International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 03 | March - 2024 SJIF Rating: 8.176 ISSN: 2582-3930

# An Experimental Study Using Canola Oil Biodiesel to Examine the Properties of a Diesel Engine with Decanol as an Additive

**G.Rajesh[1], Y. Prudhvi Rajesh[2], P.Hemanth[3], K.R L Sai Kumar[4]**

[1] *professor, Mechanical Department, DVR Dr HS MIC College of Technology*

[2, 3, 4] *Student, Mechanical Department, DVR Dr HS MIC College of Technology*

**Abstract -** A naturally beneficial use of diesel is primarily threatened by the depletion of natural resources and the alarming rise in pollution levels. The majority of research conducted to date has been on the use of lower alcohols; information regarding a higher alcohol mix in canola oil biodiesel is less abundant. This study investigates the effects of adding a ternary mixture of diesel, biodiesel, and decanol as an additive to a CI engine. Diesel and biodiesel were combined with decanol to conduct tests. While the diesel concentration was maintained at 50% throughout, the decanol mixing concentrations were 10%, 20%, and 30% by volume. According to the study, as decanol concentration rises, brake specific fuel consumption falls and brake thermal efficiency rises. At full load, BTE values of 32.24% and 31.68% for pure diesel and D50COME20DEC30, respectively, were noted. The ternary blend D50COME20DEC30 BSFC was 12.89% and 20.63% lower than those of COME100 and D50COME50. Although the total heat release rate is seen to be reduced during the end phase of ignition, heat release rate is observed to increase with the expansion of decanol content in the ternary mix. NOx emissions for D50COME50 and for 10%, 20%, and 30% of decanol in the ternary blend were 1869 PPM, 1838 PPM, 1819 PPM, and 1810 PPM. Therefore, in order to increase engine performance and emissions without altering the CI engine, the present examination recommends a 30% blend of decanol, 20% biodiesel, and 50% diesel.

***Key Words*****:** COME (Canola oil methyl ester), Decanol, Diesel, Performance, Combustion, Emission, CI Engine.

## 1. INTRODUCTION

The world's population was expanding more quickly, and this meant that more cars were needed. As a result, fossil fuel use was exceedingly high. The position of petroleum product availability was likewise inadequate after a while and was expected to come to an end soon. Therefore, it is imperative that natural and renewable sources such as vegetable oil and fats be used in place of fossil fuels immediately. Biodiesels can also be used to limit dangerous emissions from CI engines. However, harmful pollutants such as nitrogen oxides ($NO_X$), carbon monoxide (CO), unburned hydrocarbons (UHC), particulate matter (PM), and ozone-depleting chemicals ($CO_2$, $CH_4$, $N_2O$) are present in diesel fuel discharges. These emissions affect the ozone layer directly as well as indirectly. The drive to focus research on fuel options based on vegetable oils is accelerated by these factors. Due to their physical and chemical similarities to diesel fuel, a few endless vegetable oils, like maize oil, soybean oil, rice bran oil, and tamarind seed oil, might be utilized as advantageous alternatives for diesel engines. According to Ramalingam et al. (2018), using vegetable oils could potentially reduce the harmful pollution that CI engines emit. In addition to producing biodiesel from maize oil, Balamurugan et al. (2018) conducted performance and emission testing on blends of B10, B20, and B30 as well as pure diesel and corn oil methyl ester (COME). Brake thermal efficiency (BTE) of the blends declined in the performance test as the mix proportion in the diesel increased. All mixes have minimal BTE as compared to diesel. When the amount of blend grew, the brake specific fuel consumption (BSFC) increased as well. When compared to diesel, all blends produced high values of BSFC. From an emission perspective, when the blend % increases, the amounts of hydrocarbons (HC), carbon monoxide (CO), and nitrogen oxides (NOX) drop. Vegetable oils, however, offer a lot of potential to replace diesel but have some drawbacks as well, like high thickness, poor calorific value, and high specific gravity. To overcome these constraints, the transesterification technique was utilized. The process of transesterification converts triglycerides into a mixture of methyl esters and glycerol. Compared to diesel, biodiesel has a higher oxygen content, which improves ignition productivity, lowers CO, UHC, and PM emissions, but produces more noticeable NOx emissions (about 10% more than diesel).Additionally, a number of analysts tried using various additives to reduce emanation characteristics and increase fuel economy of various types of biodiesel. The effects of 1-pentanol and 1-butanol as additives with Calophyllum Inophyllum biodiesel were evaluated by Nanthagopal et al. (2019). A 2011 study by Jinlin Xue et al. examined the effects of biodiesel on CI engines. A thorough analysis is conducted on the effects of biodiesel on engine power, economy, and discharges, encompassing both directed and undirected outflows. Utilizing biodiesel results in a significant reduction in PM, HC, and CO emissions as well as an increase in fuel consumption and NOx emissions. The engine's power decreased due to the biodiesel's high thickness and loss of calorific value. The content of unsaturated mixtures in biodiesel may have a significant impact on emissions of NOx. however, produced more NOx emissions when compared to pure diesel, with increases ranging from 5.58% to 25.97%. Ramalingam S et al. (2018) conducted studies to enhance performance and lower emissions by adjusting the operating settings and adding antioxidant chemicals to biodiesel. When compared to pure diesel, the use of biodiesel in diesel engines resulted in a minor drop in performance and a reduction in exhaust pollutants. To increase performance, engine operating parameters like injection pressure (IP), timing (IT), and compression ratio (CR) were changed. BTE was found to be 18.39%, 27.48%, 18.5%, and 19.82% for diesel and biodiesel blends such B10, B20, B30, and P50, respectively. When CR was raised from 14 to 18, the HC and CO emissions decreased by 52% and 37.5%, respectively, and the NOx emissions increased by 36.84%. Additionally, they discovered that enhanced IT by 50CA resulted in higher BTE and NOx emissions and decreased emissions of BSFC, CO, HC, and smoke. More reductions in HC, CO, and smoke emissions were seen, but a rise in NOx emissions was noted along with increases in CR, IP, and IT advancement. In the end, it was determined that, when compared to diesel with standard values of CR, IP, and IT, the combination of CR 18:1, IP 240 bar, and IT 26 °CA was superior. With just modest engine changes, antioxidant additives can be used in diesel engines as an alternative fuel. Their appeal could increase due to economic and environmental factors. The study conducted by Devarajan Y et al. (2018) examined the performance, combustion, and emission analysis of blends of n-octanol and mustard oil biodiesel in diesel engines. The blends, consisting of n-octanol and pure methyl ester mustard oil biodiesel, were tested with additions of 10%, 20%, and 30% of n-octanol to increase the oxygenated buffering, which increases the combustion rate and lowers emissions. The study found that both blends of n-octanol and mustard oil biodiesel have higher thermal efficiency than neat biodiesel. The higher energy density and oxidation effect of n-octanol enhance the fuel's oxidation capability and lower emissions of CO, HC, and $NO_X$.

## 2. MATERIALS AND METHODS

The crude canola oil that is taken out of the canola fruit pulp has a slightly heavier and thicker consistency. When it is used directly in the engine, it increases the ignition delay, chokes injectors, sticks on piston rings, and results in poor fuel atomization. Inadequate fuel atomization causes an increase in BSFC to produce the same power output as diesel, but it also causes an erratic rise in HC and soot emissions. Engine vibration might result from detonation brought on by an increase in ignition delay. Therefore, before adding crude canola oil to the engine's combustion chamber, its thickness should be decreased. Like other vegetable oils, free fatty acids (FFA) are present in crude canola oil. It's possible that these free fatty acids are not naturally saturated. Cornitic acid, oleic acid, steric acid, and linoleic acid are the acids found in vegetable oils. An equal proportion of cornitic acid in saturated form is present in crude canola oil. Vegetable oils can be made thinner using a variety of methods, including transesterification, preheating, mixing with diesel, and making micro emulsions. Transesterification is the method most frequently employed to lessen the thickness of vegetable oils among those mentioned above. The process of transesterification involves changing vegetable oil triglycerides into methyl or ethyl esters of fatty acids. The amount of methanol or ethanol, the kind of catalyst, the amount of free fatty acids, the reaction temperature, and the amount of water all affect this process. Because the chosen crude canola oil has more than 0.5% FFA by weight, base catalyzed transesterification will produce the necessary amount of biodiesel. A rise in FFA in crude oil causes soap to develop during the esterification process, which could hinder the process of separating biodiesel from glycerol. For a significant volume of oil to be produced, transesterification requiring both base- and acid-catalyzed must be completed. Saturated fatty acids are eliminated by the acid esterification process, whereas unsaturated fatty acids are eliminated by as catalyzed esterification.

### 2.1 Esterification using acid catalysts

The esterification process must be acid catalyzed since the chosen crude oil has a higher acid concentration. Initially, 5 ml to 95 ml of a mixture of $H_2SO_4$ and methanol are created after preheating crude canola oil. The two solutions are now combined in a 2000 ml round-bottom container and shaken in a reactor. The amount of methanol to oil, reaction time, reaction temperature, and catalyst utilized all affect the production of biodiesel. Thus, employing 1% weight concentration of $H_2SO_4$, the same process is repeated for different methanol to oil ratios of 50:1, 30:1, 20:1, and 16:1, as well as for varied durations of 30 min, 45 min, 60 min, and 90 min, and for varied reaction temperatures of

400 C, 50ºC, and 60ºC. Research has shown that a methanol to oil molar ratio of 20:1, a reaction period of 60 minutes, and a reaction temperature of 60ºC result in the highest production of biodiesel.

## 2.2 Esterification using base catalysts

For this investigation, KOH has been used as the catalyst. The base esterification process is done in two steps, depending on the FFA content. The product obtained from the acid esterification procedure is combined with methanol and a catalyst KOH combination in the current work. The mixture is constantly agitated in the reactor at 500 revolutions per minute. The aforementioned procedure is repeated with 0.25g, 0.5g, and 1g of KOH for varying lengths of time and for varying cycles and methanol to oil molar ratios of 6:1, 9:1, 16:1, and 24:1. The biodiesel yield reaches its peak after 30 minutes of mixing, 400 degrees Celsius of reaction temperature, and 1% weight concentration of KOH. Methanol has a boiling point of 65.50C, so if the aforementioned procedure is done at a temperature higher than 600C, the production of biodiesel will not be adequate.

## 2.3 Washing and Purification

After the aforementioned procedure, the mixture is left to settle for 12 hours in order to facilitate the separation of glycerol and biodiesel. Glycerol collects at the bottom of the container and biodiesel is collected at the top. After that, the collected biodiesel is violently shaken with water at 500°C. Through this procedure, contaminants in the biodiesel are reduced and the pure biodiesel is recovered. After this process, the biodiesel output is close to 94%.

## 2.4 Fuel Properties

Gas chromatography-Mass spectrometry analysis was performed to determine the composition of fatty acids, and the resulting chromatogram is displayed. One important component that significantly affects combustion and emission characteristics is the content of unsaturated fatty acids. Canola oil methyl ester is cooked in an oven for GC-MS analysis. The oven's temperature is raised steadily at a pace of 100 C per minute until it reaches 573K. The chemicals are sent for analysis using mass spectrometry, where they undergo filtration, ionization, and ultimately compound detection. The saturated and unsaturated fatty acids contained in the biodiesel sample are cornitic acid, stearic acid, oleic acid, and lindoleic acid. Table 1 lists the fatty acid content following GC-MS analysis; Table 2 shows the chemical and physical characteristics of the additive (Decanol) and methyl ester of crude oil. Additionally, Table 3. represents the properties of all the samples that were determined experimentally using various equipment. The formula for calculating cetane index is provided below. The cetane index was computed in accordance with ASTM guidelines.

**Table-1:** Fatty acid composition of canola oil methyl ester

| FATTY ACID | AREA % BY GC-FID |
|---|---|
| CORNITIC ACID | 6.0 |
| HEXADECENOIC ACID | 0.1 |
| STEARIC ACID | 3.2 |
| OLEIC ACID | 31.0 |
| LINOLEIC ACID | 58.4 |
| ARACHIDIC ACID | 0.2 |
| EICOSENOIC ACID | 0.2 |
| BEHENIC ACID | 0.7 |
| LIGNOCERIC ACID | 0.2 |

**Table-2:** Physical and chemical properties of COME, Diesel and additive Decanol

| Properties | Test Method ASTM D 6751 | COME | DIESEL | Decanol |
|---|---|---|---|---|
| Calculated cetane Index | ASTM D 613 | 51 | 48 | 50 |
| Calorific value kJ/kg | ASTM D 4809 | 39650 | 42500 | 41818 |
| Flash point ($^0$c) | ASTM D 93 | 169 | 54 | 108 |
| Density @15$^0$c in gm/cc | ASTM D 1298 | 0.890 | 0.830 | 0.8297 |
| Kinematic Viscosity @40$^0$C in CST | ASTM D 445 | 6.40 | 3.08 | 4.6 |

**Table-3:** Properties experimentations

| Properties | Test Method ASTM D | COME100 | D50COME50 | D50COME40 DEC10 | D50COME30 DEC20 | P50COME40 DEC10 |
|---|---|---|---|---|---|---|
| **Calculated cetane Index** | ASTM D 613 | 51 | 50.05 | 49.84 | 49.63 | 49.42 |
| **Net Calorific value kJ/kg** | ASTM D 4809 | 39650 | 40765 | 41043.8 | 41322.6 | 41601.4 |
| **Flash point ($^0$c)** | ASTM D 93 | 169 | 110 | 104.6 | 98.7 | 92.8 |
| **Density @15$^0$c in gm/cc** | ASTM D 1298 | 0.890 | 0.8619 | 0.85549 | 0.84908 | 0.84267 |
| **Kinematic Viscosity @40$^0$C in CST** | ASTM D 445 | 6.40 | 4.825 | 4.818 | 4.811 | 4.804 |

## 3. EXPERIMENTAL PROCEDURE AND TEST SET-UP

A 4-stroke, single-chambered C.I. motor (Kirloskar Engines) served as the basis for the current study. From no load to full load, performance, emissions, and combustion parameters were examined. Every fuel mix that is shown in different plots has undergone three performance and emission parameter tests; the average results are used to create the final graphical depiction. Figure 3.1 shows the experimental setup that was employed for this study. To put the engine under load, an eddy current dynamo meter was connected to it. The estimation of the fuel stream rate was conducted by timing the use of a known quantity of fuel (10cc) from a glass burette. A variety of performance and emission characteristics, including BSFC and BTE, as well as HC, CO, and NOx, were assessed. Evaluating the dark smoke emitted by the diesel engine was the primary motivation behind smoke assessment. When evaluating the potency of smoke, deceivability served as the foundational threshold. The diesel motor smoke was estimated using a Bosch meter. It consists of an assessment unit and a testing siphon. Nearly 300cc of exhaust gas were moved by the examination siphon using a spring-operated siphon and released by the middle abdomen's pneumatic activity. In addition, the gas test was obscured by being drawn through the separating paper. A recalibrated photocell reflects meter was used to measure the spot precisely on the filter paper and determine its intensity. Bosch smoke units, which range from white to black on a scale of 10, were used to assess the spot's intensity arbitrarily. The exhaust's smoke density was measured with a smoke meter. CO and HC emissions were measured using HORIBAMEXA-324 FB. The amount of pressure released during an engine cycle was measured using a piezoelectric transducer. P-theta and HRR graphs were obtained using a cathode ray oscilloscope (CRO). The gas pressure was determined by measuring the potential difference between the cylinder's inner and outer curved surfaces. The air-box method can be used to measure the air flow rate. Initially, air was drawn into the opening at the air box's entrance. Using a U-tube differential manometer, the pressure difference between the orifice and its predecessor was measured in terms of the water column. The water column is changed into a corresponding air column. The volumetric efficiency can be determined using the obtained head of air. Nonetheless, there are several outside variables that affect the engine's performance, emissions, and combustion parameters.

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 03 | March - 2024 SJIF Rating: 8.176 ISSN: 2582-3930

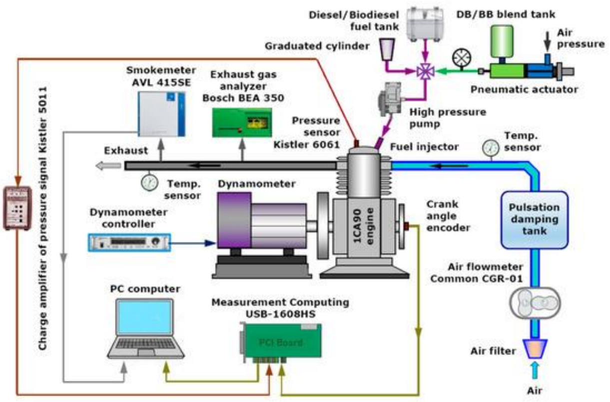


**Fig-3.1:** Schematic Outline of Experimental Test Set-up

## 4. RESULTS AND DISCUSSIONS

### 4.1 Performance characteristics

The following sections describe various performance parameters such as brake specific fuel consumption and brake thermal efficiency at different loading conditions.

### 4.1.1 Brake thermal efficiency

The variance in brake thermal efficiency with relation to brake mean effective pressure for various tested fuels and ternary mixes is displayed in Figure 4.1. It was observed that when the brake mean effective pressure rose, so did the brake thermal efficiency. Diesel fuel has a greater BTE than other tested fuels due to its lower viscosity. The primary cause of the decline in efficiency relative to D100 was the higher calorific value of D50COME50. However, because D50COME50 had a larger calorific value, its BTE was higher than COME100's. Ternary blends' BTE was greater than that of COME100 and D50COME50. This resulted from the ternary mixes' increased oxygen concentration and calorific value, which affected the fuel's atomization and rate of burning. Ultimately, it was found that D50COME20DEC30 BTE was almost identical to D100. D50COME20DEC30 had a BTE that was 3.1% greater than D50COME50 and 4.71% higher than diesel.

### 4.1.2. Brake specific fuel consumption

Figure 4.2 shows variations in brake-specific fuel usage throughout brake mean effective pressure. The amount of fuel used per unit of generated brake power was defined as the brake specific fuel consumption, or BSFC. The efficiency with which an engine transforms energy input into usable work output is measured by brake specific fuel consumption (BSFC). For any engine, a lower BSFC value is always preferred, and this can be attained by increasing the fuel's heat content (calorific value). With a rise in brake mean effective pressure, all fuel samples show a reduction in BSFC, which is a general tendency for all diesel engines operating at constant speed. The BSFC of COME100 was found to be 0.34 kg/kWh, which is 20.58% and 8.82% greater than those of D50P50 and diesel fuel, respectively. Because biodiesel naturally contains oxygen, it has a lower heat content, which means more fuel is needed to produce the same amount of power. However, the fuel reformulation via decanol has lowered the BSFC value at all engine loads in comparison to pure biodiesel. The main cause of the decrease in fuel consumption for the ternary blends as compared to D50COME50 is more heat emitted due to a higher calorific value. Furthermore, compared to COME100 and D50COME50, the BSFC of the ternary blend D50COME20DEC30 was 20.58% and 12.90% lower.

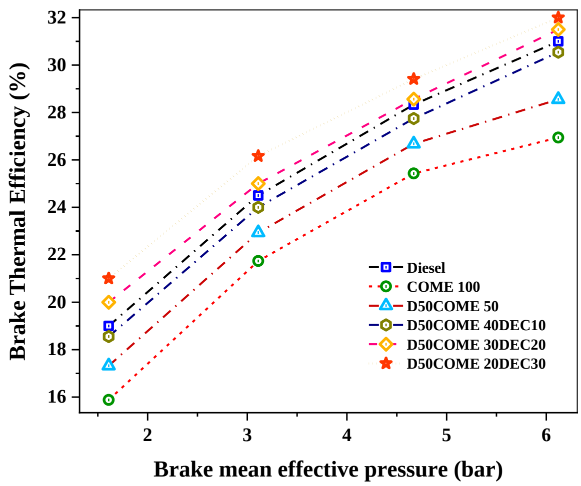


**Fig-4.1:** Biodiesel and additive concentration effect on Brake Thermal Efficiency.

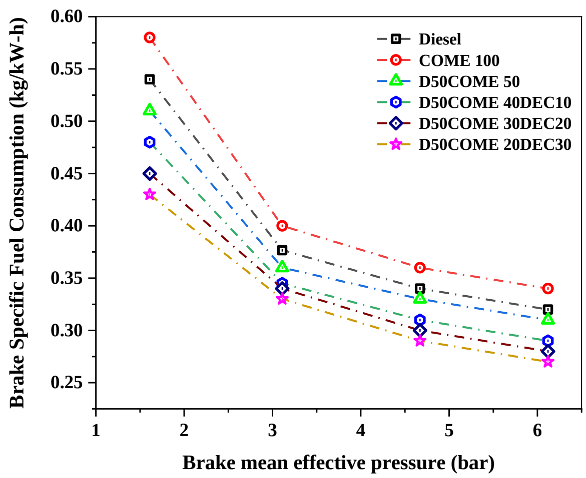


**Fig-4.2:** Biodiesel and additive concentration effect on BSFC

### 4.2 Emission parameters

The next part shows the smoke opacity, oxides of nitrogen, and unburned hydrocarbons as the outflow characteristics for different ternary blend samples. The primary determinants of emission characteristics are the degree of combustion and the amount of heat released.

#### 4.2.1 Unburnt Hydrocarbons

The deviation of unburned hydrocarbon (UBHC) for distinct samples of test fuels was shown in Fig.4.3. The primary source of the hydrocarbon emissions is incomplete combustion inside the combustion chamber, which can be brought on by incorrect fuel-air mixing or flame quenching. As engine load increases, there is a decreasing tendency in the creation of hydrocarbon emissions, which could be attributed to rising temperatures and power output. On the other hand, the natural oxygen content of COME biodiesel and the decanol in diesel fuel improve combustion and lower HC emissions. The HC emission for COME100 was reported to be 49 ppm, which was less than that of diesel fuel. This could be because biodiesel contains more oxygen. This resulted from the decanol's higher oxygen content and decreased density, which sped up the combustion process when decanol was added in the 10%, 20%, and 30% range. Compared to D100, COME100, and D50COME50, the HC emissions for D50COME20DEC30 were 26.66%, 20%, and 12% lower. Conversely, a lower concentration of DEC in the blend has resulted in higher HC emission because of the slower evaporation of DEC in the blend, which may enhance the flame quenching and lean flame out zones inside the combustion chamber.

#### 4.2.2 Nitrogen Oxide Emissions

The nitrogen molecule was stable, and dissociation occurs as the temperature rises over 1200 °C. Due to its high reactivity, the fragmented nitrogen molecule combines with the incoming oxygen molecule to generate nitrogen oxides in order to return to equilibrium. The maximum temperature inside the cylinder and the amount of oxygen in the fuel were two of the most significant factors in the emission of nitrogen oxides. NOx emissions formed at higher combustion temperatures and oxygen concentrations. NOx emissions are formed by a number of other variables, including the compression ratio, cylinder geometry, inlet air temperature and pressure, and fuel's chemical composition. The comparative study of NOx emissions for diesel, COME, and all ternary mixes in relation to engine loads is shown in Fig. 4.4. It has been noted that when engine BMEP grows, nitrogen oxide emissions rise as well. This is because rising engine load causes the gas temperatures inside the combustion chamber to rise to a high of approximately 1500 °C, which is conducive to the creation of NOx emissions. Additionally, compared to normal diesel, the NOx emission rose by almost 33% when pure COME gasoline was used to fuel the diesel engine. When compared to pure diesel, COME has a greater cetane index, which shortens the ignition delay time and promotes better combustion with increased NOx generation. Decanol would lower the blend's cetane number and may have an impact on the diesel aromatics, which are crucial for diesel combustion. Furthermore, compared to D50COME50, the higher latent heat of vaporization of decanol may cause an excessive amount of heat to be observed, slowing down the combustion process and lowering NOx emission by a very small concentration.

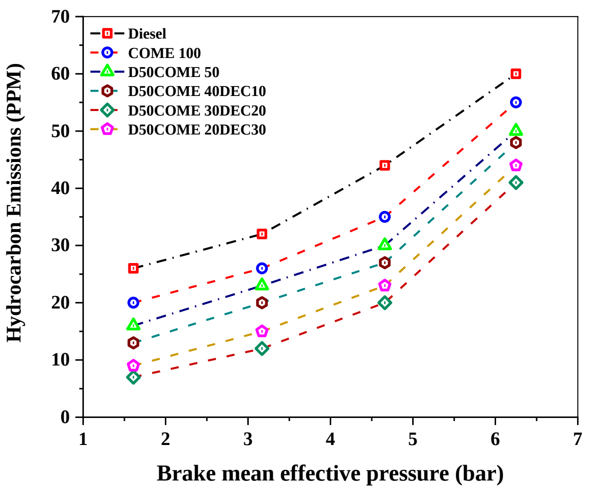


**Fig-4.3:** Biodiesel and additive concentration effect on Hydrocarbon Emissions

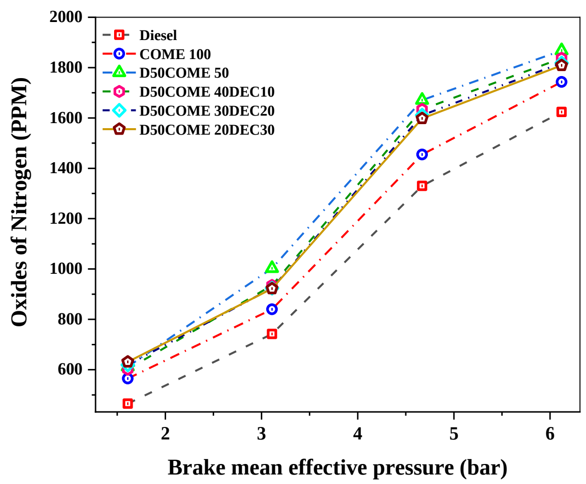


**Fig-4.4:** Biodiesel and additive concentration effect on NOx Emissions

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 03 | March - 2024 SJIF Rating: 8.176 ISSN: 2582-3930

### 4.2.3 Smoke Opacity

One of the important emission factors is smoke opacity. There was a correlation between the production of smoke opacity emission and the fuel-rich zones. The comparison of the smoke opacity emissions for diesel, COME, and all ternary blends with regard to engine loads is shown in Fig. 4.5. It has been noted that when engine BMEP rises, opacity emissions rise as well because rich mixtures enter at greater loads, which are ideal for the production of smoke emissions. When diesel was used at maximum load, pure biodiesel had 25.47% more smoke opacity. This resulted from using more fuel to produce the same amount of power, which led to incomplete combustion. It's interesting to note that the decanol fuel reformulation with diesel-COME has greatly reduced the smoke opacity emission, with the decanol content in the mix playing a major role in this decrease. Decanol would lower the blend's cetane number and may have an impact on the diesel aromatics, which are crucial for combustion. Furthermore, when the concentration of decanol was increased, the behavior of smoke emissions decreased. This could be explained by the accelerated combustion brought about by the increased oxygen content. For D100 and D50COME20DEC30, the observed smoke opacity was 65.66% and 72.7%, respectively. This suggests that for all loads, the smoke emissions for D50COME20DEC30 were almost identical to those of diesel.

### 4.3 Combustion Analysis

Various combustion parameters such as heat release rate, cylinder pressure with respect to crank angle,

mass fraction burnt was analysed in the following sections.

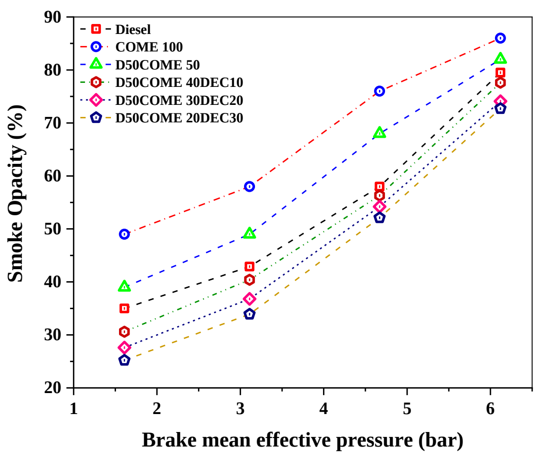


**Fig-4.5:** Biodiesel and additive concentration effect on Smoke opacity

### 4.3.1 Cylinder Pressure

Generally speaking, the internal cylinder pressure released during combustion and its change with respect to crank angle are determined by the fuel's oxygen concentration and calorific value. Because diesel fuel has a higher calorific value than COME100, it often produces higher peak pressures due to increased combustion rates and even higher temperatures. Diesel, biodiesel, and decanol were utilized as ternary fuel samples in the current investigation. The sample burns more quickly when the decanol alcohol has a high oxygen rate and calorific value. When compared to other biodiesel ternary blends, the D50COME20DEC30, with its 30% alcohol concentration, created higher pressures because an increase in alcohol content raises the blend's calorific value and oxygen content. As a result represented in Fig.4.6, high peak pressures were produced for these samples. When D50COME20DEC30 was compared to pure diesel, the peak pressure it produced was 3.75% lower.

### 4.3.2 Heat Release Rate

The pace at which heat is released is primarily determined by the pressure that is produced. This is also due to thermodynamics, which states that as a substance's pressure increases, so does its temperature. In comparison to diesel and additive-added biodiesel, the combustion of pure biodiesel releases less heat at a faster rate. Because pure biodiesel and its blends have high viscosities, low calorific values, and high densities, they don't produce a lot of heat. However, when alcohol is added to the blend, it liberates closer to the diesel and exhibits a distinct, attractive curve in the graph because alcohol has a high cetane number, high oxygen content, and a higher combustion rate than biodiesel. Therefore, the D50COME20DEC30 blend batter has a higher net heat release rate than the other blends. The HRR of COME100 is 20.16% lower than that of D50COME20DEC30. Compared to the ternary blend, pure diesel yields some better leasing.

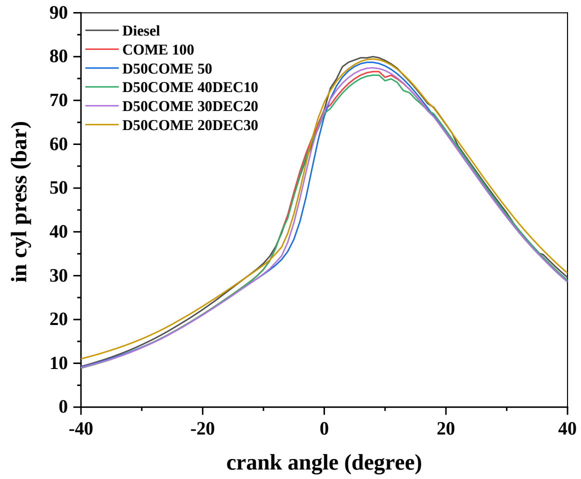


**Fig-4.6:** Biodiesel and additive concentration effect on in cylinder pressure

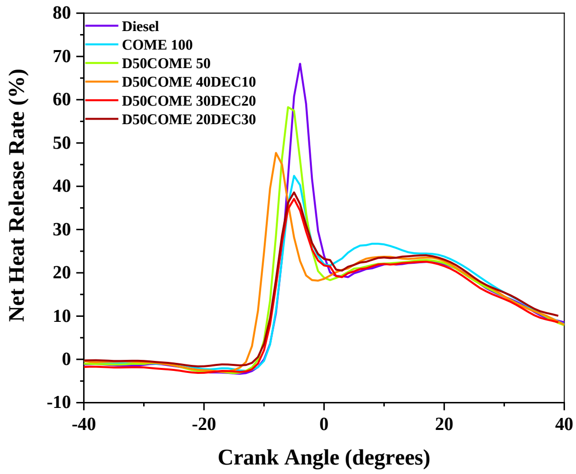


**Fig-4.7:** Biodiesel and additive concentration effect on Net Heat Release Rate

## 4. CONCLUSION

The current study focused on the addition of decanol at volumetric concentrations of 10%, 20%, and 30% to diesel and biodiesel. At first, pure diesel (D100) was compared with 50% and pure biodiesel. Decanol was added in increments of 10%, 20%, and 30% by volume, all while keeping the diesel concentration at 50%. For decanol additions of 10%, 20%, and 30%, the biodiesel concentrations were 40%, 30%, and 20%.

a. According to the study, as decanol concentration rises, brake specific fuel consumption falls and brake thermal efficiency rises. At full load, BTE values of 32.24% and 31.68% for pure diesel and D50COME20DEC30, respectively, were noted.
b. The ternary blend D50COME20DEC30 BSFC was 12.89% and 20.63% lower than those of COME100 and D50COME50. Although the total heat release rate is seen to be reduced during the end phase of ignition, heat release rate is observed to increase with the expansion of decanol content in the ternary mix.
c. NOx emissions for D50COME50 and for 10%, 20%, and 30% of decanol in the ternary blend were 1869 PPM, 1838 PPM, 1819 PPM, and 1810 PPM. Therefore, in order to increase engine performance and emissions without altering the CI engine, the present examination recommends a 30% blend of decanol, 20% biodiesel, and 50% diesel.
d. When compared to all biodiesel and ternary blends, the diesel combustion yielded a higher cylinder pressure. The calorific value, density, and viscosity all affect the pressure that is generated. Blends with a high calorific value will burn more effectively. When compared to pure diesel, the peak pressure generated by D50COME20DEC30 was slightly lower by 3.82%, and it was 4.69%, 4.31% higher than that of COME100 and D50COME50. As can be seen from the cylinder pressure graphs, the addition of decanol suppresses the biodiesel's reduced heating value impact, raising the cylinder pressure once more.

REFERENCES

[1] Nanthagopal k , Ashok B, Saravanan B, Patel D, B. Sudarshan, Ramasamy RA (2018) An assessment on the effects of 1-pentanol and 1-butanol as additives with Calophyllum Inophyllum biodiesel. Energy Conversion and Management 158, 70-80.
[2] Fattah IMR, Masjuki HH, Kalam MA, Mofijur M, Abedin MJ (2014) Effect of antioxidant on the performance and emission characteristics of a diesel engine fuelled with corn biodiesel blends. Energy Conversion and Management 79, 265–272.
[3] Ramalingam S, Rajendran S, Ganesan P, Govindasamy M (2018) Effect of operating parameters and antioxidant additives with biodiesels to improve the performance and reducing the emissions in a compression ignition engine. Renewable and Sustainable Energy Reviews 81, 775–788.
[4] Alagu K, Beemkumar N (2018) Impact of antioxidant additives on the performance and emission characteristics of C.I engine fuelled with B20 blend of rice bran biodiesel. Environmental Science and Pollution Research.
[5] El-Arab R, Amin A (2017) Study on the characteristics of corn oil–biodiesel–diesel fuel blend, Egyptian Journal of Petroleum.
[6] Vijay raj K, Sathiyagnanam AP (2016) Experimental investigation of a diesel engine with methylester of mango seed oil and diesel blends. Alexandria Engineering Journal 55, 215–221.
[7] Velmurugan K, Sathiyagnanam AP (2015) Impact of antioxidants on NOx emissions from a mango seed biodiesel powered DI diesel engine. Alexandria Engineering Journal.
[8] K. Nanthagopal, B. Ashok

(2019) Study on decanol and Calophyllum Inophyllum biodiesel as ternary blends in CI engine. Fuel 239, 862–873.

[9] Venu H, Subramani L, Raju VD (2019) Emission reduction in a DI diesel engine using exhaust gas recirculation (EGR) of corn biodiesel blended with TiO2 nano additives. Renewable Energy 140, 245-263. [10] Anbumani K and Pal Singh A (2010) performance of mustard and neem oil blends with diesel fuel in CI engine. Journal of Engineering and Applied Sci, VOL. 5, NO. 4. [11] Prabu SS, Asokan MA, Prathiba S, Ahmed S, Puthean G (2018) Effect of additives on performance, combustion and emission behaviour of preheated corn oil/diesel blends in DI diesel engine. Renewable Energy 122, 196-205. [12] Srinivas, Abhimanyu, Posangiri R (2018) Emission Characteristics of Totapuri Mango Methyl Ester Biodiesel Fuelled Single Cylinder Four Stroke Diesel Engine. International Journal of Research in Advent Technology, Vol.6, No.11. [13] Imtenan S, Masjuki HH, Varman M, Kalam MA, Arbab MI, Sajjad H, Rahman SMA (2014) Impact of oxygenated additives to corn and jatropha biodiesel blends in the context of performance and emissions characteristics of a light-duty diesel engine. Energy Conversion and Management 83, 149–158.

[14] Pugazhvadivu M (2009) Studies on the effect of ethanol addition to biodiesel: Performance and emissions of a diesel engine, Indian Journal of Science and Technology. Vol.2 No. 11, ISSN: 0974-6846. [15] Narkpakdee J, Permsuwan A, Deethayat T, Kiatsiriroat T (2012) Performance and Emission of Small Diesel Engine Using Diesel-Crude Corn Oil-Water Emulsion as Fuel. Energy Science and Technology, Vol. 3, No. 2, pp. 38-45, ISSN 1923-8479.

[16] Hasan Ali MD, M Mashud (2013) Biodiesel from Neem oil as an alternative fuel for Diesel engine. 5th BSME International Conference on Thermal Engineering, Procedia Engineering 56, 625 – 630. [17] Ashok B, Nanthagopal K, Perumal LA, Babu JM, Tiwari LA, Akhil Sharma (2019) An investigation on CRDI engine characteristic using renewable orange-peel oil. Energy Conversion and Management 180, 1026–1038. [18] Sreeja C, Prasanthi G (2015) Experimental investigations of performance and emission characteristics of a compression ignition engine fuelled with diesel pine oil blends and by adding 2-ethoxy ethyl acetate as an additive. International Journal of Applied Research 1(12): 158-164.

[19] Anand BP, Yadav SPR, Aasthiya B, Akshya G, Arulmozhi K (2018) Effect of Fuel Injection strategies on performance of common rail diesel injection (CRDI) engine powered by Biofuel. International journal of ambient energy, DOI: 10.1080/01430750, 1517690. [20] Ashok B, Raj RTK, Nanthagopal K, Krishnan R, Subbarao R (2017) Lemon-peel oil- A novel renewable alternative energy source for diesel engine. Energy Conversion and Management 139:110-121