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Environmental emission characteristics of diesel engine performance using biodiesel by cotton and pumpkin seed

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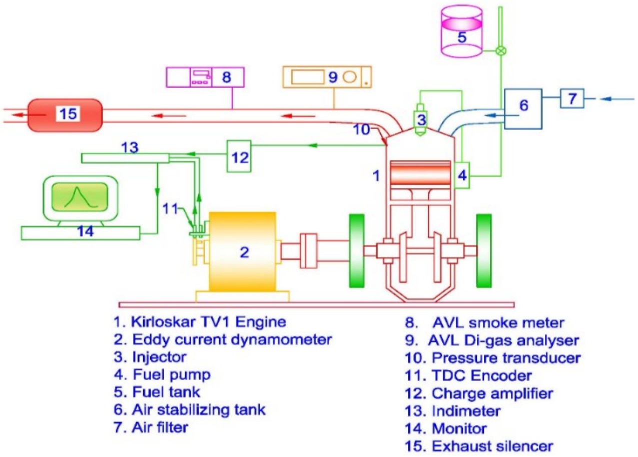
Graphical abstract



Abstract

The hunt for alternative fuels that may be utilized in place of conventional fuels is intensifying quickly since the availability of fossil fuels is dwindling daily. In this work, biodiesel derived from pumpkin and cotton seed oils is presented for use as diesel engine fuel. Related to diesel, the calorific value of this precise biodiesel is low. In a 4-stroke diesel engine, four mixes (B0, B25, B50, B75 and B100) of biodiesel were evaluated. The engine's emissions and combustion results were contrasted with the diesels. When all blended fuels are related to diesel fuel, the test repercussions illustrate a small increase in the thermal efficiency of the brakes and a decrease in the consumption of fuel specifically for the brake. Emissions of Carbon monoxide and the usage of biodiesel subsequent in a reduction in hydrocarbon emissions and an upsurge in carbon dioxide and nitrogen oxide emissions. The experiment's results showed that biodiesel, which is derived from these seed oils, maybe a useful diesel replacement for compression ignition engines. The carbon monoxide (CO) and hydrocarbons (HC) emissions are 0.27 and 0.56 g/kWh, respectively, based on the optimal B100 mix

Keywords: Biodiesel, cotton seed oil, emissions, pumpkin seed

1. Introduction

An oil crisis has resulted from the growing demand for petroleum goods brought on by the depletion of fossil resources and environmental damage. Alternative or renewable fuels are being developed to replace petroleum-based fuels due to the increasing demand for petroleum goods. Emissions from diesel engines harm the environment by causing acid rain, greenhouse effects, ozone layer depletion, and human illnesses. The biodiversity and balance of landmasses have already been impacted by energy use and pollution from petroleum fuels. The automotive industry is extensively investing in investigating to discover another fuel and create better technology to enhance fuel effectiveness, economy, and contamination because fuel is the lifeblood of the transference sector. The biodegradable, renewable nature, non-toxic & less polluting of vegetable oils has sparked fresh interest in biodiesel manufacturing. Primary alcohols, biomass, biogas, and vegetable oils are examples of alternative fuel sources. Vegetable oils are a great substitute for edible oils since they are plentiful, biodegradable, safe for the environment, and renewable. Globally, edible oils are the primary source of biodiesel production; however, unsalted oil seeds, such as cotton (Gossypium spp.), pongamia (Ponamia pinnata), and jatropha (Jatropha curcas), are widely accessible in India.

The jatropha tree, which grows to a minimum height of 20 feet (6 metres), is a small tree or semi-evergreen shrub. It is regarded as a biodiesel plant because of its many great qualities, which include its high oil content, resistance to drought, high production ability, and good-quality plant oil. It can thrive in deserts since it is tolerant of extreme aridity. The dried seeds were machine-pressed to extract the Jatropha crude oil, which was then utilised to produce biodiesel. The progression for create biodiesel is as follows: crude oil, methyl alcohol, and KOH are combined first, and hexane is then added to the mixture.

2. Literature survey

The usage of honing oil as a diesel engine replacement fuel (Venkanna *et al.*2015), who concentrated on the oil's decreased viscosity when combined with diesel fuel. According to experiments, hone oil and its mixes may prove to be a better replacement for diesel engines in the forthcoming. A fuel blend containing up to 20% hone oil is appropriate for short-term usage without requiring modification or having any negative consequences. After producing biodiesel from cotton seed oil (Narun *et al.* 2009) tested it on diesel commercial engines. The output was limited to 77%, and Carbon monoxide, PM, and smoke were decreased. However, the performance was somewhat worse than that of fossil diesel (Huseyin *et al.* 2009) compared biodiesels B0, B5, B20, B50, B75, and B100 while investigating the emissions and performance of CSOME in a 10 horsepower Rainbow-186 single cylinder diesel engine. The torque was higher with B5, the BSFC was lower with B20, and the emissions of CO, Sulfur dioxide, smoke, & Nitrous oxide were lower with B20 than with FD. A Kirloskar TV-1 diesel engine to study the performance (Anbarasu *et al.* 2013) used combustion, and emission properties of fossil diesel, CSOME, and CSOME + ethanol blends. The findings revealed a 38% drop in smoke opacity, a lower heat release rate, lower emissions of NOx, Carbon monoxide, & HC, and a greater BSEC when compared to blends with 15% ethanol. utilising several mixes of biodiesel (Anand *et al.* 2009) used cotton seed oil methyl ester to study the emissions & performance of a Kirloskar Engine. For B20, the greatest peak pressure was 90.66 bar, but as blend ratios dropped, so did the pressure. At low loads, there was less smoke opacity.

Experiments were done (Fujia *et al.* 2009) on how biodiesel fuels and a Cummins ISBe6 diesel engine performed in terms of emissions. The results indicated that biodiesel decreased emissions of PM, SOO, HC, CO, and NOx, with CSOME having the lowest NOx emissions. The percentages of decreases ranged from 53 to 69%. (Liu *et al.* 2022) investigated the method of reducing NOx in a 3.7 kilo watt of Kirloskar AV1 engine that was used to power JOME. They did this by employing the hot EGR approach. The engine's emissions did not decrease while it ran at hot EGR levels of 5–25%. 15% of hot EGR in particular produced the lowest Carbon monoxide, Hydro carbon, and Nitrous oxide emissions coupled with a decent BTE. But the drawback of the EGR technology was a greater amount of smoke. Rajesh et al. carried out experimental and computational investigations. As a means to track the rates of mass burning and the flame shapes of spherical particles fed biodiesel, they employed porous spheres. The finite volume technique was used to solve the transient governing equations. Burning 11% slower than fossil diesel was biodiesel. Performance, combustion, and emission characteristics of jatropha oil methyl esters of B20, B40, B60, B80, and B100 on a 5.2 kW single cylinder Kirloskar TV1 diesel engine under various FIT, FIP, and load circumstances examined (Liu *et al.* 2022). The BTE of B20 was about the same as that of fossil diesel, and it gets smaller as the blend ratio rises. Moreover, B20's EGT, smoke, and NOx levels were comparable to those of fossil diesel, demonstrating its appropriateness in comparison to the other blends. For both B20 and fossil diesel fuels, higher BTHE was achieved at a static injection time of 23 Degree b TDC and 160 kg.cm^2. On a 3.68 kilo watt single cylinder Kirloskar Engine, (Pradeep *et al.* 2007) investigated JOME and its blends, B0, B25, B50, B75, and B100, as an alternative fuel. Compared to fossil fuel, which had greater CO and NOx emissions, they found that JOME had higher BTHE, lower exhaust gas temperature, and Carbon dioxide emissions.

As long as information (Rajesh *et al.* 2008) on the B20 and B100 combustion features of JOME in a single-cylinder Kirloskar TV1 diesel engine weighing 5.2 kW, with varying fuel injection pressures of 20, 23, and 26°b TDC. Comparing B20 with 26°b TDC to fossil diesel and plain JOME, the results revealed greater BTE, higher peak heat release rate, lower BSEC, shorter ignition delays, higher cylinder peak pressure, decreased HC emission, and reduced smoke opacity. Experiments on the 4.4 kilowatt single-cylinder Kirloskar engine (Manieniyan *et al.* 2008), which has a FIT of 23°b TDC, a FIP of 200 bars, and a CR of 17.5:1. They contrasted the outcomes with fossil fuel after looking at JOME in terms of B10, B20, B30, B40, and B50. Overall, it was discovered that the B20 had the longest ignition delay period, the lowest SFC and CO_2 emissions, and the highest braking thermal efficiency. For every combination of biodiesel, the smoke opaqueness was greater than that of fossil diesel. An experiment on jatropha oil methyl ester (JOME)-fossil diesel blends in different configurations was carried out by Lakshmi Narayana Rao et al. using an injector opening pressure of 250 bar, commencing at 23.4°b TDC, a compression ratio of 17.5:1, and a rated speed of 1500 rpm. For the whole load range, the JOME's ignition delay, combustion duration, BTHE, Hydrocarbon, and CO emissions were lower than the FDs, and they got even lower as the blend ratio increased. When JOME concentrations rose with FD, the cylinder peak pressure, BSFC, EGT, and NOx emission increased even more. In a study conducted (Chen *et al.* 2024) biofuels such as palm oil, coconut oil and rubber seed oil were investigated as diesel substitutes for compression ignition engines. As demonstrated by the results, preheating enhanced performance and coconut oil decreased viscosity. Although they have less brake specific energy power than diesel, heated vegetable oils, especially coconut and rubber seed oils, can somewhat increase brake thermal efficiency. Biodiesel, or karanja and jatropha methyl esters, as a substitute fuel for diesel engines (Amarnath *et al.* 2014) assessment looked into. It was used for the experiments. The findings demonstrated that at maximum torque, karanja and jatropha biodiesel had lower (BSFC) (BTHE) than diesel. While diesel had lower Carbo monoxide emission levels, karanja had greater levels at 20 Nm of torque. Both biodiesels provided an engine with thermal performance that was largely on par with that of pure diesel.

Chicha oil biodiesel was first introduced (Luo *et al.* 2013) as a fuel for diesel engines. Chicha oil methyl ester (COME) is produced by trans esterifying chicha oil with methanol and utilising catalyst as potassium hydroxide. In comparison to diesel, biodiesel has a reduced calorific value. Tests conducted on mixes and COME revealed a small reduction in BSFC and an improvement in BTHE. Moreover, biodiesel decreased Carbon monoxide and Hydro carbon emissions while raising CO_2 & Nitrous oxide emissions. The findings point to biodiesel as a potential diesel substitute. Transesterification was used (Bayrakçeken *et al.* 2012) to test the biodiesel produced from refined and crude soybean oil. In a diesel engine, the things of refined and crude soybean methyl ester on emissions and performance of the Engine were investigated. The engine power and moment were found to be lower while using this fuel than when using diesel, but the specific fuel consumption was higher. Emissions of carbon monoxide fell by 6.96% and 11.98%, respectively. When using crude soybean methyl ester, nitrogen oxide emissions dropped by 20.5%; however, when using refined soybean methyl ester, emissions rose by 20.1%. Tests conducted in a diesel engine (Prabhu *et al.* 2020) using palm biodiesel and diesel fuel revealed that the properties of the two fuels were similar. Due of its low heat content, palm biodiesel has a similar output power to diesel fuel but a greater brake specific fuel consumption. According to the study, using palm biodiesel in place of an unmodified diesel engine greatly lowers its hazardous emissions. In their study, (Misel *et al.* 2020) compared the emission level and engine performance of Vanuatu's naturally grown trees with those of diesel while using oils extracted from copra (CPO), virgin coconut (VCO), tamanu (TMO), and ngae (NGO) trees. Gas chromatography was used to transform the oils into fatty-acid methyl-esters (FAMEs). The main fatty acids were determined to be oleic acid, palmitic acid, capric acid, and caprylic acid. The BTHE was found to be similar to diesel. The findings imply that local SVOs can assist Vanuatu achieve the sustainable development objectives of the UN by serving as an excellent and affordable fuel replacement. The investigation performance of diesel engine (Liu *et al.* 2023) and emissions with castor biodiesel and its 0%–40% diesel mix. Under optimal circumstances, the transesterification method based on acid produced the greatest yield, measuring 82.5%. The castor biodiesel's FTIR spectra revealed C=O and C–O functional groups. In comparison to ordinary diesel, B40 exhibited the least amount of black smoke, according to the smoke emission test. Caster seed oil blends are a good substitute fuel for diesel as the optimised blending ratio enhanced specific fuel consumption.

3. Proposed methodology

The purpose of this study is to evaluate the viability of using diesel as a substantial replacement for blends of cotton seed oil and jatropha seed oil, such as B0, B25, B50, B75, and B100, in diesel engines. Creating an investigational setup is part of the research to examine the combustion, performance of engine & features of emissions in a steady state. These mixes were used in experiments to assess and analyse their features related to combustion, emission, and performance. The outcomes were contrasted with those of the traditional engine, which had a static injection time of 20 b TDC at complete load and an ideal nozzle opening pressure of 250 bar. The study offers insightful information about biodiesel's potential as a diesel engine fuel source.

4. Experimentation

An experimental setup with the necessary tools is set up to test a “4” stroke, single-cylinder DI diesel engine. The determination of this setup is to evaluate the performance of engine, emissions, and features of combustion under various operational circumstances The experiment utilizes a water-cooled, single-cylinder, Direct Injection (DI) diesel engine with a 17.5:1 compression ratio. The overall design of the investigational apparatus is depicted in Figure 1. Piston-hemispherical bowls are observed.

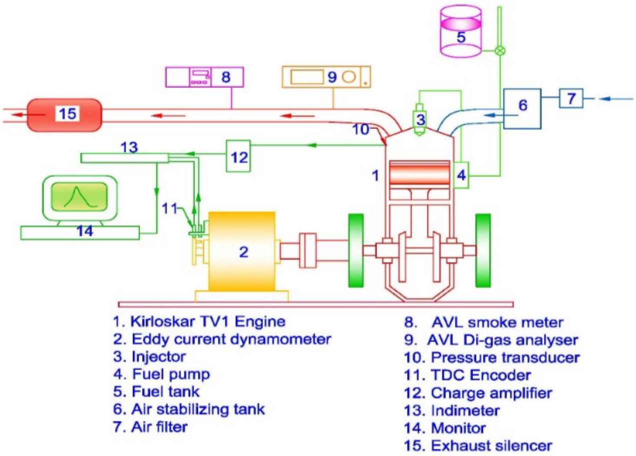


Figure 1. Digramatic Layout of Diesel Engine Engine Specifications

Figure 2. Experimental setup of the diesel engine

Throughout all load testing, the engine is permitted to operate at a steady 1500 rpm. A variety of mix proportions of cotton seed oil and jatropha oil are tested for performance, combustion, and emissions using nozzle opening pressures of 240, 250, and 260 bar with static injection timings of 19, 20, 21, 22, 23, and 24 b TDC. Water is supplied to the engine through the cylinder head and the engine's water jackets to cool the engine. A piezoelectric pressure transducer installed on the cylinder head surface can be used to measure the cylinder pressure.

The dynamometer records the ambient pressure, temperature, and humidity and uses this information to manage the engine load by maintaining a constant engine speed. Temperatures of the exhaust gas and fuel flow are measured once the engine has been stabilised at a specific operating point. To get the engine to a steady state, it is let to run for 20 to 30 minutes. Appendix I displays the test engine's specs.

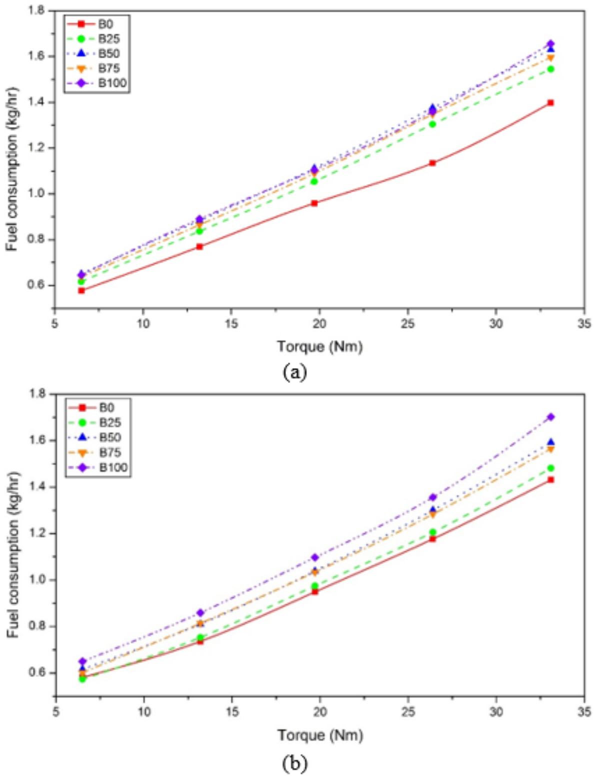
Table 1. Specifications of the Engine

Model	**Kirloskar TV - I**
Engine type	Vertical cylinder, DI diesel engine
Brake Power (rated)	5.2 kilo watt
Cooling System	H_2O
Fuel	Diesel, cotton seed oil, pumpkin seed oil
Static Injection Timings	19°, 20°, 21°, 22°b TDC
Nozzle Opening pressures	240, 250, 260 and 270 bar
Ignition System	Compression Ignition
Number of Cylinder	1
Bore X Stroke (mm)	87.5 × 110
Compression Ratio	17.5:1
Velocity (rpm)	1500

5. Results and discussions

5.1. *Fuel usage*

The variation in fuel consumption for B0 to B100 different blend ratios for COME and POME is shown in Figure 1 (a) and (b). By the test consequences, it could be observed that the torque of fuel usage in a courteous manner to torque for all the loads for COME, POME and conventional engine. At full load, COME and POME consume substantially more gasoline than the typical approach. The % rise in fuel consumption at starting torque to ending torque d is below 0.6% to 1.7% respectively as compared to B0 to B100. Then POME is the same to increase the fuel consumption.



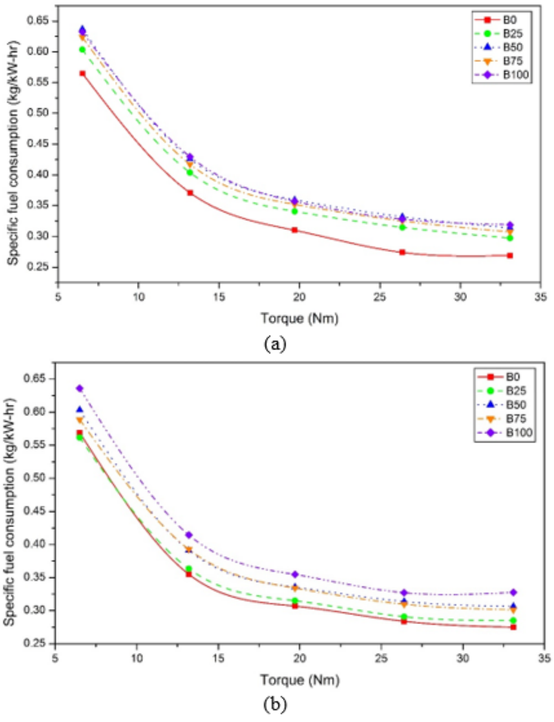
(a)

(b)

Figure 3. Fuel consumption vs Torque (a) cotton seed oil (b) pumpkin seed oil

5.2. *Specific Fuel Consumption*

The specific fuel usage variation for COME and POME, respectively, from B0 to B100 is depicted in Figures 2(a) and 2(b), in relation to torque. The test findings show that, with regard to blend ratio, there is a tendency towards higher specific fuel consumption for all loads for both COME and POME. When compared to the COME, the POME shows a slightly lower specific fuel usage in both no-load and full-load conditions. For every other load, the same pattern is observed. In comparison to every other blend and every load aside from B0, the B100 blend exhibits the lowest % increase in exact consuming fuel. The possible causes of this could be that the calorific value of B0 is 8.6% larger than that of B100, and that when the load intensifications, the amount of fuel intensified as well, improving air use and burning.



(a)

(b)

Figure 4. Specific Fuel consumption vs Torque (a) cotton seed oil (b) pumpkin seed oil

5.3. *Brake Thermal Efficiency (BTHE)*

The variance in BTHE for B0 to B100 for COME and POME, respectively, is depicted in Figures 3(a) and 3(b). The test findings showed that, for all loads for both COME and POME, there is a trend toward a diminishing BTHE with respect to torque. When comparing the BTHE at no load and full load, POME outperforms COME by a small margin. Every other load shows the same pattern. With the exception of B0, all other blends provide a lower percentage increase in brake thermal efficiency than does the B100 blend. This could be because B0's calorific value is 3.5% higher than B100's, and when load increases, fuel quantity increases as well, improving air use and resulting in improved combustion. Diesel engines run on an extremely lean mixture when they are not under load.

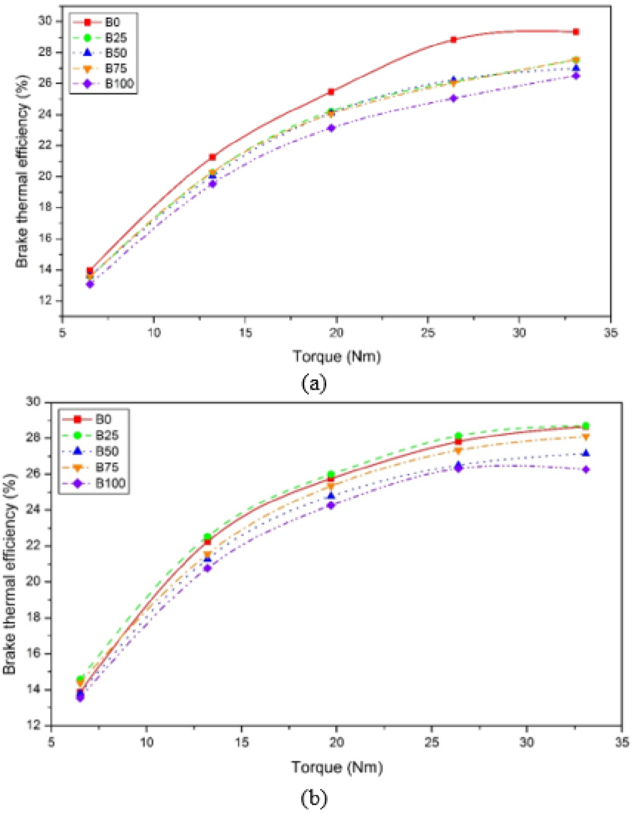


Figure 5. Brake Thermal Efficiency Vs Torque (A) Cotton Seed Oil (B) Pumpkin Seed Oil

5.4. Exhaust Gas Temperature

Figures 4(a) and 4(b) illustrate how exhaust gas temperature changes for COME and POME, respectively, from B0 to B100 in relation to torque. Figure 4(a) shows that the B0 has the highest exhaust gas temperature at 176.8°kJ.m^{-3}, followed by the B100, which has the highest exhaust gas temperature at 146.1°kJ.m^{-3}. The result for the B100, at 0-degree torque at a full-load state, is 85.1° kJ.m^{-3}. In comparison to all other mixes, this suggests that B0 fuel burns more efficiently. At zero-degree crank angle, however, the B100's heat release rate is reduced by 42.03% in comparison to B0. This results from an 8.28% decrease in calorific value for B100 relative to B0.

5.5. Smoke Density

Smoke density variation for B0 to B100 for COME and POME, respectively, is depicted in Figures 5(a) and 5(b). It is evident from the test findings that for all fuel blends for both COME and POME, there is a trend toward increasing smoke density relative to torque. When there is no load and maximum load, the POME produces a somewhat lower smoke density than the COME. For all other loads, the same pattern is noted. mix for mix, the B100 produces the least amount of smoke for every load when compared to any other blend. Because the process completely burns out, the POME produces the least amount of smoke density as compared to the COME. B100 has the lowest smoke density overall and at maximum load in POME when compared to all other blends. When comparing B100 to B0 fuel in COME, the decrease in smoke density is 0.61 percentage & 1.21 percentage, correspondingly; nevertheless, in POME, the B100 likewise generates the lowermost smoke density, at 1.71 percentage & 2.38 percentage, correspondingly, when comparing the % decrease in the density of smoke to B0 fuel. Regarding all other loads, the same pattern is seen. These results show that, under all load situations, B100 has the lowest smoke density for together COME & POME. This could be because B100 has a larger cetane number (45–50) than B0.

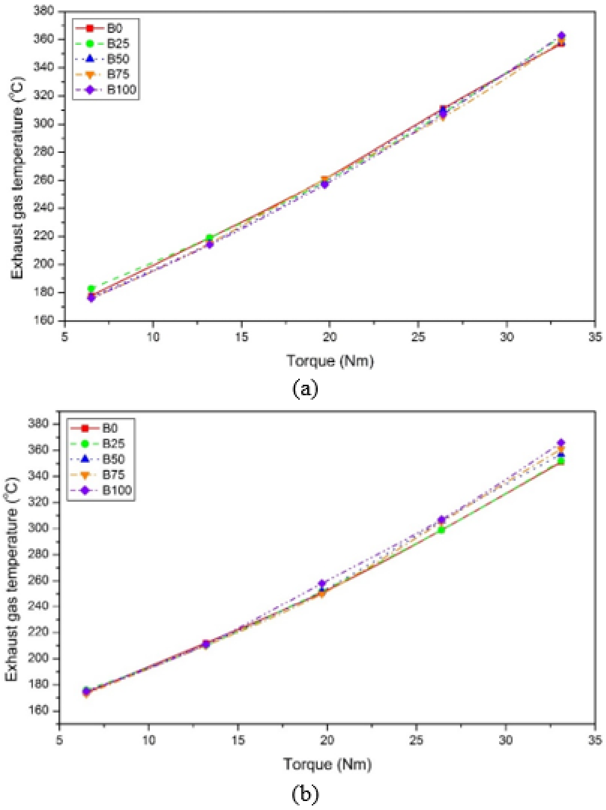
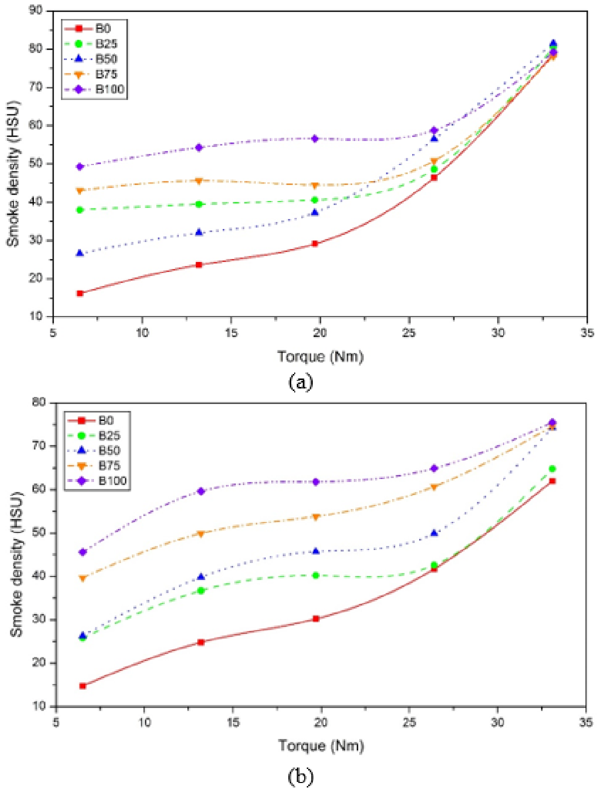


Figure 6. exhaust gas temperature vs Torque (a) cotton seed oil (b) pumpkin seed oil

5.6. Nitrogen Oxides

The NO in relation to brake power for B0 to B100 for COME and POME, correspondingly, are displayed in Figures 6(a) and 6(b). According to the test results, torque is showing an improving trend for all gasoline mixes, including COME and POME. For COME, the lowest NOx (kg/kg of fuel) at no load is given by B100 at 1 and by B0 at 1.75; at full load, the values are given by B100 at 0.72 and by B0 at 0.77. However, in the POME scenario, B100 yields the lowest NOx of 0.500 and B0 yields 1, but at full load, B100 yields a value of 0.7 and B0 yields a value of 0.76. Regarding all other loads, the same pattern is noted. The reason for this is a drop in the temperature of exhaust gases. It is commonly recognized that fuel made from vegetables has a trace quantity of nitrogen in it. This adds to the creation of NOx. When compared to B0, the reduction for B100 in the COME scenario is twelve percentage & 7.14 percentage at no load and full load, correspondingly, while the reduction for B100 in the POME case is 14.23 percentage & 7.91 percentage at no load and full load, correspondingly. Related to COME, the POME reduces NOx by the largest amount under both no-load & full-load settings, according to these data.



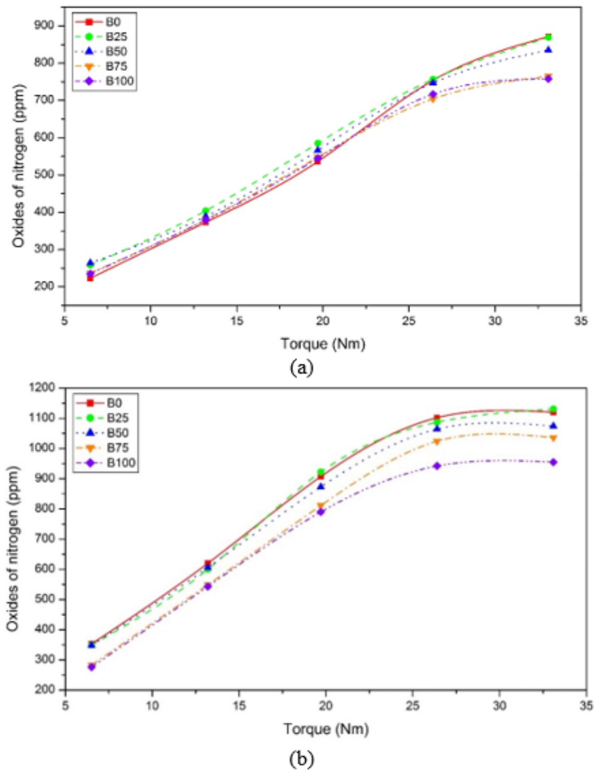
(a)

(b)

Figure 7. Smoke density vs Torque (a) cotton seed oil (b) pumpkin seed oil

5.7. *Carbon Monoxide*

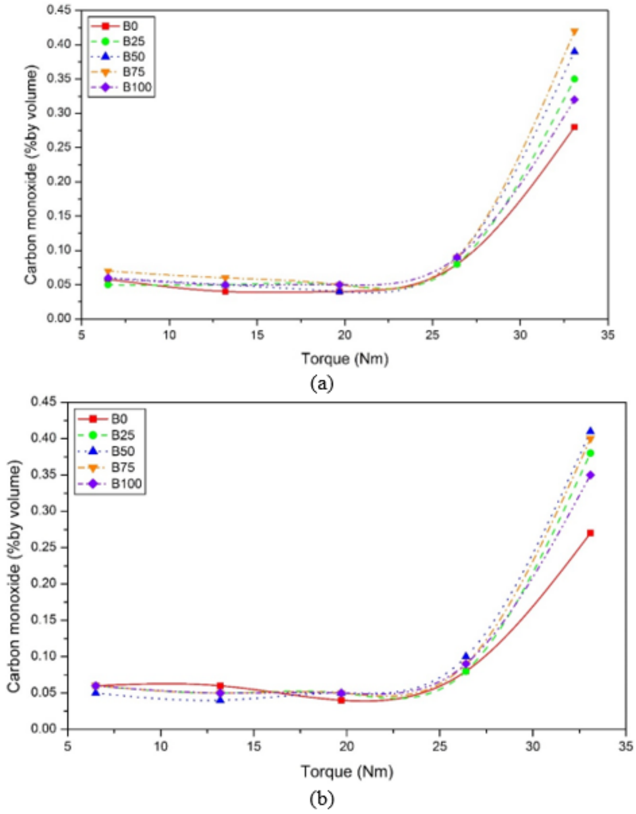
The fluctuation in CO for B0 to B100 for COME and POME, respectively, with respect to torque is depicted in Figures 7(a) and 7(b). The test results indicate that, for all gasoline mixes, both COME and POME, there is an increasing trend of CO with regard to torque, with a notable increase at full load. Under both no-load and full-load scenarios, the POME produces less Carbon monoxide than the COME. For every other load, the same pattern is seen. For all loads, the blend with the lowest CO is the B100 in comparison to all other blends. The COME results likewise show the same conclusions. The cetane number and oxygen concentration in the mix are the reason for this. It is thought that in the case of biodiesel, the high oxygen content somewhat made up for the oxygen-deficient operation under the oil type. The detachment of Carbon dioxide to Carbon monoxide during the highest loads, which corresponds to procedures with high fuel concentrations and high combustion temperatures, can also result in increased carbon monoxide emissions.



(a)

(b)

Figure 8. Nitrogen Oxides Vs Torque (A) Cotton Seed Oil (B) Pumpkin Seed Oil



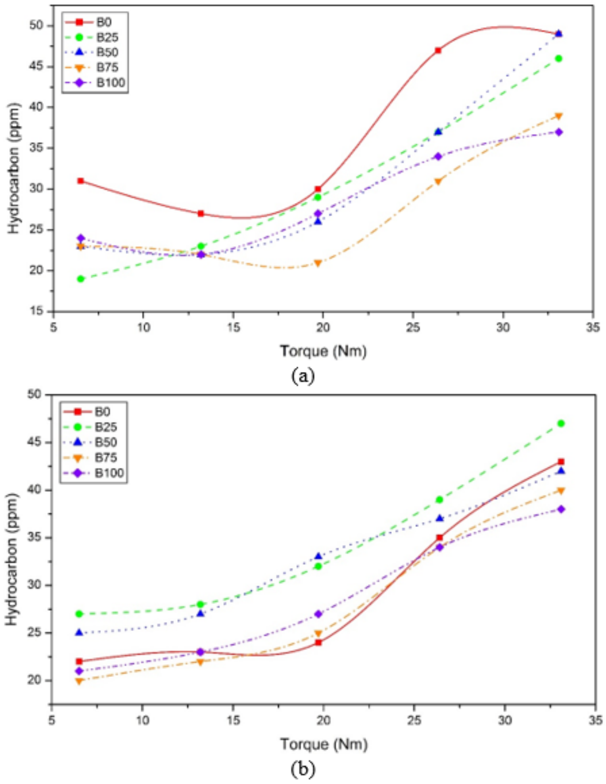
(a)

(b)

Figure 9. Carbon Monoxide Vs Torque (A) Cotton Seed Oil (B) Pumpkin Seed Oil

5.8. *Hydrocarbon*

Hydrocarbon is shown in Figures 8(a) and 8(b) for COME and POME, respectively, about torque for B0 to B100. Based on the test findings, it is seen that for all gasoline mixes for both COME and POME, Hydrocarbons are becoming more and more prevalent for torque. Figure 8(a) shows that, when compared to all other fuel mixes, B100 produces the lowest hydrocarbon at no load and full load, correspondingly. When compared to B0, the hydrocarbon reduction for B100 at no load and full load is 33.34% and 5.88%, respectively. For every other load, the same pattern is noted. When compared to all other fuel blends, Figure 8(b) shows that B100 produces the lowermost hydrocarbon under no load and full load, respectively, at 0.011 and 0.031. In comparison to B0, the hydrocarbon decreases for B100 is 10 percentage & 5.06 percentage, respectively, at no load and full load. Regarding all other loads, the same pattern is noted. According to the results, POME produces the least amount of hydrocarbon as compared to COME since the process is completely burned. This is because the viscosity of fuel and surface tension have an impact on its droplet size, maximum penetration and penetration rate, all of which have an impact on how well the fuel and air mix. Another important factor in the igniting process is the fuel's tane number. B100 has a cetane number that is 1.92% greater than B0's. As a result, B0 emits more hydrocarbon than any other gasoline blend. This is because biodiesel has a better combustion chamber because oxygen atoms are present in it.



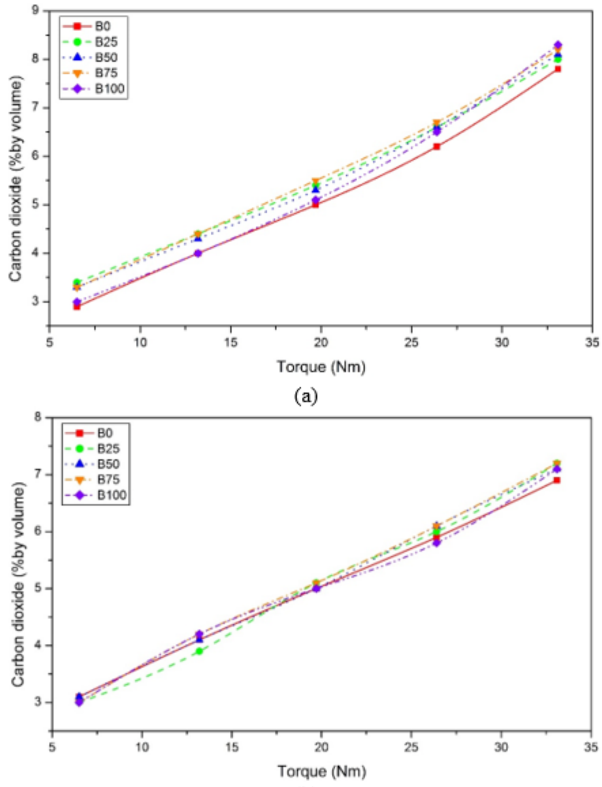
(a)

(b)

Figure 10. Hydrocarbon Vs Torque (A) Cotton Seed Oil (B) Pumpkin Seed Oil

5.9. Carbon Dioxide

The change in Co_2 with reverence to torque for B0 to B100 for COME & POME, respectively, is depicted in Figures 9(a) and 9(b). It is evident from the test findings that CO_2 for both COME and POME is trending upward in relation to torque. At no load and full load, the COME produces somewhat more CO_2 than the POME. For all other loads, the same tendency is noted. When compared to all other fuel blends, including B0, B100 produces the maximum CO_2 output across all loads. When compared to B0, the CO_2 rise for B100 at no load and full load is 2.78% and 1.25%, respectively, while for POME, the CO_2 increase for B100 is 4.41% and 3.71%, respectively. For every other load condition, the same pattern is seen. The results indicate that B100 exhibits superior combustion for both COME and POME when compared to the other mixes. This could be because of the blend's cetane number and oxygen percentage. Because there is oxygen present in the fuel itself, the methyl ester of mahua oil-based fuel functions as a less potent combustion stimulant within the cylinder.



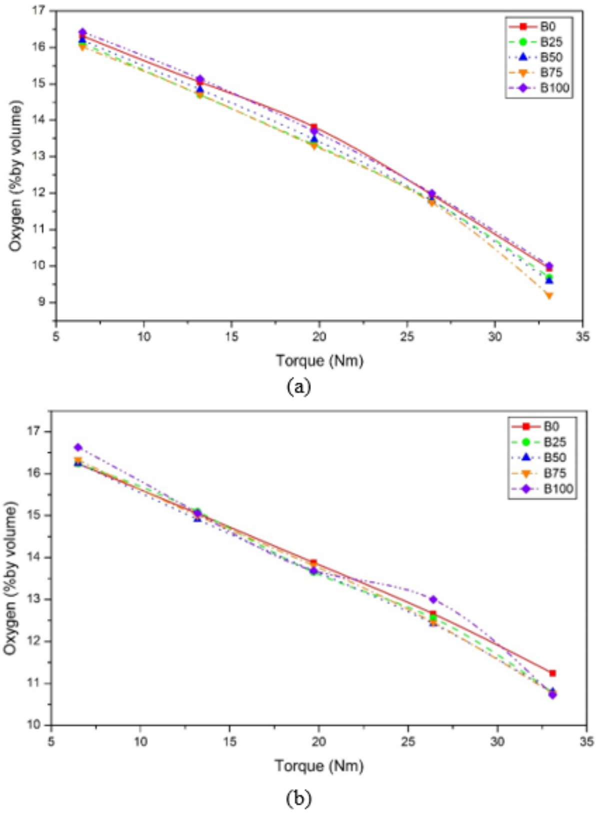
(a)

(b)

Figure 11. Carbon Dioxide Vs Torque (A) Cotton Seed Oil (B) Pumpkin Seed Oil

5.10. Oxygen

The oxygen concentration for B0 to B100 for COME and POME, respectively, is shown against torque in Figures 10(a) and 10(b), respectively. According to the test results, for all fuel blends for both COME and POME, there is a trend toward a decreasing oxygen content in relation to torque. Because the process is completely burned, the POME produces the lowest oxygen concentration when compared to the COME. The oxygen content for B0 drops in POME compared to other fuel blends. Based on the test results, B0 offers the lowest oxygen concentration (15.9% by volume at no load and 9.1% at full load) when there is POME present. B25, on the other hand, provides about the same oxygen concentration as B0. However, out of all the fuel mixes, B100 has the highest oxygen concentration (16.2% and 9.4% by volume). The same pattern is seen with various fuel mixtures, and COME also yields findings that are remarkably comparable. When comparing the oxygen content of different oil types, POME performs somewhat better than COME. This is because POME effects might improve combustion more effectively. In the POME instance, B100's oxygen concentration increases by 1.6 percentage and 3.3 percentage, correspondingly, during no load and full load in comparison to B0. It is clear from the test results that the oxygen concentration drops with increasing load. The exhaust's oxygen content indicates that the combustion chamber's air is being used somewhat inefficiently. Given that gasoline based on ester includes oxygen, reduced fuel-to-air ratio is needed for full combustion when compared to diesel fuel. When comparing B100 to B0, the % increase in O_2 at no load is larger than the % increase at full load. It suggests that during operation, B100 tends to have incomplete combustion.



(a)

(b)

Figure 12. Oxygen Vs Torque (A) Cotton Seed Oil (B) Pumpkin Seed Oil

6. Conclusion

In this investigation, four mixes of biodiesel and a diesel engine with four strokes were used to test cotton seed oil and pumpkin seed oil diesel blends. The conclusions from this experimental investigation are, that there is no discernible difference in the evaporation constant value between B0 and B100 and B25 to B75 when the engine is operating with the ideal mixes. Owing to the slower combustion of POME, for all COME mixes, the exhaust gas temperature is greater at full load than it is for diesel. At full load, it is seen that COME and its blend exhibit elevated levels of both CO and HC emissions. The CO and HC emissions are 0.27 and 0.56 g/kWh, respectively, based on the optimal B100 mix. Because NOx lowers the working fluid's flame temperature and oxygen concentration in the combustion chamber, it is regulated by both COME and POME. It is widely believed that the finest POME Diesel blend B100 may be utilized as fuel in a compression ignition engine without the need for modifications; nevertheless, there may be a little reduction in engine performance.

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