Impact of Coconut Water Emulsion Fuel in a CI Engine

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ABSTRACT
In transportation sector, there are two primary justifications for using alternative fuels. One is to lessen our reliance on petroleum fuel, the other one is reduction of emissions from on-road cars. In diesel engine cars, biodiesel has been demonstrated to cut down the exhaust emissions. Particular attention should be paid to this in inner-city locations where rigorous environmental rules, such as EURO standards, are in effect. The fatty acid composition of biodiesel fuels was found to have a considerable impact on emissions in the literature. The coconut oil can be utilised to enhance the properties of coconut biodiesel because it has a greater cetane value and a lower iodine value. So, the purpose of the current experimental analysis was to examine the effects of mixing various amounts of coconut biofuels with water. To increase the uniqueness and dependability of the research, experiments were conducted. The study made use of a Kirloskar single-cylinder diesel engine (Model TV-1). Three different mixtures of the coconut oil and water were created to form the emulsion. The three separate blends, DCW10, DCW20, and DCW30, were created by combining Coconut Oil and Water Emulsion in various amounts viz. 10%, 20%, and 30%, respectively with Diesel fuel. On the basis of comparison under various loads operating situations, ***performance and emission characteristics results were examined*** *to comprehend the behavior of the aforementioned biodiesel blends. From the result analysis, it is concluded that the biodiesel of coconut oil and water blends reduces emissions from the diesel engine, but simultaneously it affects the performance parameters of the engine.*

Keywords: - CI Engine, Coconut Oil, Water Emulsion

I LITERATURE REVIEW

Large number of papers is reviewed and some of them discussed here to identify the research gap of the research work. **Badrana O., Emeish S., et al**. tested two micro-emulsions that contained 3.5 and 7% by volume of distilled water dispersed in diesel fuel together with the required surfactants/cosurfactants, namely Crillet-6/Span-20. Similar water micelles size distribution with an average dimension of 18 nm were present in both examined micro-emulsions. The investigation's findings showed that burning the tested water-fuel micro-emulsion in the AVL research engine reduced soot particle emissions even by 50% as compared to burning diesel fuel [1]. A rapid compression machine and a Komatsu direct-injection heavy-duty diesel engine with a high pressure common rail fuel injection system were used in an experiment **by Taisuke M., Kazutaka H., et al.** In order to assess the impact of water vapour dispersion on cylinder temperature and NOX generation, computational fluid dynamics simulations of the injection and combustion processes were also used to validate the hypothesis. According to research, when the timing of the water injection is correct, the combustion speed is slower and the cylinder temperature is lower than it would be with normal diesel combustion. As a result, emissions of NOX are drastically reduced, and soot emissions are also reduced. The computer outcomes offer thorough information on the mixing process and are consistent with experimental findings [2].

Koc B. & Abdullah M. in their experimental study discovered that as the water concentration in biodiesel nanoemulsions went from 10% to 15%, the rate of NOx reduction was faster than the rate of CO increase. The effects of raising the water concentration in biodiesel emulsions on lowering NOx and soot emissions from a 4-cylinder diesel engine were well supported by these data. A viable alternate strategy for decreasing harmful emissions from diesel engines without considerable engine changes is the use of emulsified biodiesel fuel [3]. In their investigation, **Armas O., Ballesteros R. et al.** discovered that the presence of DEE and water in the prepared fuels increased both performance and emission properties. Conclusion: By adding DEE and water, respectively, air pollution from the transportation and industrial sectors may be greatly reduced [4]. In an experimental study, **Wamankar A.K. and Murugan S** discovered that the engine could operate with all four emulsions without requiring any engine modifications. The findings showed that as compared to diesel running at full load, emulsions had a longer igniting delay of roughly 1-3°CA. While using the emulsions, the brake specific energy consumption (BSEC) was roughly 0.8 to 25 percent greater than when using diesel at maximum load. The outcomes also showed that, at full load, all of the emulsions reduced NO emissions by roughly 16–42% [5]. In their study, **López J.J. and Novella R.** validated the findings about the appropriateness of cutting-edge computational CFD modeling techniques for simulating the intricate processes connected to dual-fuel sprays. Furthermore, the significant advantages offered by dual-fuel mixes are validated, especially when taking into account the anticipated decrease in pollutant emissions as a result of the variations in flame structure seen [6]. By using plain or B50 blends of the test biodiesel fuels, **Ismail H.M. et al.** discovered that the most substantial reduction in soot level is attained at high load operation, while the largest NOx reduction is observed under low load conditions. The optimal operating situation for biodiesel use to simultaneously reduce soot and NOx is at midload with an engine speed of 2000 rev/min [7].

Saad and Bari S I looked into how guide vanes placed in front of the intake runner of a compression ignition (CI) engine running on biodiesel affected their research. While using biodiesel, the vane model demonstrated the greatest advantages since it decreased brake-specific fuel consumption (BSFC), carbon monoxide (CO), and hydrocarbons (HC), as well as improving engine efficiency [8]. In their investigation, **Bari S., et al**. discovered that utilising fake flax biodiesel instead of diesel fuel reduced engine power and torque levels. The performance of the engine was further diminished by butane addition to biodiesel and diesel. When biodiesel was utilised instead of diesel fuel, CO2 emissions were reduced. Also, compared to diesel fuel, the CO2 emissions of diesel-biodiesel fuel blends were improved by butane. False flax biodiesel reduced CO emissions compared to diesel fuel, while butane addition to diesel-biodiesel blends improved CO emissions [9]. In their research**, Li J., Yang W.M., An H., and Zhao** discovered that A-Start of Injection (SOI) may provide greater control over combustion start, combustion phasing, and other factors while adjusting gasoline ratio. Regarding the production of emissions, adding more gasoline might result in more homogenous combustion, which would concurrently reduce NOx and soot emissions. However, the soot generation would rise when C-SOI and A-SOI were employed, especially when more biodiesel was injected. The specified spray angle for C-SOI is 78° [10]. According to **Hadi T., Shahram K., Soheila M., and Samad J**., regardless of the fuel type, 2000 rpm displays generally superior IP (indicated power), IMEP (indicated mean effective pressure), chemical availability, and thermo-mechanical availability. A different pattern may be seen in the mean irreversibility rate for the PMC (pre-mixed combustion) and MCC (mixing controlled combustion) combustion phases [11]. A CFD analysis conducted by **Harch C.A., et al.** revealed that 5% and 10% BLS biodiesel performed best for various injection timings and compression ratios. According to the simulation results, B10 biodiesel generally offers higher performance and efficiency and much lower engine emissions. As opposed to petroleum diesel, the B5 blend offers somewhat better performance and efficiency as well as slightly lower emissions [12]. **Yang W.M. and Li J.** discovered that the combustion chamber's narrow entrance could produce a powerful squish, especially at high engine speed, improving the mixing of air and fuel. Also, according to the simulation results, Omega Combustion Chamber (OCC) is preferable at high engine speed compared to Shallow Combustion Chamber (SCC) at low engine speed. As a result, at low engine speeds, SCC will produce considerably more NO than the other two piston bowl types. Similar to this, the high performance of OCC bowl shape may cause a high NO emission under conditions of high engine speed [13]. Six reaction mechanisms were used in the model **by Chen Z., Ke L., and Zongxuan** to characterize the chemical kinetics of various fuels under varied piston trajectories and to show the free piston engine's capacity for multi-fuel combustion. In terms of the in-cylinder gas temperature trace, the indicated output work, heat loss, and the process of radical species accumulation, analysis of the simulation data exposes the effects of the piston trajectory on the combustion [14]. **Khanbabazadeh M. and Jafarmadar S** demonstrated that combustion and emission behaviors' are significantly influenced by chamber shape. Also, they demonstrated that the high swirl, tumble, and low temperature combustion in the reentrant combustion chamber resulted in a reduction in soot and NOx emissions. Also, it is well known that the depth of the chamber affects the generation of NOx and soot [15]. **Hakan F.O., Varol Y., et al**. In their investigation, the conventional type and roof type combustion chambers' flow and heat transmission were numerically examined. In order to study the flow and heat transfer parameters during the intake stroke, a dynamic mesh model was used. For the turbulence solution equations, the k- turbulence model was selected. Using the finite volume method and the commercial programme FLUENT-12.0, the governing equations were solved. The inner velocity profile and temperature distribution of the results were presented, along with a comparison to both types of chambers [16]. Based on the crank angle degree parameters, simulation work by **Semin, Rosli A.B.,** and colleagues showed the diesel engine intake and exhaust valves rising and moving. As a result of this visualisation and simulation, the diesel engine model's air fluid flow and intake and exhaust valve lift movements are visible [17]. **Abdul G.C.P. et al**. discovered that for piston geometries with high bowl to piston diameter ratios as opposed to low diameter ratios, variation in initial swirl impacts in-cylinder pressure, temperature, and the emission parameters more strongly. Also, an optimization is done on the numerous cases findings for different beginning swirl and diameter ratios. The best emission and performance parameters are observed in the two examples with 70% diameter ratio and 0.5 beginning swirl ratio and 55% diameter ratio and 2.5 initial swirl ratio [18]. A mathematical model of spray combustion in direct-injection diesel engines was created by **Roberto F., Daniela M., et al.** to forecast engine performance, thermal efficiency, and pollutant emissions. The injected gasoline spray was broken up into several little packets. The temperatures of the gas and fuel droplets as well as the fuel evaporated mass in each package were calculated

[19]. The role of mass transfer in the creation of the two most significant engine emissions, unburned HC and CO, was studied by **Komninos N.P**. The findings show that mass transfer during combustion and expansion has a major impact on the production of both unburned HC and CO emissions, and as a result, this aspect of the closed engine cycle—compression, combustion, and expansion—must be taken into consideration [20].

Mustafa Canakci et al. in their study, discovered that biodiesel is a non-toxic, biodegradable, and renewable alternative fuel that requires little to no modification to operate in diesel engines. Although pricey, biodiesel would be more affordable if it could be made from cheap oils (restaurant waste, frying oils, and animal fats). These inexpensive feedstocks have a harder time processing because of their high quantities of free fatty acids. In earlier articles, a procedure for turning these feedstocks into fuel-grade biodiesel was devised. This study's goal was to look into how high-free-fatty acid feedstocks used to make biodiesel affected engine performance and emissions. Yellow grease made from animal fat and containing 9% free fatty acids and soybean oil were used to make two different types of biodiesel. The neat fuels and their 20% mixes with No. 2 diesel fuel were investigated in a four-cylinder turbocharged diesel engine under steady-state running conditions. Although the emissions of particulates, carbon monoxide, and unburned hydrocarbons were significantly reduced by both biodiesel fuels, the nitrogen oxides rose by 11% and 13% for yellow grease methyl ester and soybean oil methyl ester, respectively. Energy from the biodiesel fuel was converted to work at a rate that was equivalent to that of diesel fuel [21]. In the work **by Magín Lapuerta et al.** waste cooking oil methyl and ethyl esters are utilised as fuels in diesel engines This experiment was carried out to assess the diesel engine's output and emissions. The outcome reveals a small rise in fuel use, reduction in emissions of smoke, hydrocarbons, and particulates, but a rise in NOx emissions when compared to diesel [22]. According to **Zafer Utlu et al. i**n this study, waste frying oil (WFO) methyl ester is used as an experimental material, For the purpose of producing methyl ester from this kind of oil; a reactor was created and set up. The methyl ester's physical and chemical characteristics were studied in the lab. A direct-injection, turbocharged, four-cylinder diesel engine was used to test the methyl ester. The collected data was contrasted with No. 2 diesel fuel. The findings of engine tests used to compare torque and power measurements as well as specific fuel consumptions are very similar. Moreover, waste frying oil has fewer emissions than No. 2 diesel fuel, including CO, CO2, NOx, and smoke darkening [23]. **Gomez et al.** studied the performance and exhaust emission characteristics of a Toyota van with an IDI, naturally aspirated diesel engine that runs on vegetable-based waste cooking oil methyl ester. When compared to the No. 2 diesel fuel, the waste vegetable oil methyl ester created much less smoke opacity and reduced CO, CO2, and SO2 values, but had higher O2, NO2, and NO levels. With the two fuels, the power values were comparable [24]. **A. P. Roskilly et al.** carried out an experimental research of the use of biodiesel (recycled cooking fat and vegetable oil) on small marine craft diesel engines. The Perkins 404C-22 (Marinised) in Boat No. 1 (Fair Countess) and the Nanni Diesel 3.100HE in Boat No. 2 both underwent testing (Aimee 2). The test findings demonstrate that using biodiesel as fuel lowered NOx emissions. When the engines used biodiesel at higher loads, the CO emissions were found to be lower [25]. **Bhaskar Mazumdar et al.** in their experimental research, used waste cooking oil collected from a restaurant to manufacture biodiesel through a transesterification process and evaluated the chemical kinetics of biodiesel synthesis. Several ratios of biodiesel to petroleum diesel were used. Using baseline data from petroleum diesel, the blends' engine performance, emissions, and combustion parameters were assessed in a four-stroke, four-cylinder, indirect injection transportation engine. It has been noted that the mass emission of different regulated pollutant species from biodiesel blends is comparable to that of standard petroleum diesel. When biodiesel concentrations in blends grew, nitrogen oxide (NOx) emissions climbed and carbon monoxide (CO) emissions declined. When compared to petroleum diesel, biodiesel blends were shown to have superior brake thermal efficiency in all cases. All biodiesel blends were shown to have lower brake specific fuel consumption (bsfc) and brake specific energy consumption than petroleum diesel, with B20 having the lowest values. In this study, a diesel engine is powered by waste vegetable biodiesel. In this experiment, fuel containing 50% biodiesel and 50% diesel was utilised to assess the engine's properties, including injection pressure and combustion. Blending biodiesel reduces production and torque. Moreover, it provides reduced peak combustion pressures and lower auto ignition delays. Pressure and heat release traces alter as a result of pressure wave propagation [26]. In one study **by Gerhard Knothe et al.**, the fatty acid profile of utilised frying oils from 16 local restaurants was compared to the fatty acid profile of the oil or fat before usage. Gas chromatography and proton nuclear magnetic resonance spectroscopy were used to evaluate the fatty acid profiles. The samples' acid value and dynamic viscosity were also calculated in addition to their fatty acid composition. Due to some samples' non-Newtonian behaviour, dynamic viscosity was calculated. The findings show that oils and fats increase in saturation to variable degrees when used for cooking or frying, with the amount of these changes ranging from sample to sample, i.e., utilised frying oil samples have a highly unpredictable composition. The samples under investigation had acid value and viscosity, both of which regularly and randomly increased with use. There is minimal consistency of used cooking oil obtained from the same supplier, according to multiple independent samples taken from the same eateries. The potential fuel qualities of biodiesel made from these leftover frying oils are examined in light of these findings [27]. According to **Hamad M. Algasim et al** in their study, biodiesel is made from used vegetable oil utilising the Fuel Pod 2TM method,. Methanol and sodium hydroxide were the catalysts employed in chemistry. Biodiesel made about 87% of the product, with the remainder being glycerin and soap. The cost of producing biodiesel was assessed in light of factors such as chemical costs, operating expenses, waste oil collection costs, etc. The cost of biodiesel was discovered to be roughly 60 pence per litre, which is less than half the cost of conventional diesel. The effects of petro diesel/biodiesel mixes on the functionality and emissions of the diesel engine were studied using a Ford Puma 2.4 litre diesel engine. Three blends, B10 (10% biodiesel and 90% petro diesel), B15, and B20 were tried in addition to petro diesel and biodiesel (B100) fuels. Engine load levels ranged from 25, 50, 75, and 100% full. The engine's revs ranged from 1500 to 2200 to 2600 to 3000 to 3300. Engine torque, fuel consumption, and emissions were assessed under these circumstances. As a result, performance metrics like engine power, specific fuel consumption, and engine efficiency were assessed. Total unburned hydrocarbons (THC), carbon dioxide (CO_2), carbon monoxide (CO), and nitric oxides were among the exhaust emissions that were being measured (NOx) [28]. **Abuhabaya et al .'s** research was targeted to determine whether using waste and vegetable oils as an alternative to or addition to regular diesel fuel was feasible. Using a commercially available "fuel pod," the transesterification process was employed to create bio-diesel oil from rapeseed, sunflower, and spent cooking oil. The characteristics of the base oils were first assessed against diesel and then measured again following the conversion. The fuels were then put to the test utilising a cutting-edge four-cylinder compression ignition engine on a steady state engine test apparatus. During the transesterification procedure, a noticeable increase in viscosity was seen in the waste vegetable oils (WVO). Due to the WVO's reduced viscosity, both the specific fuel consumption and exhaust gas emissions were decreased. With biodiesel, the engine's thermal efficiency might be considered acceptable. It has been determined from the characteristics and engine test results that biodiesel from WVO can replace diesel without an engine modification or fuel preheating. Only small fleet operators may utilise the alternative fuel since sustainability constraints prevent widespread use [29]. **Rakopoulos C.D. et al** investigated in a fully instrumented, six-cylinder, turbocharged and after-cooled, direct injection (DI), Mercedes-Benz mini-bus diesel engine installed at the author's laboratory. The experiment was to evaluate the use of sunflower and cotton seed oil methyl esters (bio-diesels) of Greek origin as supplements in the diesel fuel at blend ratios of 10/90 and 20/80. The results demonstrate that using the aforementioned fuel blends with the engine running at two speeds and three loads lowered the smoke density. The amount of reduction increases as the percentage of biodiesel in the blend increases. When compared to those of neat diesel fuel, the NOx emissions were somewhat higher with all biodiesel blends; this rise was greater the higher percentage of biodiesel in the mix. By using only biodiesel fuel, the CO emissions were lowered, and the amount of biodiesel in the blend that was cut the CO emissions the most. Sunflower or cottonseed oil biodiesel blends produced engine performance that was comparable to that of clean diesel fuel, with approximately identical brake thermal efficiency and high brake specific fuel consumption [30].

II CONCLUSION FROM THE LITERATURE SURVEY

(a) A number of researchers have been attempting to use vegetable oils such sunflower, peanut, soybean, rapeseed and palm oil, as well as cottonseed and linseed, as an alternative fuel for diesel engines in recent years. It has been extensively researched in the literature; several studies have been conducted on the use of biodiesel and its blends in engines. It's also clear that single biodiesel provides acceptable engine performance and emissions characteristics for internal combustion engines. Experiments with the mixing of diesel and blend of water with biodiesel (Coconut oil) have been undertaken very sparingly.

(b) A large number of research papers were reviewed to find the objective for the present research work. Most of the research papers were based on the biodiesel which comprises the blends of biofuels with diesel fuel in varying proportion of biofuels. The literature survey reported that the improvement in combustion and performance parameters by using biodiesel, and it also affects emissions parameters by compromising with combustion and performance characteristics. By reviewing the above literature survey, Research gap is defined in terms of use of biofuels and diesel fuel.

(c) Although, researchers have worked with water and diesel blend with many biofuels, but no work was performed experimentally by using blend of Coconut oil and Water with diesel fuel in different proportions. Hence, the present research will be aimed to investigate the effects of varying quantity of Coconut biofuels with different proportions of water. Coconut –Water blends will be mixed with diesel fuel to understand the behavior of blends on Combustion, Performance and Emission Characteristics inside the combustion chamber.

(d) On the basis of experimentally verified performance and emission characteristics parameters, the effect of biodiesel made from blend of Coconut oil and Water with diesel fuel in different proportions will be studied.

III MATERIALS & METHOD

(a) Introduction

Emissions testing and biodiesel manufacturing have both been the subject of extensive study. Biodiesel research has focused toward making it more economically viable by lowering production costs and boosting the energy yields from various feed stocks, such as corn and at the same time lowering the emissions. When it comes to better understanding how these fuels operate in all diesel applications, research has been inadequate. A single-cylinder diesel engine will be used in this study to test the usefulness of biodiesel. So our primary goal is to conduct engine testing in order to analyze the performance and emissions. The testing was done at varied loads and at constant speed without any engine change in this study. The influence of various blends on the brake thermal efficiency, and the brake specific fuel consumption was observed and was noted. This chapter explains the experimental set-up utilised to meet the goals.

Engine testing is carried out in accordance with the aforementioned matrix for each fuel blend and load. Biodiesel blends and pure diesel fuel have been tested under varying loads, and the results will be recorded as per below parameters.

(i) Brake Specific Fuel Consumption (BSFC)

(ii) Brake Thermal Efficiency (BTE)

Exhaust emissions, such as Carbon monoxide (CO), Hydrocarbon (HC) and Nitrogen oxide (NOx), have been measured for various Coconut oil-water mixes and pure diesel under varied driving conditions. Unburned Hydrocarbon (HC) and Carbon monoxide (CO) are byproducts of incomplete combustion, but Oxides of Nitrogen (NOx) are formed at extremely high temperatures and is therefore more hazardous.

(b) Emission Measurement System - An exhaust gas analyzer is part of the emission measuring system, which measures the composition of exhaust gas. CO2, CO, NOx, HC, and O2 are all measured by the exhaust gas analyzer, which is a type of gas chromatograph that is used to analyse exhaust gas (O2). Figure 3.8 shows a photograph of the emission measurement equipment assembled for the experiment.

(c) Transesterification - Engine performance issues, such as carbon deposits and lubricating oil pollution, remain despite the use of oils and other solvents and micro emulsions of vegetable oils to lower the viscosity. Biodiesel fuel yields more biogasoline during pyrolysis than biogasoline does. Biodiesel is produced primarily through transesterification. Conversion from one ester to another, as the name says. Alcoholysis refers to the transesterification reaction between the initial ester and alcohol. By combining the reactants, the transesterification is an equilibrium reaction and the transformation takes place. Although the adjustment of the equilibrium is speed up greatly by the presence of a catalyst (usually a strong acid or base), in order to get a high amount of the ester, a lot of alcohol must be utilised. Transesterification is illustrated in Figure 1.

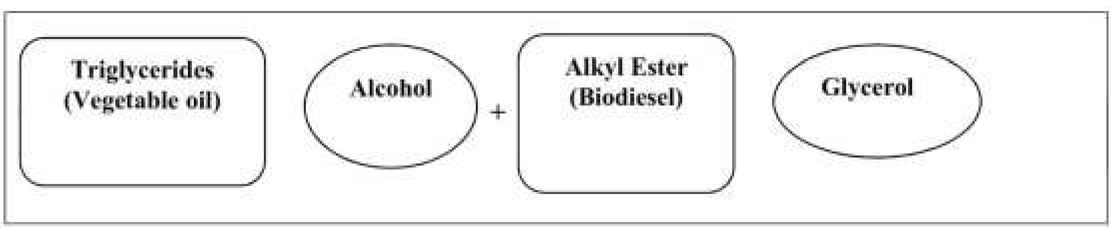

Fig. 1 Basic Transesterification Reaction

Typically, biodiesel is made from methanol or ethanol, both of which are types of alcohol. Transesterification can be catalysed in either a base or an acid environment. Acid catalysis is faster than alkali catalysis in homogeneous catalysis (sodium or potassium hydroxide or the corresponding alkoxides).

IV RESULTS AND DISCUSSIONS

Results are classified as Engine Performance Parameter and Engine Emission Parameter for various fuel Blends such as Diesel, DCW10, DCW20, and DCW30 at various loads.

(a) Engine Performance Parameters

(i) Brake Specific Fuel Consumption (BSFC) - The fuel flow rate per unit of power output is used to define Brake Specific fuel Consumption (BSFC). The engine's ability to produce work with the fuel it receives is assessed using this parameter. Because the engine uses less fuel to provide same output, a lower BSFC number is preferable. For comparative fuel testing, this is one of the most critical parameter to monitor.

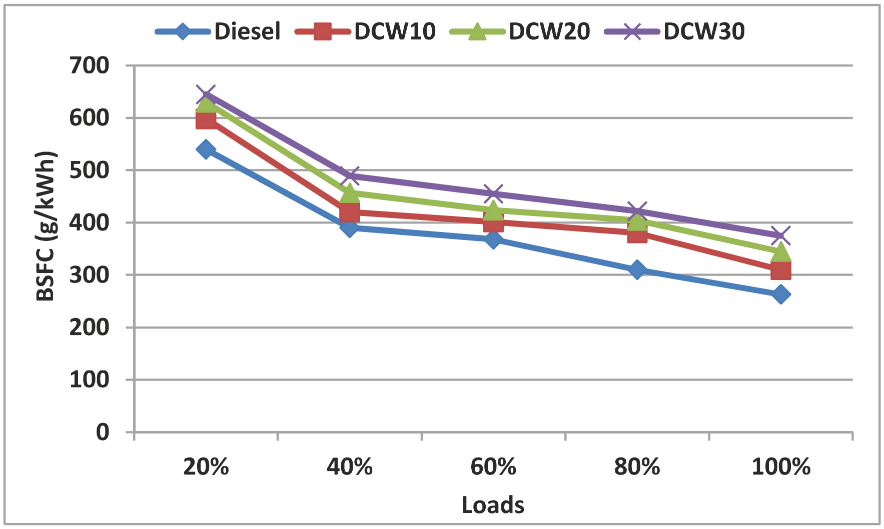

Fig. 2 Variation of Brake Specific Fuel Consumption at various Engine Loads

It can be seen from above figure 2 that BSFC is decreasing from 20% load to 100% load. But with respect to variation from Diesel to DCW30 it is increasing.

(iii) Observation: -

- The fuel flow rate per unit of power output is termed as the brake specific fuel consumption (BSFC). Hence, BSFC-is the amount of fuel consumption per unit of power produced by the engine in one hour.
- When the amount of Water in the blend increases the Calorific Value of the fuel decreases. So, BSFC is increasing accordingly.
- BSFC decreases with increase in load- Due to increase in total energy released i.e. the rate of increase in brake power is much more than that of fuel consumption.

(b) Brake Thermal Efficiency - Fuel injection mass flow rate multiplied by the lower calorific value yields the fuel energy input. Thermal efficiency is the ratio of power production to fuel energy input. Brake specific energy consumption is thus the inverse of thermal efficiency. Because experimental engine studies commonly uses braking power to determine thermal efficiency, the efficiency discovered is truly brake-specific. Biodiesel blends and pure diesel brake thermal efficiency is illustrated in the figures for varied loads. There is some evidence to suggest that biodiesel blends have a brake thermal efficiency somewhat below that of normal diesel under all loads.

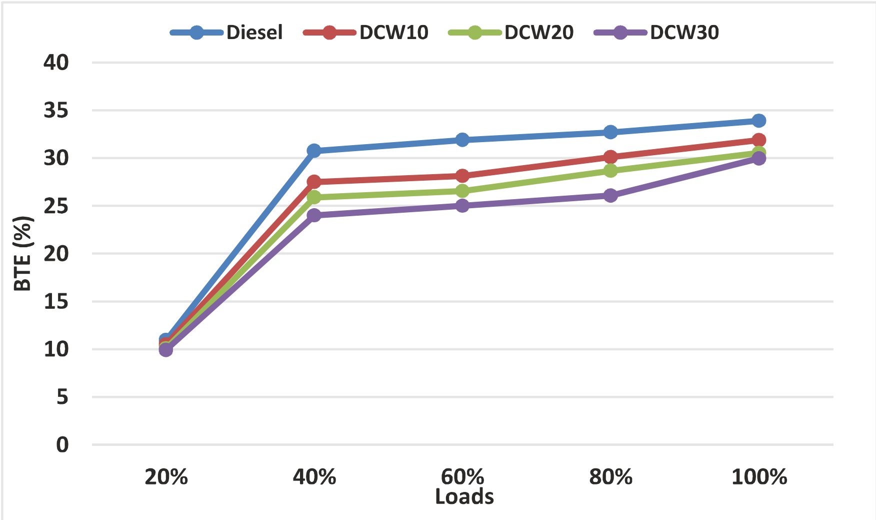

Fig. 3 Variation of Brake Thermal Efficiency at various Engine Loads

It can be seen from above figure 3 that BTE is Increasing from 20% load to 100% load. But with respect to variation from DCW30 to Diesel, it is increasing.

(i) Observation

- BTE- Brake thermal efficiency depends on LHV for constant effective power.
- It indicates the ability of the combustion system to accept the experimental fuel and assessing, how efficiently the fuel energy is converted to mechanical energy.
- Heat sinking phenomena: - Heat required to vaporization of particles.
- The heat sinking phenomena of water particles, reduces BTE
- As water quantity increases- LHV reduces, simultaneously BTE reduces.

(c) Engine Emission Test

(i) Carbon Monoxide (CO) - Lack of oxygen and low combustion temperature cause incomplete oxidation of carbon particles to carbon dioxide, resulting in CO emissions. Inhaling CO results in a lack of oxygen in the blood, which can cause headaches, unconsciousness, coma, or even death, depending on the time and concentration of CO exposure. As a result, it is crucial to do research into CO emissions.

It can be seen that CO emissions increase with load for all fuel blends. Furthermore, some blends appear to have lower CO emissions than diesel. Because biodiesel contains more oxygen molecules, its combustion is more complete, resulting in a lower CO emission rate.

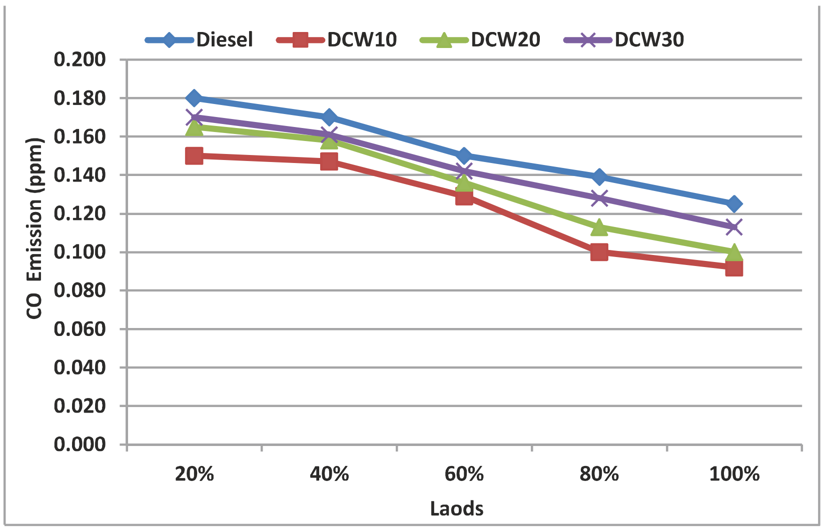

Fig. 4 Variation of Carbon Monoxide at various Engine Loads

Figures 4 show that CO emissions fall as the load increases. Biodiesel blends have lower CO emissions than that of Diesel, because their engine performance improves with better fuel combustion at higher temperatures.

Carbon monoxide (CO) is a sign that the chemical energy of the fuel has not been fully utilised. Coal combustion chamber design and atomization rate, engine load and engine speed all have an impact on CO emissions.

(ii) Observation

- As water quantity increased in the blend, peak in cylinder temperature gets reduced due to heat sinking effect of the water.
- Low in cylinder temperature results to incomplete combustion.
- Thus, CO emission increased, but not much as found in case of pure Diesel Fuel.
- Formation of CO emission is restricted by the oxygen quantity of the blended fuel.
- Higher amount of water in fuel decreases in cylinder temperature. Results to incomplete combustion but blends fuel restricts the CO formation in the combustion chamber.

(d) Unburned Hydrocarbons (HC) - Hydrocarbon emissions (HC emissions) are the unburned gasoline components seen in engine exhaust that contain hydrocarbon components. Incomplete combustion of fuel molecules results in the release of unburned hydrocarbons (UBHCs). Fuel-air mixture non-homogeneity is the primary cause of HC emission. Because UBHC emissions contribute to photochemical haze, their investigation is critical.

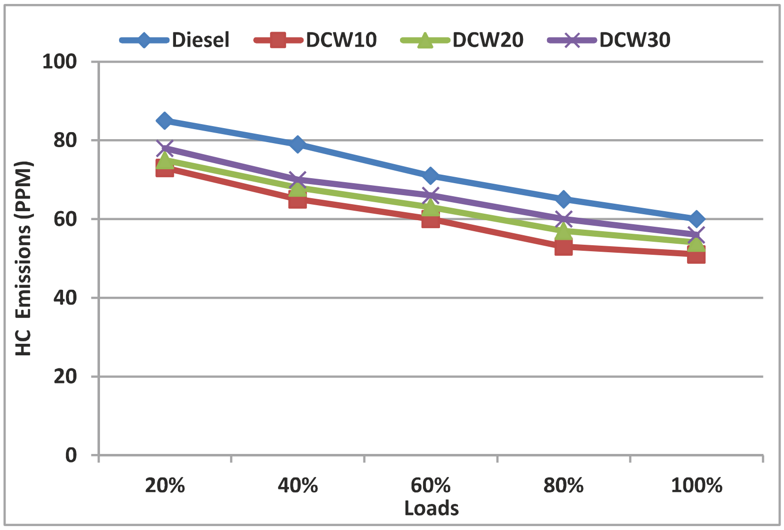

Fig. 5 Variation of Unburned Hydrocarbons at various Engine Loads.

The Fig 5 shows the comparative results of the unburned HC emissions at various loads for all the fuels under consideration viz. Diesel, DCW10, DCW20 and DCW30. It is observed from the figure that when the engine load is increased the unburned HC emissions are reduced.

Figure 5 shows the HC emission of an engine with various loads and for the various blends and diesel fuel. All biodiesel fuels were shown to emit fewer HC emissions than base diesel fuel.

Emissions of hydrocarbons (HC) reduced as a function of the amount of oxygen in the combustion chamber, whether that air or fuel was oxygenated. Biodiesel, on the other hand, despite having a lower final distillation point than diesel, has been found to have a higher volatility. Due to possible incomplete vaporization or burning of the final portion of the diesel fuel, higher levels of ultra-high concentration (UHC) emissions may result. Because biodiesel and biodiesel-diesel blended fuels are utilised in diesel engines, decreased UHC emissions should be expected.

(i) Observation

- As water quantity increased in the blend, peak in cylinder temperature gets reduced due to heat sinking effect of the water
- Low in cylinder temperature results to incomplete combustion.
- Thus, HC emission increased, but not much as in case of pure Diesel Fuel.
- Formation of HC emission is restricted by the oxygen quantity of the blended fuel.
- The peak temperature increases as load increases, which leads to complete combustion but high amount of water in fuel decreases in cylinder temperature.
- Results to incomplete combustion but blended fuel restricts the HC formation in the combustion chamber.

(ii) Oxides of Nitrogen (NOx) - In addition to contributing to acid rain, NOx is one of the most common air pollutants. At high temperatures, nitrogen and oxygen combine to generate NOx. CI engines produce more NOx due to greater combustion temperatures.

The following graphs compare the NOx emissions of diesel and various blends of biodiesel at varying loads. When comparing all biodiesel blends with diesel at various loads, it was found that NOx emissions skyrocketed significantly as the load increased.

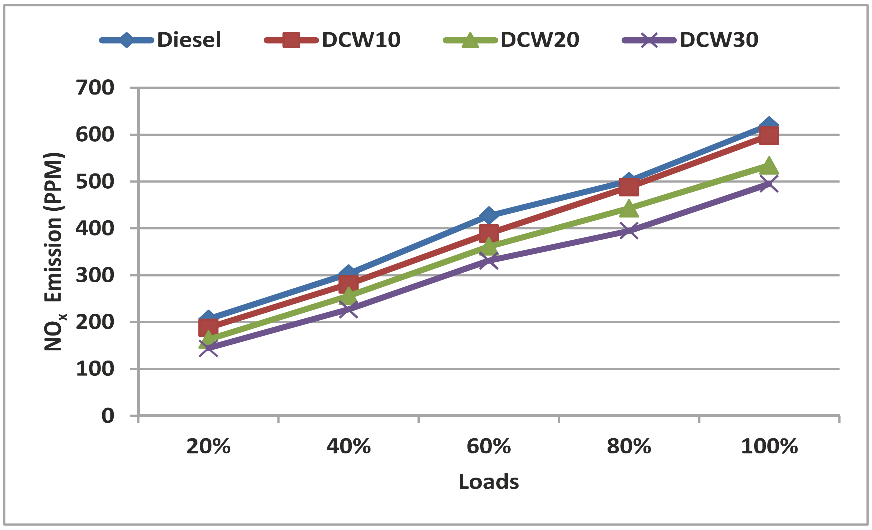

Fig. 6 Variation of emission of NOx at various Engine Loads

Figure 6 shows the variation in NOx concentration during the operation of the biodiesel-diesel blended with water fuel in maximum fueling mode, under varied loads. In terms of NOx emissions, the DCW30 has the lowest, followed by DCW20 and mixed biodiesel DCW10. It has been found that at full load (100%) DCW10 biodiesel emits higher nitrogen oxides (NOx), compared to other biodiesel mixes.

(i) Observations

- Nitrogen oxide (NOx):- Dissociation of molecular nitrogen and oxygen. The formation of NOx emission is highly depending up on the in-cylinder temperature.
- As water quantity introduced, heat sinking phenomena (micro combustion phenomena- the heat absorbed by the water particles in the form of sensible and latent heat reduces the combustion chamber temperature) presents thus, reduces NOx emission
- Heat sinking phenomena of water particles reduces peak temperature of the combustion process. As the load increases, more amount of fuel is injected inside cylinder. Accordingly, heat sinking phenomena is continuously acting at increasing load. Thus, NOx emission decreases at all loads due to application of Coconut water blended fuel.

V CONCLUSION

A detailed analysis of the performance and emission parameters of an Internal combustion diesel engine has been carried out with various biodiesel blends. Performance and emission analysis of an Internal combustion diesel engine carried out at different Biodiesel - Water blends have been examined for Diesel and mixed biodiesel of Coconut and Water (DCW10, DCW20 and DCW30). The following conclusion are made as per the results of performance and emission parameters.

(a) The Brake Specific Fuel Consumption (BSFC) of biodiesel blends are higher than that of Diesel fuel. The highest BSFC was recorded for DCW30 blends and trend shows that the BSFC of Diesel fuel and Blends reduces as load increases. It is better to run engine on low BSFC.

(b) The Break Thermal Efficiency (BTE) of biodiesel blends are lower than that of Diesel fuel. The lowest BTE was recorded for DCW30 blends and trend shows that the BTE of Diesel fuel and Blends increases as load increases. It is better to run engine on High BTE.

(c) The Carbon Monoxide (CO) emission of biodiesel blends are lower than that of Diesel fuel. The lowest CO emission was recorded for DCW10 blends and trend shows that the CO emission of Diesel fuel and Blends reduces as load increases. It is better to run engine on low CO emission formation.

(d) The Unburned Hydrocarbons (HC) emission of biodiesel blends are lower than that of Diesel fuel. The lowest HC emission was recorded for DCW10 blends and trend shows that the HC emission of Diesel fuel and Blends reduces as load increases. It is better to run engine on low HC emission formation.

(e) The Nitrogen Oxide (NOx) emission of biodiesel blends are lower than that of Diesel fuel. The lowest NO emission was recorded for DCW30 blends and trend shows that the NO emission of Diesel fuel and Blends increases as load increases. It is better to run engine on low NO emission formation.

From the above analysis, it is concluded that the biodiesel of coconut oil and water blends reduces emissions from the diesel engine, but simultaneously it affects the performance parameters of the engine. So to achieve the desired emission from the engine, one should compromise with the performance of the engine while using biodiesel of coconut oil and water blends. By considering different parameters of emissions, DCW10 blends resulted efficiently to reduce CO and HC emissions. However, to aim reduction of NOx emission, DCW30 shows good result after examination.

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