PM emission from the CI engines, emulsification techniques are adopted.

Basha et al. [19] investigated the performance and emissions of a diesel engine fuelled with biodiesel emulsion fuel incorporation of alumina nanoparticles in the mass fractions of 25, 50 and 100 ppm, with a higher concentration of water. They observed that the magnitude of NOx, and smoke emission was 870 ppm and 49% for JBDS15W100A (83% jatropha biodiesel + 2% surfactant + 15% water + 100 ppm of alumina) fuel at full load.

Sanap and Ghuge [20] In this work, the CI engine is tested using different hybrid bio diesel i.e. mixture of Cotton seed and Eucalyptus i.e. Nilgiri oil biodiesel in equal proportion as fuel. Different blends of both oils are prepared and performance and emission characteristics of C.I. engine is determined. Comparative performance study gives the best blend for the diesel engine. The results shows that engine performance when fuelled with the biodiesel are comparable to that when fuelled with petroleum diesel. B37 is found to be the best blend as it has highest Brake power and volumetric efficiency as well as higher brake thermal efficiency and less emissions as compared to the other blends.

3.0 EXPERIMENTAL SET UP

3.1 BIODIESEL PREPARATION

200 ml of methanol was added in a beaker with 3.5 gm. of potassium hydroxide (KOH). Potassium hydroxide was mixed completely methanol so that no un dissolved particles appear. One litre of vegetable oil was heated in a glass beaker at 55°C. Mixture of methanol and potassium hydroxide was then added to the hot oil with an electromagnetic rotor inside the beaker so that oil and mixture mixes completely as shown in fig. 4.2.The new mixture was allowed to be blended for 30 to 40 minutes at 55°C.

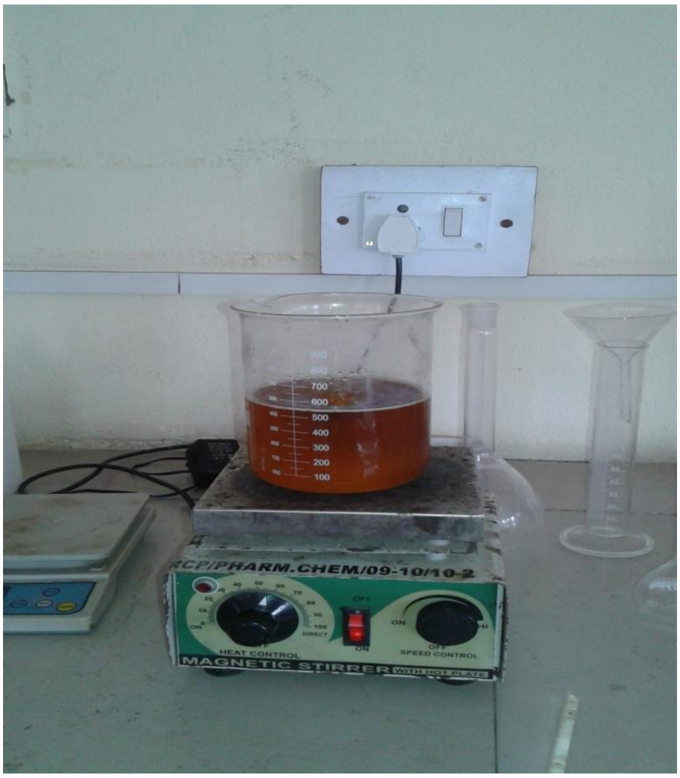

Figure 3.1 Heating of oil

After Completion of reaction mixture was poured into conical glass flask as shown in fig. 4.3.Mixture was allowed to settle down for one day so that glycerine and biodiesel separate because of gravity separation. As biodiesel is lighter than glycerine it floats on the top layer. Glycerine was removed and hot water was added to remove impurities remaining in biodiesel..

Figure 3.2 Gravity Separation

The mixture of water and biodiesel was also allowed to settle for one day so that impurities settle down with water and then water was also removed from lower layer with remaining impurities.

Figure 3.3 Cleansing of Biodiesel

3.2PREPARATION OF BIODIESEL BLENDS

The two biodiesels palm oil and soybean oil which were prepared by the Trans esterification process. The dual biodiesel blends with the diesel into different proportions as:

Blend 1-Diesel 90%, POB 10% by volume basis; Blend 2-Diesel 90%, SOB 10% by volume basis, Blend 3-Diesel 95%, POB 2.5% and SOB 2.5% by volume, Blend 4- Diesel 90%, POB 5% and SOB 5% by volume and Blend 5- Blend 4 + .5% Al_2O_3 by weight.

3.3 NANOFUEL PREPARATION

3.3.1 Nanoparticles

A nanoparticle is a microscopic particle with minimum one dimension is lower than 100 nm. Nanoparticle research is currently an area of intense scientific research, due to a wide variety of potential applications in biomedical, optical, and electronic fields.The properties of many conventional materials change when formed from nano particles. Nanoparticles used in this experiment were aluminium oxide as shown in Fig. 3.3..

Figure 3.3 Aluminium Oxide Nanoparticles

3.3.2 Surfactant

Between two liquids or a liquid and a solid for reduction of surface tension or interfacial tension compounds used are called surfactants. Surfactant utilized as a part of this experiment was span 80. Span 80 is light yellow viscose oily liquid. Span 80 is unsolvable in water but it's soluble in organic solvents. It is used as emulsifier, stabilizer, softener, anti-static agent etc. The chemical properties of Span 80 .

3.3.3 Ultrasonicator

Ultrasonic cavitation is used to disperse Nano-size particles into liquids, such as water, oil, solvents or resins. Nanofuel was prepared by mixing known weight of nanoparticles in biodiesel blend using ultrasonicator. The ultrasonicator generator changes 220V/50Hz electric supply to 20 kHz electric energy and supplies it to transducer. The barium zirconate piezoelectric vibrator makes elastic deformation at 20 kHz frequency along with alternating voltage. The control unit and mixing chamber of ultrasonicator are shown in Fig. 3.6

Figure 3.4 Control unit and Mixing chamber of Ultrasonicator

3.3.4 Preparation method of nanofuel blends

Blend 4 was taken as a base fuel to prepare Nanofuel. The maximum capacity of ultrasonicator is 250 ml so for proper mixing of nanoparticles 200 ml was taken at one time. Hence it took five turns to make one litre of Nanofuel. 200 ml of blend was weighed using precision weighing machine and .8 gm. (.5% by weight) aluminium oxide nanoparticles were added to it.1 ml of span 80 (.5% v/v) was measured using injection and was added to blend .This solution was then kept in ultrasonicator for 45 minutes at 20 kHz for proper mixing of nanoparticles in biodiesel blend.

Figure 3.5 Preparation of .5 wt. % Al_2O_3 Nanofuel

At the end of ultrasonication Nanofuel obtained was of pale yellow colour as shown in Fig. 4.10. This Process was repeated four more times for preparation of one litre of Nanofuel.

Figure 3.6 Prepared Al_2O_3 blended Nanofuel

3.4 MEASUREMENT OF THERMO PHYSICAL PROPERTIES

The properties like density and calorific value of mixed blends with diesel were determined using precision weighing machine and bomb calorimeter respectively.

3.4.1 Measurement of Calorific value

The digital bomb calorimeter is used to find out the calorific value of blending biodiesel with diesel at different proportion. For measurement of calorific value 1gm of fuel was taken with known weight of wire and thread fixed in the arrangement. This arrangement was placed in the bomb containing 1 L water. Electric spark was provided and temperature change of water was measured. By energy balance calorific value was determined.

3.4.2 DENSITY MEASUREMENT

For density measurement 200 ml of blend was taken in a beaker and was weighed using precision weighing machine as shown in Least count of this machine is .01 gm.

3.5ENGINE AND DYNAMOMETER

The Engine elected for current experimentation is a computerized Kirloskar make CI Engine as shown in Fig. 3.7 with its properties This engine can go through higher pressures faced. Therefore, this engine is selected for carrying experiments.

Figure 3.7 The Engine and Dynamometer

An absorbing dynamometer performs as a load which is driven by the prime mover which is under test. The dynamometer must be able to operate at any speed and load to any level of torque that the test requires. A dynamometer can be uitlised to determine the torque and power for the operation of a driven machine. Absorbing dynamometers are not to be confused with "inertia" dynamometers, which calculate power solely by measuring power required to accelerate a known mass drive roller and provide no variable load to the prime mover.

3.6 RATE OF FUEL CONSUMPTION MEASUREMENT

Fuel Consumption was measured using burette method.. Time taken for consumption of 5 ml of fuel was recorded using a digital stopwatch.

3.7 EXHAUST GAS ANALYZER

For measurement of CO, CO_2, NOx and Unburnt Hydrocarbons were measured using AVL digas 444 Exhaust gas analyzer. A probe connected with the instrument was inserted in the exhaust pipe and respective amounts of gases was displayed on the screen.

3.8 MATHEMATICAL EQUATIONS

Mass Flow Rate of fuel

$m_f = \rho * V / t$ kg/hr.

Brake Power

BP = *0.746 kW

Brake Specific Fuel Consumption

$BSFC = m_f / B.P$ kg/kWh

Indicated Power

$IP = FP+BP$

Brake Specific Energy Consumption

$BSEC = BSFC*C.V.$

Brake Thermal Efficiency

$\eta_{bth} = B.P / M_f * CV * 100$

Indicated Thermal Efficiency

$\eta_{ith} = I.P / M_f * C.V$

Mechanical Efficiency

$\eta_{me} = B.P / I.P * 100$

4.0 RESULTS

4.1 PERFORMANCE ANALYSIS

4.1.1 Variation of mass flow rate of fuel with brake power

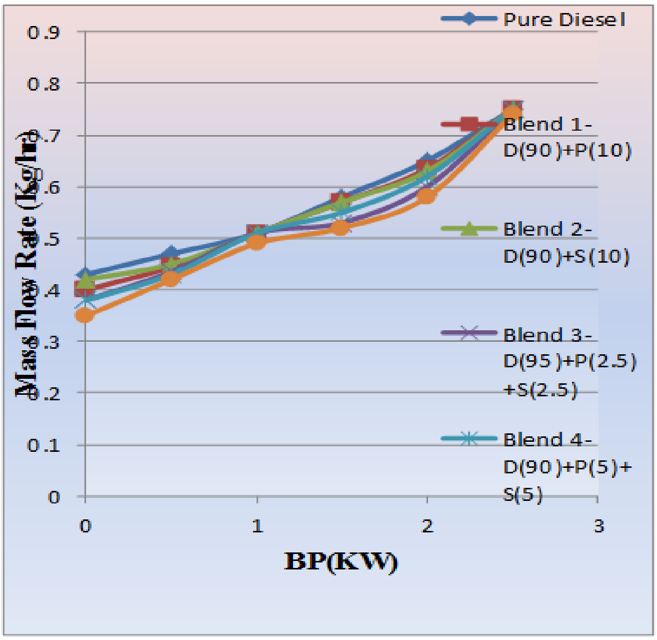

Figure 4.1 Variation of mass flow rate of fuel with brake power

Mass flow rate of fuel is the mass of fuel consumed per unit time and its variation with brake power is shown in Fig. 4.1.With increase in brake power mass flow rate of fuel increases for all the fuels. A significant decrease in mass flow rate is observed with addition of biodiesel which is proportional to the amount of biodiesel added. Mass flow rate reduction is because of better combustion with addition of biodiesel because addition of biodiesel reduces the phase stratification effect. Further reduction in mass flow rate is observed with addition of alumina nanoparticles as alumina nanoparticles acts as a catalyst for combustion to improve combustion. Mass flow rate of fuel for blend 5 has reduced by 3% in comparison to conventional fuel diesel at full load.

4.1.2 Variation of indicated power with brake power

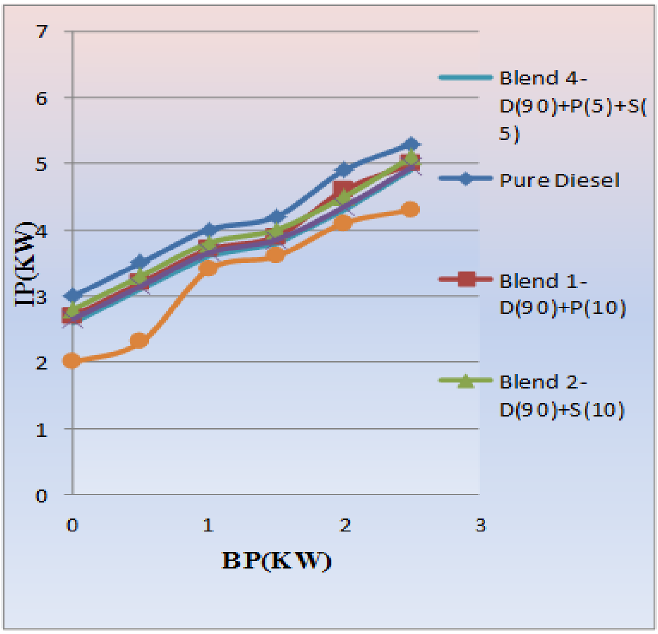

Figure 4.2 Variation of indicated power with brake power

The effect of brake power on indicated power is shown in Fig. 4.2. Indicated power is summation of brake power and friction power. Frictional power was found out from Willian's line. As brake power increases indicated power also increases linearly. At same brake power with addition of biodiesel indicated power reduces and further reduction in indicated power can be seen with addition of nanoparticles. Reduction of 18% can be seen in indicated power of blend 5 if compared to that of neat biodiesel.

4.1.3 Variation of brake specific fuel consumption with brake power

Variation of brake specific fuel consumption is shown in Fig. 4.3. Brake specific fuel consumption is rate of fuel consumption per unit brake power. As brake power increases brake specific fuel consumption for all biodiesel blends decreases and slight reduction is also seen after adding nanoparticles. As mass flow rate of fuel is lower for biodiesel blends the brake specific energy consumption is also less. Decrease in brake specific fuel consumption of blend 5 as compared to diesel fuel is 3% at full load condition.

International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 04 | Apr-2018 www.irjet.net p-ISSN: 2395-0072

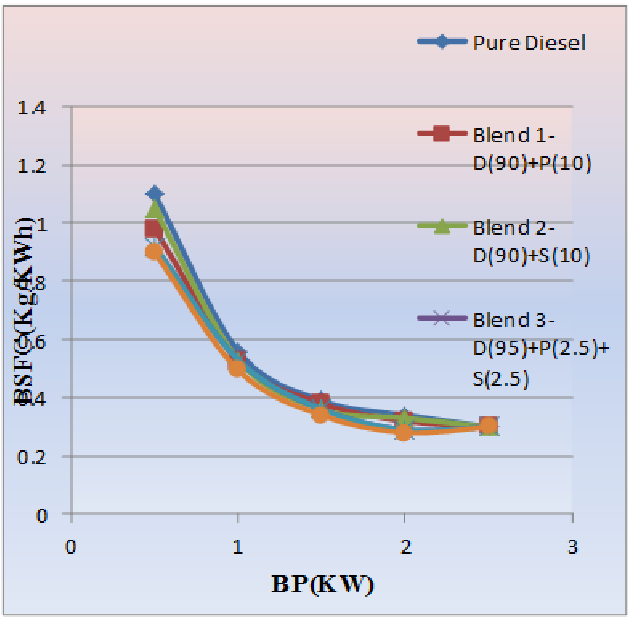

Figure 4.3 Variation of brake specific fuel consumption with brake power

4.1.4 Variation of brake specific energy consumption with brake power

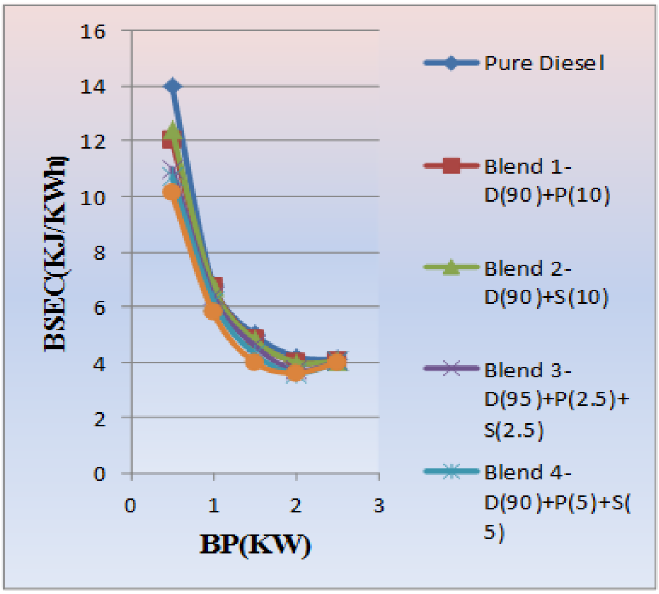

Figure 4.4 Variation of brake specific energy consumption with brake power

The effect of brake power on specific energy consumption is shown in Fig. 4.4. The specific energy consumption is energy of fuel consumed per unit brake power. It is the ratio of the product of mass fuel rate and calorific value to brake power. With addition of biodiesel, energy consumption is decreased and further reduction can be seen with addition of nanoparticles. Blend 5 has shown 7% reduction in brake specific energy consumption compared to conventional fuel diesel at full load.

4.1.5 Variation of brake thermal efficiency with brake power

The effect of brake power on brake thermal efficiency is shown in Fig. 4.5. The brake thermal efficiency is the ratio of the output power to the product of mass fuel rate and Calorific value.

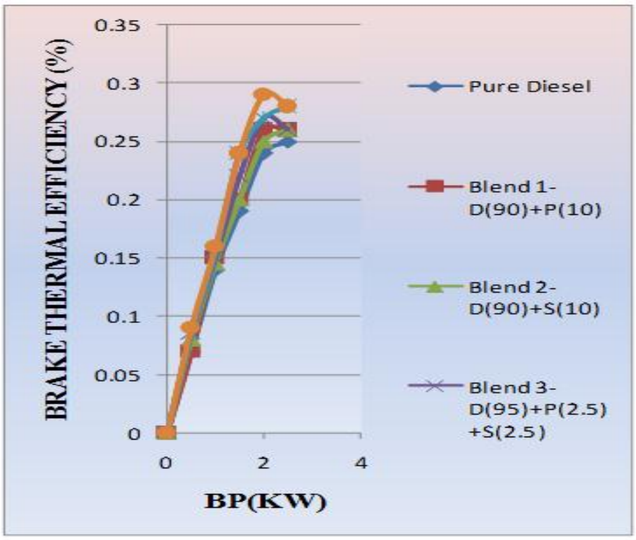

Figure 4.5 Variation of brake thermal efficiency with brake power

Brake thermal efficiency increases with increase in brake power. With addition of biodiesel brake thermal efficiency has shown significant increase and an increase can also be seen with addition of nanoparticles because of the lower heating value and mass flow rate of fuel of blends in comparison to diesel. Blend 5 has shown 7% increase in brake thermal efficiency compared to conventional fuel diesel at full load.

4.1.6Variation of mechanical efficiency with brake power

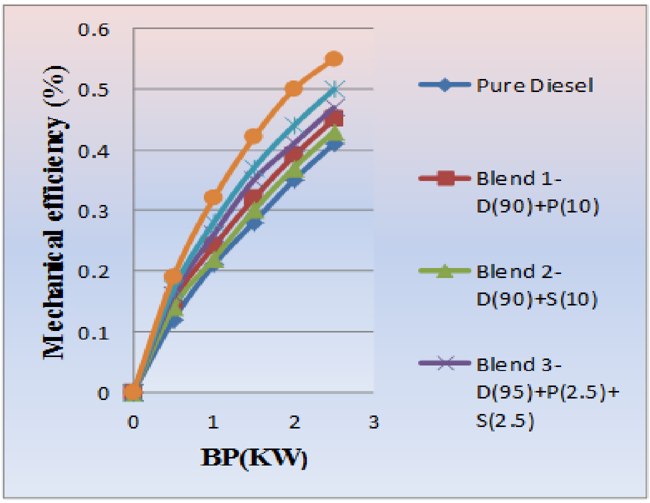

Figure 4.6 Variation of mechanical efficiency with brake power

The mechanical efficiency varies with brake power is shown in Fig. 4.6. Mechanical Efficiency is ratio of output power to input power. Mechanical efficiency increases with increasing brake power. Significant increase in mechanical efficiency is seen with addition of biodiesel and also further increase is seen after adding nanoparticles. 11% increase in mechanical efficiency is seen as compared to conventional fuel diesel. If compared with blend 4 in which nanoparticles were added mechanical efficiency has increased by 5%.

4.2 EMISSION ANALYSIS

4.2.1 Variation of Carbon monoxide emissions with load

Variation of carbon monoxide emissions with load are shown in Fig. 4.7. As biodiesels are oxygen containing compounds so emissions in blend 4 are reduced. Further reduction with addition of nanoparticles can also be seen because of oxygen present in alumina nanoparticles which enhances combustion. Blend 5 has shown 18% reduction in carbon monoxide emissions in comparison to neat biodiesel and 13% reduction in comparison to blend 4 at full load condition.

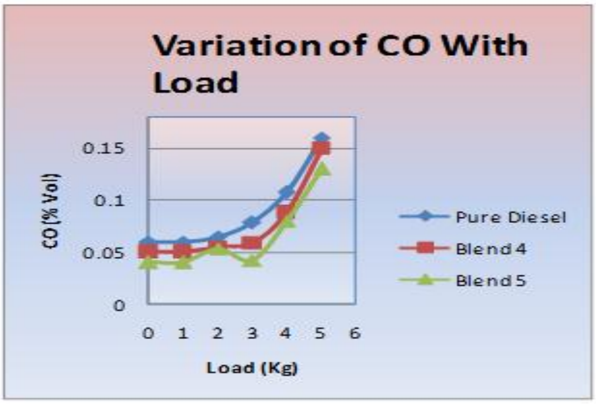

Figure 4.7 Variation of carbon monoxide with Load

4.2.2 Variation of unburnt hydrocarbons emissions with load

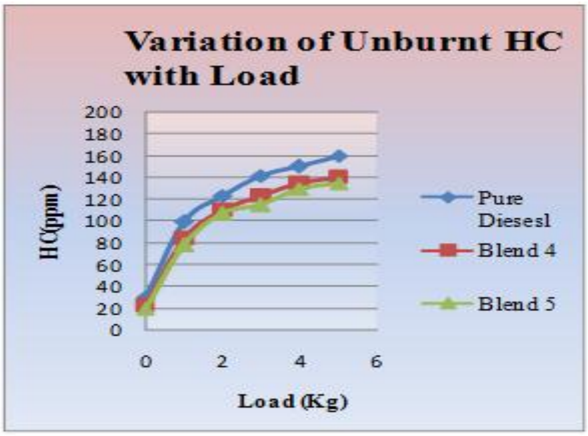

Figure 4.8Variation of unburnt hydrocarbons with Load

Variation of Unburnt hydrocarbons emissions with load is shown in Fig. 4.8. Reduction in hydrocarbon emissions can be seen with addition of biodiesel due to proper combustion because more oxygen molecules are present in biodiesel blends than conventional fuel diesel. Due to availability of oxygen, after adding nanoparticles hydrocarbon emissions reduces further. At full load blend 5 has shown 13% less emissions than conventional fuel diesel and 6% less than blend 4 of biodiesel.

4.2.3 Variation of NOx emissions with load

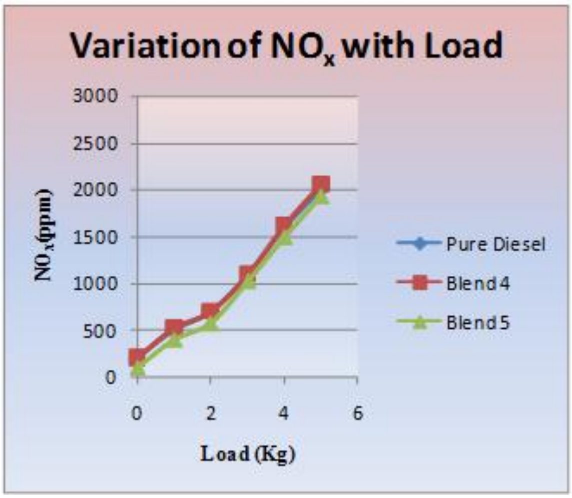

Figure 4.9 Variation of NOx with Load

Variation of NOx emissions with load can be seen in Fig 4.9. Slight increase in NOx emissions can be seen with addition of biodiesel. Oxygen content of biodiesel is an important factor in NOx formation because it causes increased local temperatures due to excess hydrocarbon oxidation, and when the oxygen levels increase, the maximum temperature during combustion increases, and the NOx formation also increases. Addition of nanoparticles also provide oxygen content but metal nanoparticles in fuel also absorbs some of the heat content due to which local temperatures do not increase and NOx emissions eventually fall down. At full load blend 5 has shown 3% reduction in NOx emissions in comparison to blend 4.

4.2.4 Variation of carbon dioxide emissions with load

Variation of carbon dioxide emissions with load is shown in Fig. 4.10. A slight increase of 1% is seen in carbon dioxide emissions with addition of biodiesel to neat diesel. As there is more oxygen available in biodiesel blend conversion of carbon monoxide to carbon dioxide will be more and same reason withstands for increase in carbon dioxide emissions with addition of alumina nanoparticles.

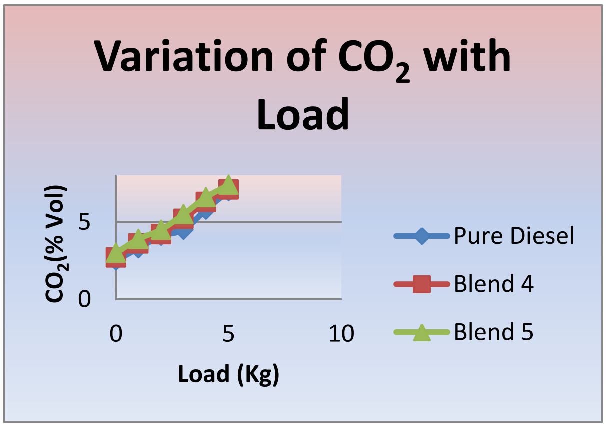

Figure 4.10Variation of carbon dioxide with Load

4.3 THERMOPHYSICAL PROPERTIES

4.3.1 Density of Blends

Densities of different blends are shown in Fig. 4.11. With addition of biodiesels density increases as they are more dense than diesel. Nanoparticle addition has also shown increase in density because they are solid particles having weight. Density of diesel, blend1, blend 2, blend 3, blend 4 and blend 5 is 831, 839,849,841,843 and 845 respectively.

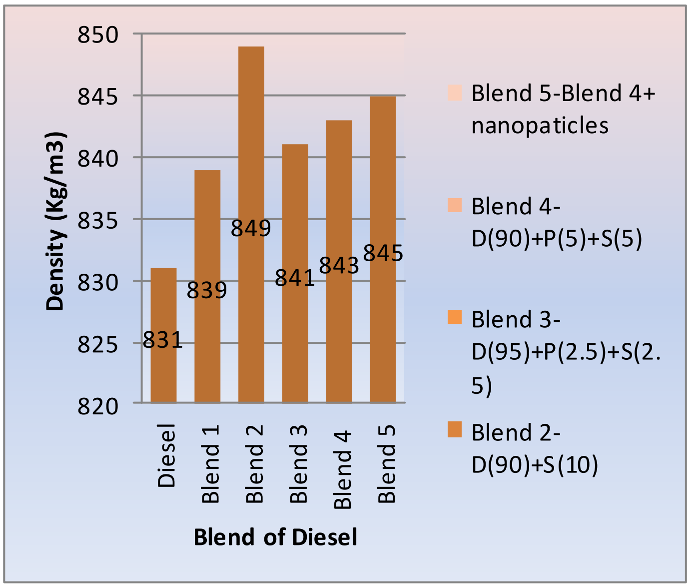

Figure 4.11 Density of biodiesel blends

4.3.2 Calorific value of blends

Calorific value of different blends are shown in Fig. 4.12. Biodiesels have lower calorific value than diesel. When blending is done calorific value also reduces for blends in proportion to amount of biodiesel added. After adding nanoparticles a slight increase in calorific value was observed. Calorific value of Diesel, blend 1, blend 2, blend 3, blend 4, blend 5 are 44620, 43600, 43650, 43180, 42350 and 42370 respectively.

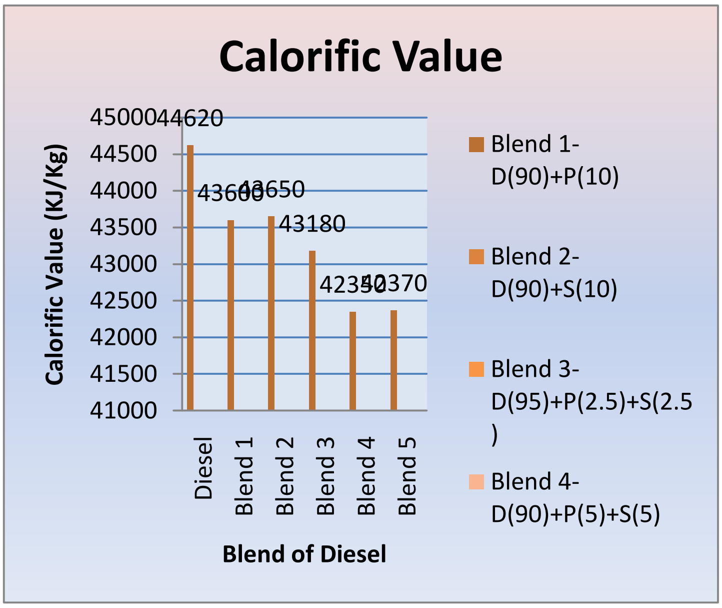

Figure 4.12 Calorific value of biodiesel blends

5.0 CONCLUSIONS

The results that came out of this study are very encouraging and reported in detail in previous section. Some of the salient results are summarized below.

- Mass flow rate of biodiesel blends are found to be lower than that of conventional fuel diesel and brake specific fuel consumption also follows the same trend.
- As the amount of biodiesel in blends increased indicated power decreased at same brake power and indicated power is minimum for alumina nanoparticles added blend.
- Brake specific energy consumption decreases with increasing break power.
- Nanofuel blend has reduction in CO and UBHC emissions than conventional fuel diesel and carbon dioxide emissions increased slightly with addition of biodiesels and nanoparticles.
- NOx emissions for biodiesel blends were slightly higher than conventional fuel. Whereas alumina nanoparticles reduced NOx emissions.

6.0REFERENCES

[1] O. M. Ali, R. Mamat, N. R. Abdullah and A. A. Abdullah, “Investigation of Blended Palm Biodiesel-Diesel Fuel Properties with Oxygenated Additive” ARPN Journal of Engineering and Applied Sciences,2016 v. 11, pp. 5289-5293.

[2] S. Ingle,V. Nandedkar,M. Nagarhalli, "Prediction of Performance and Emission of Palm oil Biodiesel in Diesel Engine" IOSR-JMCE, pp. 16-20.

[3] X. Liu, H. He, Y. Wang,S. Zhu,X. Piao, "Transesterification of soybean oil to biodiesel using CaO as a solid base catalyst" Fuel, 2008 v. 87, pp. 216-221.

[4] D.Y.C. Leung, X. Wu, M.K.H. Leung, "A review on biodiesel production using catalyzed transesterification" Applied Energy, 2010 v. 87, pp. 1083-1095.

[5] D.H. Qi, L.M. Geng, H. Chen, Y.Z.H. Bian, J. Liu, X.CH. Ren, "Combustion and performance evaluation of a diesel engine fuelled with biodiesel produced from soybean crude oil", Renewable energy, 2009 v. 34, pp. 2706-2713.

[6] Y.C. Lin, W.J. Lee, H.C. Hou, "PAH emissions and energy efficiency of palm-biodiesel blends fueled on diesel generator", Atmospheric Environment, 2006 v. 40, pp. 3930-3940.

[7] A.K. Agarwal, "Biofuels (alcohols and biodiesel) applications as fuels for internal combustion engines", Progress in energy and combustion science, 2007 v. 33, pp. 233-271.

[8] A.N. Alkabbashi,Md Z. Alam, M.E.S. Mirghani and A.M.A. Al-Fusaiel, "Biodiesel Production from crude palm oil by Transesterification process", Journal of applied sciences, 2009 v. 9, pp. 3166-3170.

[9] J. Song, J. Yao, J. Lv and C. Zhu, "Experimental Study on A Diesel Engine Fueled with Soybean Biodiesel", Research Journal of Applied Sciences Engineering and Technology, 2013 v. 16, pp. 3060-3064.

[10] P. Dubey, R. Gupta, "Effects of dual bio-fuel (Jatropha biodiesel and turpentine oil) on a single cylinder naturally aspirated diesel engine without EGR", Applied Thermal Engineering, 2017 v. 115, pp. 1137-1147.

[11] A. Nalgundwar, B. Paul, S.K. Sharma, "Comparison of performance and emissions characteristics of DI CI engine fueled with dual biodiesel blends of palm and jatropha", Fuel, 2016 v. 173, pp. 172-179.

[12] M.A.V. da Silva, B.L.G. Ferreira, L.G. da C. Marques, A.L.S. Murta, M.A.V. de Freitas, "Comparative study of NOx emissions of biodiesel-diesel blends from soybean, palm and waste frying oils using methyl and ethyl transesterification routes",Fuel, 2017 v. 194, pp. 144-156.

[13] A.E Ghaly, D. Dave, M. Brooks, "Production of biodiesel by enzymatic transesterification", American Journal of Biochemical and Biotechnology, 2010 v. 6, pp. 54–76.

[14] W. Theansuwan, K. Triratanasirichai, "The biodiesel production from roast Thai sausage oil by transesterification reaction", American Journal of Engineering and Applied Sciences, 2011 v. 4, pp. 130–132.

[15] P. Lawrence, P.Mathews, B. Deepanraj,"The effect of prickly poppy methyl ester blends on CI engine performance and emission characteristics", American Journal of Environment Sciences, 2011 v. 7, pp. 145–149.

[16] T. Shaafi, R. Velraj, "Influence of alumina nanoparticles, ethanol and isopropanol blend as additive with diesel soybean biodiesel blend fuel: Combustion, engine performance and emissions", Renewable energy, 2015 v. 80, pp. 655-663.

[17] J. S. Basha, R.B. Anand, "Role of nanoadditive blended biodiesel emulsion fuel on the working characteristics of a diesel engine", Journal of Renewable and Sustainable Energy, 2011 v. 3, issue 2.

[18] V. Sajith, C.B. Sobhan, G.P. Peterson, "Experimental investigations on the effects of cerium oxide nanoparticle fuel additives on biodiesel." Advance Mechanical Engineering, 2010 v. 36, pp. 1-16.

[19] J.S. Basha, R.B. Anand, "Role of nano additive blended biodiesel emulsion fuel on the working characteristics of a diesel engine." Journal of Renewable and Sustainable Energy, 2011 v. 3, pp. 1-17.

[20]. D. Sanap, S.N.C Ghuge.,"Performance Evaluation of a Diesel Engine Fuelled with Blends of Hybrid Biodiesel", IERJ, 2016, pp.1162-1168.