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Effect of Sesame oil Biodiesel Blends on the Performance and combustion of CI Engine

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ABSTRACT

Alternative fuels are the fuel for the future as it plays a vital role in mitigating pollution effect on the environment. Biodiesel prepared from sesame oil has comparable chemical properties to conventional diesel. Blending the sesamebiodiesel with mineral diesel for running a compression ignition engine is found to be economical and less polluting. This study investigated the performance analysis of sesame-based biodiesel blends. At high engine load and 1500 rpm, the peak cylinder pressure of biodiesel blends is 41.20 bar (B10), 40.21 bar (B20), 44.68 bar (B30), and 45.91 bar for diesel fuel. The maximum heat release rate of the diesel fuel exceeds 85 J / deg, with a maximum heat release rate of 80.62 J / deg (B20), 75.11 J / deg (B15), 40.63 J / deg (B10), and 20.63 J/deg (B5). The higher the fuel consumption in the system, the largest fuel is used. Quantitative heat release is better for B15 than D100, and the maximum value is about 7.7 % more than the value for D100. Brake meansadequate pressure is better for B10 as compared to D100. Indicated mean adequate pressure for B10 is 2.67% more than the value for B15. Thus, the higher the fuel consumption in the system, the largest the fuel used.

I. INTRODUCTION

Fossil fuels are depleting at a faster rate than expected them to be [1]. The combustion process in a diesel engine is mainly based on atomization characteristics and air-fuel mixing [2]. The present study examines sesamebiodiesel as an appropriate diesel replacement. The main emphasis of this research is on fuel characteristics and engine combustion issues. Finally, we analyze the performance, combustion, and emission characteristics of the sesame biodiesel blends with diesel.Sesame-basedbio-resourcesandcost-effectivewastes in the application of CI engines especially in earlier studies, it has been found that sesame is comparatively more abundantly available and cost-effectivebiofuel than mahua oil and other vegetable oils [3-5].

Piloto-Rodríguez, R et al. [6] investigated the effect of diesel engine performance when fueled with biodiesel from algae and microalgae and found the performance 66 percent effective with low emission of NOx. Naik M et al. [7] stated that unprocessed oil might also be used in diesel motors, albeit with the required motor driving habits modification. In contrast to diesel fuel, vegetable oil mainly comprises high-free fatty acid Karanja oil saturated hydrocarbons, triglycerides, and glycerol esters.Archer,S et al.[8] have revealed a distinct chemical structure for the palm oil biodiesel life cycle. Up to three fatty acids are coupled with an ester-connected glycerin molecule. The length of the carbon chain and the amount of double bonds of the fatty acids varies. The typical chain length in vegetable oils ranges from 12 to 22 carbon atoms, with the physical-chemical characteristics of the oil as opposed to diesel being responsible for 0 to 3 double bonds Gautam, R et al. [9].

II. Materials and methods

For biodiesel production, Transesterification is the technique utilized within sight of the impetus, like sodium hydroxide or potassium hydroxide, for the synthetic separating of the crude oil particle into methyl or ethyl ester and glycerol [10]. Oil usually consists of 72% vegetable oil and 28% biodiesel catalyzed by CaO. Transesterification is known as the process of eliminating in the presence of a catalyst and glycerol and fatty acids from vegetable oil [11]. Vegetable oil catalyzes mono-hydro-alcoholic drinking, such as methanol/ethanol, interacting with the presence of sodium and potassium Kouzu, M., & Hidaka, J. S. [12].

The most promising method was transesterifying triglycerides with methanol, ethanol, propanol, and butanol. Methanol is the most frequently used alcohol owing to its cheap cost. The significant factors influencing ester output during the transesterification process are free fatty acid effects and humidity, type, and concentration of catalyst, molar alcohol-oil ratio and alcohol type, reaction time and temperature effect, and intensity mixing [13].

The free fatty acid and moisture content are the essential criteria for the feasibility of the process of vegetable oil transesterification. A free fatty acid (FFA) value lower than 3 percent is required to complete the catalytic base reaction. The more the acidity of the oil, the less the conversion efficiency (Dorado et al 2002). Methoxide and hydroxide from Na and K should be kept in anhydrous condition since extended air contacts decrease the efficacy of these catalysts via moisture and CO_2 interactions [14].Alkaline catalysts are preferable to industrial operations because they are less corrosive for industrial equipment. The concentration in the range of 0.5%-1.0% (weight/weight) showed that 94%-99% of vegetable oil is converted into esters. Further increase in catalyst concentration does not impact the conversion but increases additional costs [15].

With a molar ratio of alcohol to oil and type of alcohol the industrial process employs an ester yield of more than 98 percent with a molar ratio of 6:1 Acid, peroxide, iodine, and saponification have a minor influence on the molar proportion of methyl esters. In addition, the high molar alcohol/vegetable oil ratio interferes with glycerin separation.The highest production of esters occurs at the molar ratio of 6:1 at temperatures ranging from 60°C to 80°C [16].The transesterification process is vital because NaOH-MeOH solution is immiscible with oil and fat. It is no longer required to stir after the two phases are mixed. Methanolysis was conducted at 180, 360, and 600 rpm (rpm). As a result, Methanolysis was minimal at 180 rpm [17].

Fig.1 : Separation process of sesame biodiesel and glycerine in the funnel

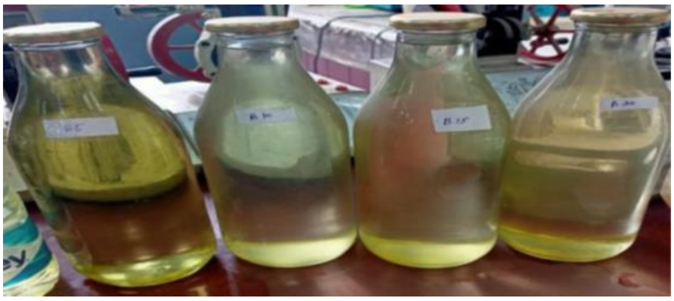

Fig. 2. Different blends of Pure Diesel and Sesame Biodiesel

III. Results and discussions

3.1. Net heat v/s crankshaft

As shown in Fig. 3, the motor's fusion rates of diesel and biodiesel vary at 5 %, 10%, 15%, and 20%. Initially, there is a negative heat output. Due to endothermic chemical and physical processes happening during the ignition delay period, and because the fuel accumulates, vaporization occurs, resulting in negative heat release. Both diesel and biodiesel burn in the same way. After the pre-muzzled combustion stage, the fuel-air combination burns quickly, and the heat release is positive when auto-ignition occurs. The fuel-air mixing velocity controls the burn rate at this step. It may be found that combustion for biodiesel mixes begins sooner, owing to a reduced ignition delay. Biodiesel is greater than 80,62J/deg (B20), 75,21J/deg (B15) and 40,63J/deg (B10), and 20,63J/deg (B20) (B5The maximum heat discharge of diesel fuel is somewhat greater when combined with biodiesel due to enhanced volatility and improved air contact. A longer ignition time for diesel fuel may also cause significant amounts of fuel to accumulate in the combustion chamber throughout the pre-measured burning duration, increasing the heat release rate. However, heat releases in biodiesel blends are only significantly less than in diesel after late combustion. This is because the more oxygen-intensive chemicals ensure that the remaining fuel is fully combusted from the primary combustion phase and burned in the later burning process.

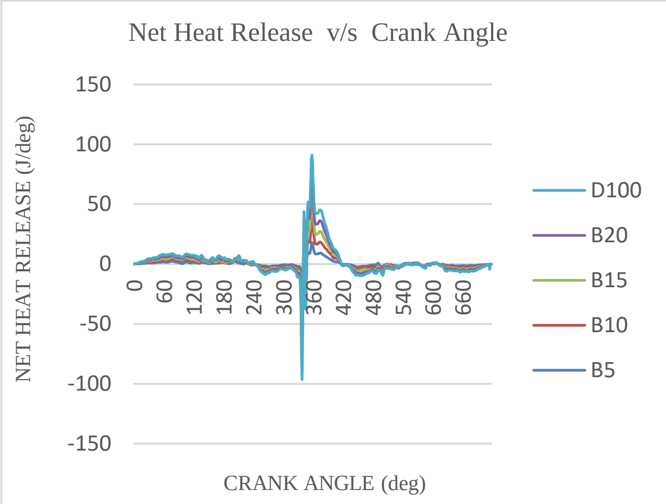

Fig. 3. Heat release graph v/s crank angle

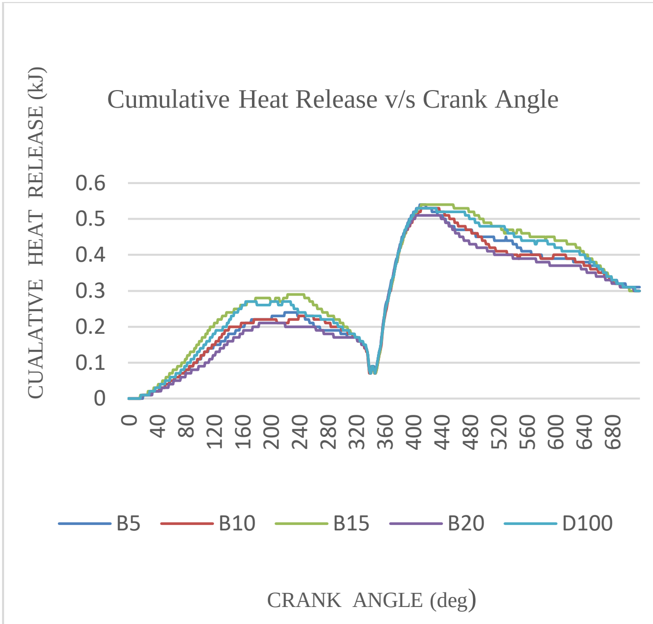

Fig. 4. Cumulative heat release v/s crank angle

Fig.4 shows the cumulative change in the heat release rate of diesel and biodiesel mixtures. The cumulative rate of heat emission of diesel fuel is 0.52 kJ, and biodiesel is 0.57 kJ (B15) (B20).

3.2. Mean gas temperature v/s crank angle

The extreme gas hotness for diesel fuel is 800.21 / daC, and the biodiesel combination is 831.21 / daC (B10), 825.5 / daC (B15), and 820.65 / daC for diesel fuels (B20). This shows 1%, 2%, and 4.4% differences in values for B5-, B10- and B20 biodiesel compared to diesel correspondingly. The air temperature at the conclusion of the compression may be seen to be high enough to spray and ignite the droplet upon entering the cylinder. The gas temperature for the diesel fuel is greater during the combustion stage and thus increases the pressure during the combustion phase. Fig. 5 illustrates variations in average gas temperature for diesel and bio-diesel mixtures in crank angles.

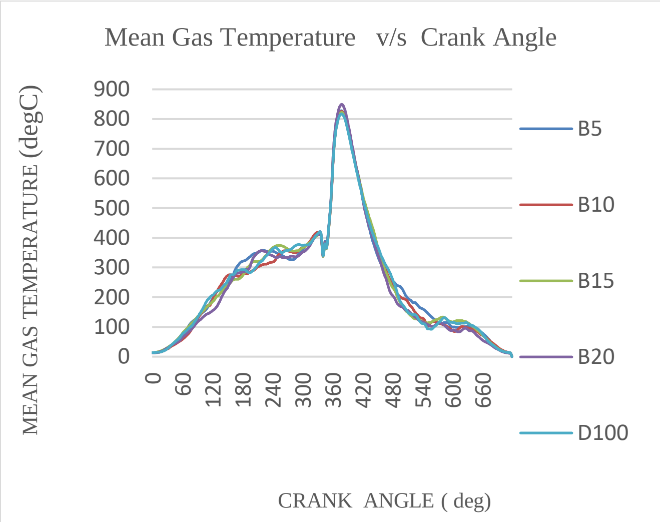

Fig. 5. Mean gas temperature v/s crank angle

3.3. Performance of biodiesel

3.3.1 Torque v/s load

Fig. 6 shows the torque vs. load graph, and it is clearly seen that when the load increases, the Torque of the blend changes. When the load 3 kg the highest Torque shown for B 10 followed by the D 100, then B 5, and lastly B 15. At the 6 kg load the highest torque shown for D 100 followed by the B 10 and B 5, B 20. At the 9 kg load the highest torque obtained for the D 100 followed by the B 10 and B 15 respectively. At 12 kg load the again highest torque obtained for the D 100 followed by the B 15 and B 5.

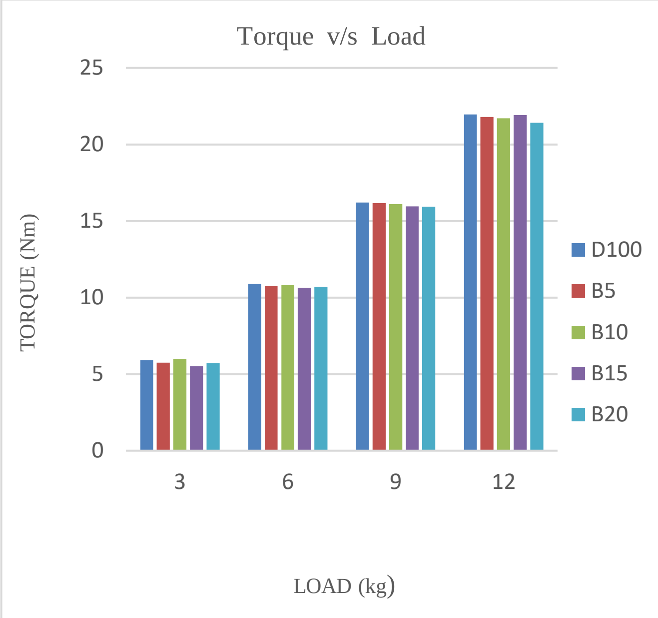

Fig. 6. Torque v/s load

3.3.2. Brake power v/s load

Fig. 7 shows the BP v/s load graph. At 3 kg load, the highest BP is shown for D 100, and in the second position, almost all blend shows the same BP. At the 6 kg load, the highest BP is shown for D 100, followed by B 5, B 10, B 15, and B 20; in the 6 kg load, the BP decreases gradually. At a 9 kg load, all materials show the same BP. At 12 kg load, the highest BP was shown for D 100, followed by the B5, B 10, B 15, and B 20, respectively.

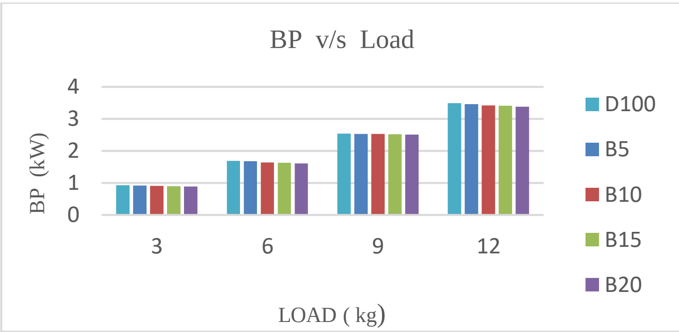

Fig. 7. Brake Power v/s load

3.3.3. Brake thermal efficiency v/s load

From Fig. 8,we can see that as the load increases, so is brake thermal efficiency. It can also be noted that the brake thermal efficiency is highest for B 10 i.e., 20.4% and lowest for D100 i.e., 19.42% at maximum load condition.

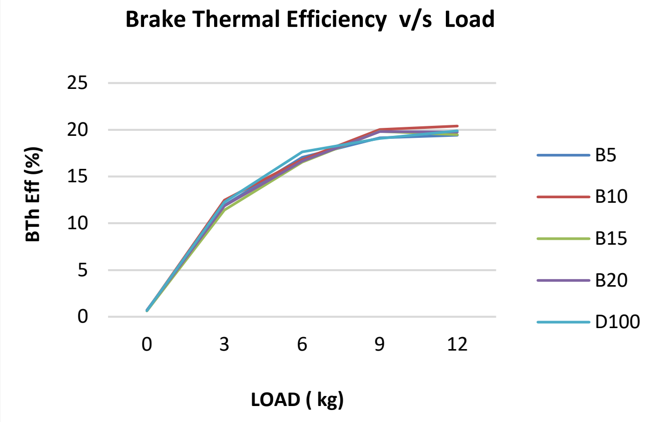

Fig. 8. Brake thermal efficiency v/s load

3.3.4.BMEP v/s load

From Fig 15, we can see that the BMEP of different sesame oil increases when the load increases. It can be noted that the highest values are seen for B 10, i.e., 4.2 bar whereas the lowest values are shown for B 20, i.e., 4.07 bar.

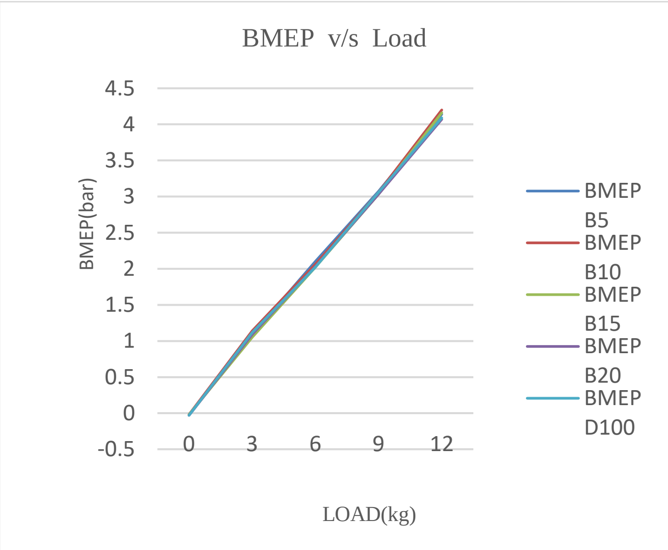

Fig. 9. Brake mean effective pressure v/s load

3.4. Fuel consumption v/s load

Fig. 10 shows the fuel intake of pure diesel and different biodiesel blends and it can be seen that as the load is increasing so is the fuel consumption. The highest fuel consumption is shown for the B 15 followed by the D 100 and others blend shows the lowest fuel consumption of the system.

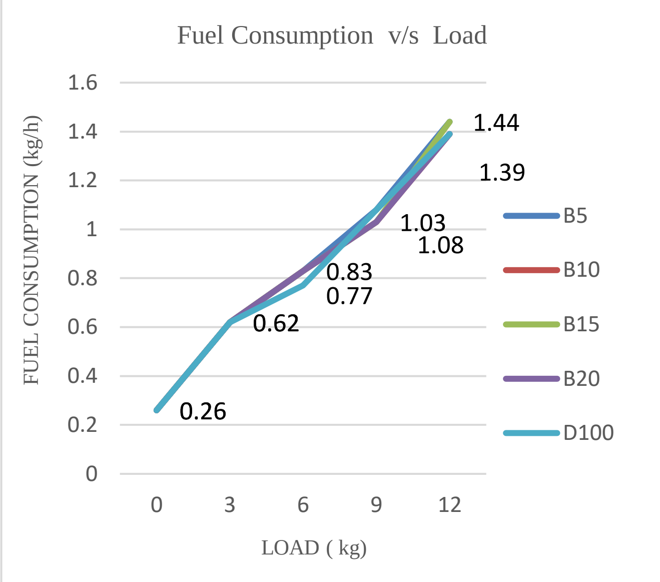

Fig. 10. Fuel consumption v/s load

IV. CONCLUSION

The maximum heat release rate of the diesel fuel exceeds 85 J / deg, with a maximum heat release rate of 80.62 J / deg (B20), 75.11 J / deg (B15), 40.63 J / deg (B10) and 20.63 J/deg (B10) (B5). The peak heat release rate for diesel fuel is somewhat higher than that in biodiesel mixtures, due to increased volatility and a better combination from diesel to air. Another factor might be a protracted ignition period in Diesel fuel, which results in a higher level of heat release during pre-feed burning phases, causing a considerable amount of fuel to build in the combustion chamber.

The highest fuel consumption is shown for the B 15 and followed by the D 100 and others blend shows the lowest fuel consumption of the system. Quantitative heat release is better for B15 as compared to D100 and maximum value is about 7.7 % better than D100 value. Mean gas temperature of B10 is more than the D100.Torque is better for D100. Fuel consumption is higher for B20 than other at all loads. Brake mean effective pressure is better for B10 as compared to D100.

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