A TRANSESTERIFICATION PROCESS STUDY ON THE PERFORMANCES, EMISSION, AND COMBUSTION CHARACTERISTICS OF SHEEP FAT OIL AS BIODIESEL.

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Abstract :

The purpose of the inquiry is to evaluate the development and application of sheep fat oil as biodiesel, as well as the effects of biodiesel on combustion, engine efficiency, and emissions. The thermo-physical characteristics of biodiesel derived from the transesterfication process as well as their blends from the processes were examined in a single cylinder, water-cooled, DI Diesel engine with an eddy current dynamometer. The test fuel was created using the following ratios: STB 25, STB 50, STB 75, and STB 100, yielding a blend of vacation diesel fuel and sheep fat oil biodiesel. The experimental results reveal a small difference when comparing the brake thermal efficiency to that of solo gasoline. The emission tests were conducted using an AVL DI Gas analyzer, and the findings showed that while NOx greatly decreased as compared to the sole fuel, CO, HC, and Smoke density increased somewhat on one side. The cylinder pressure and heat release rate were also measured using the AVL DI Gas Analyzer.

Key words: Sheep fat oil, Transesterification, Biodiesel, Oxides of nitrogen, smoke.

I. INTRODUCTION

As an alternative to diesel, biodiesel is described as fatty acid methyl or ethyl esters from vegetable oils or animal fat. It is a nontoxic, sustainable, and biodegradable oxygenated fuel [1, 2]. Despite the fact that many stakeholders believe it will help reduce greenhouse gas emissions, increase income distribution, and foster long-term rural growth [3-6]. The main reason for this is a lack of new information about the effects of biodiesel on diesel engines. For example, the reduction in engine power, as well as the increase in biodiesel fuel consumption, is not as significant as anticipated. Theearly research conclusions have been reserved, it is more prone to oxidation for biodiesel which may result in mysterious gumsand sediments that can plug fuel filter, and thus it will influence engine durability [7,8].The key issues with air pollution in the automobile industry are high NOx and HC emissions from diesel engines. In this case, using biodiesel will help minimise HC and CO emissions from the engine. However, for biodiesel blended diesel fuel, NOx emissions are marginally higher [9-13]. Biodiesel's high viscosity, surface tension, and density affect atomization by reducing the mean fuel droplet size, which improves spray tip penetration.

Many researchers have discovered that viscosity and density have the smallest effect on mean droplet size, so viscosity should be the first physical property of a fuel to be reduced to increase atomization [15-17]. Blending biodiesel with diesel fuel, which reduces the viscosity of the fuel, can solve the problem described above. Introduce an analysis of the literature on animal fat oil biodiesel, as well as its efficiency and emission analyzer.**II. Biodiesel Production and Property Analysis**

2.1 Transesterification

Three steps were proposed as the reaction mechanism for alkali catalysed transesterification. The method of converting a triglyceride with an alcohol in the presence of a catalyst to form esters and glycerol is known as transesterification. In the presence of a catalyst, animal fat oil is subjected to chemical reactions with alcohols such as methanol or ethanol. Since the reaction is reversible, more methanol is needed to lower the activation energy, causing the equilibrium to transfer to the product side. Animal fat oil contains triglycerides, which are refined into biodiesel ethyl esters. Both are biodiesel fuels with slightly different chemical combinations. Figure 1 depicts the mechanism of the transesterification reaction scheme. Sheep fat oil is transesterified to create an ester with properties comparable to diesel fuels.Schematic diagram of biodiesel plant is shown in

Figure 2. The properties of the diesel fuel and the sheep fat oil biodiesel ar summarized in Table 1.

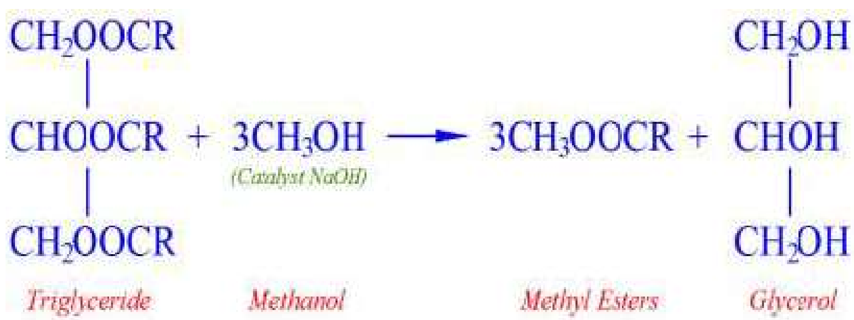

Figure 1. Mechanism of transesterification process.

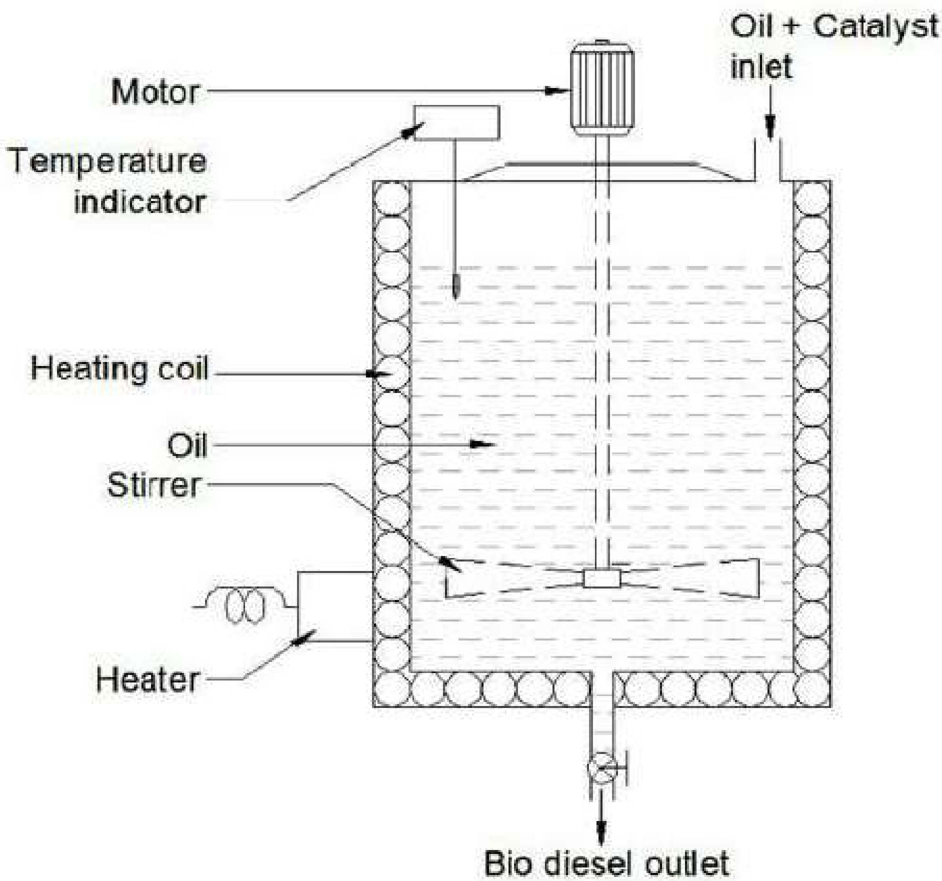

Figure 2. Schematic diagram of Biodiesel Plant

Table 1. Properties of Diesel and Biodiesel

Sample Name	Specific gravity	Density Kg/ m^3	Calorific values Kj/kg
Sole Fuel	0.8350	835	44640
STB 25	0.8635	864	43450
STB 50	0.8638	864	43100
STB 75	0.8648	865	42618
STB 100	0.8652	865	42300

III. Experimental Setup

Kirloskar TV1, a single-cylinder, water-cooled diesel engine coupled to an eddy current dynamometer with computer boundary, was used for testing. Table 2 contains the engine's extensive specifications. During the analysis, an AVL transducer is used to collect and analyse combustion records such as in-cylinder pressure and heat release rate using a data acquisition system. The exams are performed at a rated speed of 1500 revolutions per minute. Exhaust emissions including nitrogen oxides (NOx), hydrocarbons (HC), carbon monoxide (CO), and smoke are all tested in each examination. Brake thermal efficiency (BTE) and basic fuel consumption (SFC) with respect to brake power were calculated from the initial measurement (BP)From the initial measurement, brake thermalefficiency (BTE) and specific fuel consumption (SFC) with respect to brake power (BP) for different blends are calculated. Theblends of biodiesel and diesel used were B25 and B50. B75 and B100 means 25 % biodiesel fuel and 100% of diesel fuel byvolume. In order to study the effect of biodiesel blends on the engine combustion and emission characteristics, the injectiontiming was kept constant at 23° TDC. The effect of biodiesel blends was studied and results were compared with sole fuel diesel.

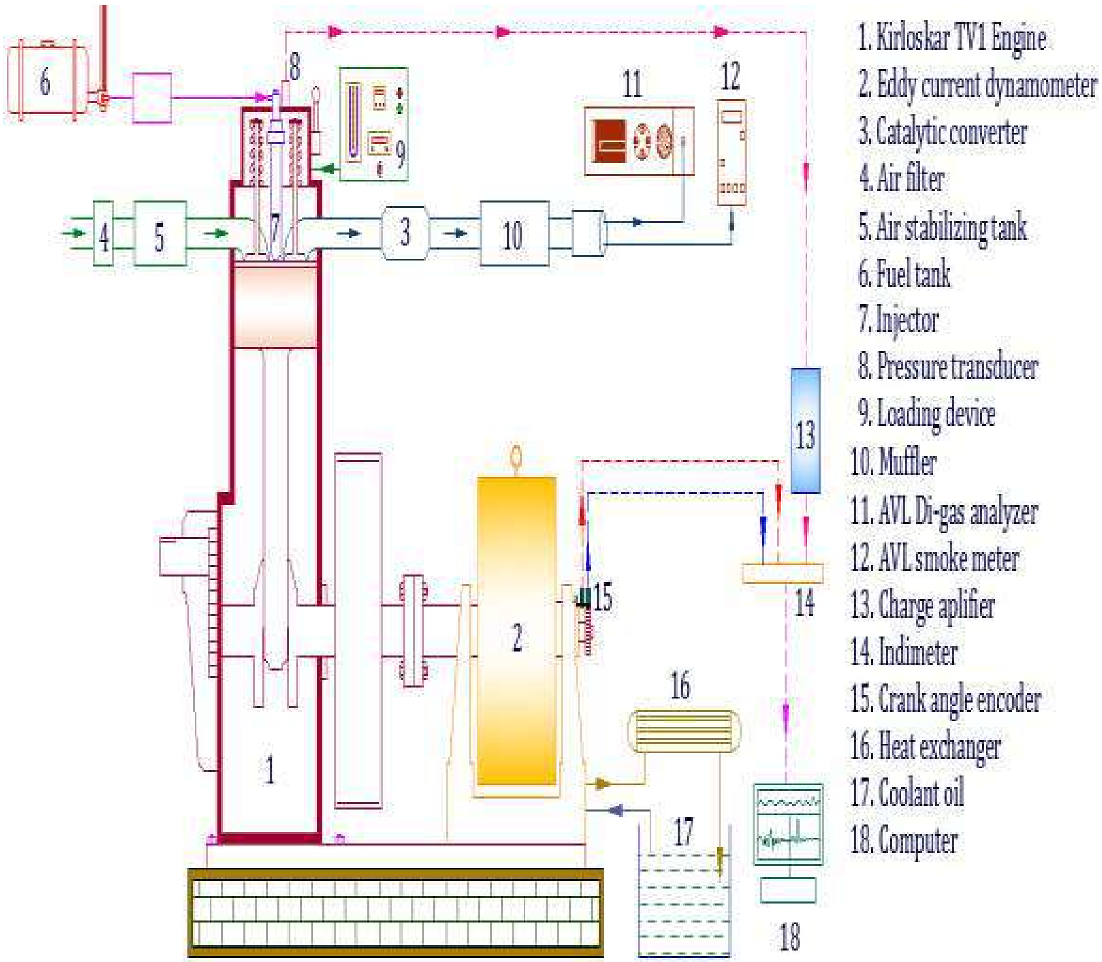

Figure 3. Schematic diagram of the experimental setup.

Table 2. Specification of test engine.

Type	Vertical, Water cooled, Four stroke
Number of cylinder	One
Bore	87.5 mm
Stroke	110 mm
Compression ratio	17.5:1
Maximum power	5.2 kW
Speed	1500 rev/min
Dynamometer	Eddy current
Injection timing	23° before TDC
Injection pressure	220kg/cm^2
Ignition timing	23° before TDC
Ignition system	Compression Ignition

IV. Result and Discussion

4.1 BRAKE THERMAL EFFICIENCY

Sheep fat oil's impact Figure 4 shows the effect of a biodiesel mixture on brake thermal performance. The figure shows that as the amount of biodiesel in the test fuels increased, the overall thermal performance of the brakes decreased. In the overall load of 5.2 kW, the brake thermal performance was less than that of sole fuel by approximately 0.8 percent to 2.5 percent for all the samples. This is because of the biodiesel blend's impact on the systems.

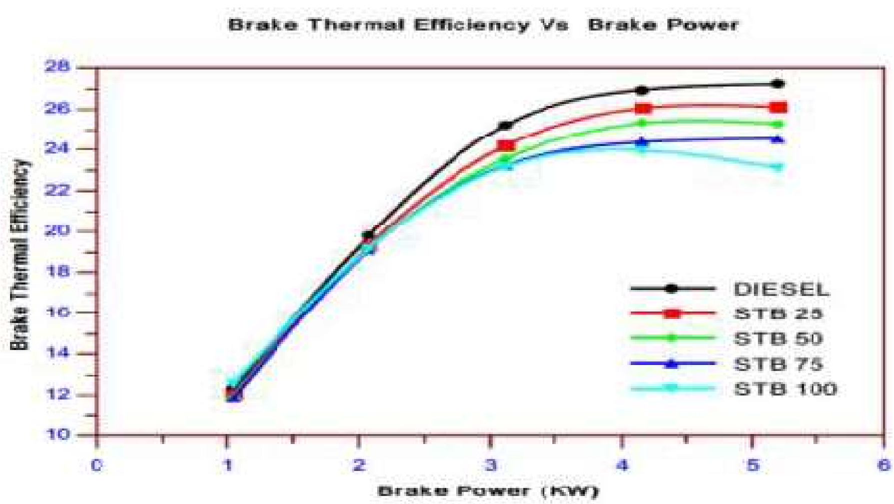

Figure 4. Brake thermal efficiency against Brake power.

4.2 CO EMISSION

The effect of the Sheep fat oil biodiesel blend on the % CO emission is shown in Figure 5. for the biodiesel and itsmixtures, the % CO emissions where greater than that of lone fuel. The least % CO emissions have been obtained for the STB 25with the higher value of 0.19% by volume at 100% load. The decrease of CO emission is due to the oxygen contented on the biodiesel mixture in the methods respectively.

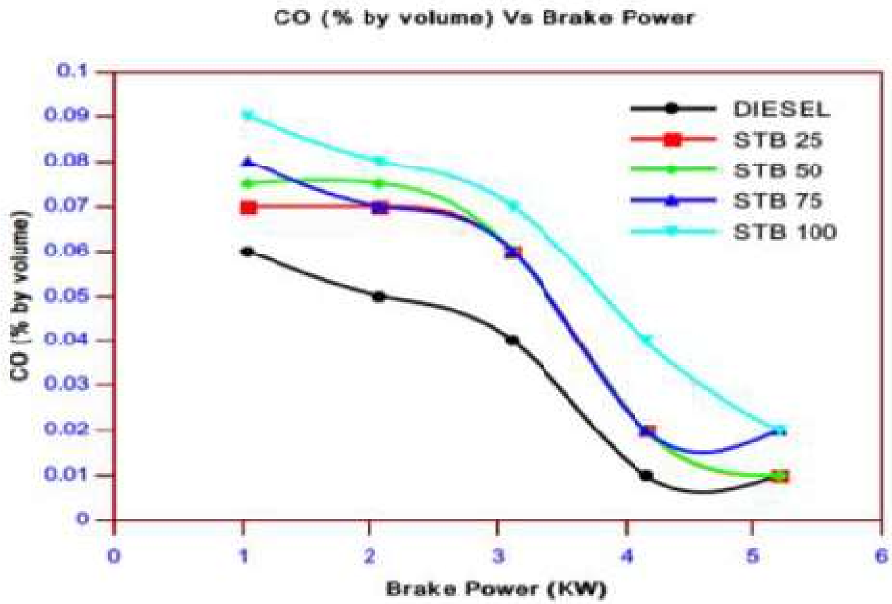

Figure 5. % CO emission against Brake power.

4.3 HC EMISSIONS

Figure 6 shows the effect of the Sheep fat oil biodiesel blend on hydrocarbon emissions. The HC emission is found to be lowest for sole fuel, with a value of 16 ppm at full load on sole fuel. For all of the tests, the HC emission is higher as compared to the single petrol. Both of the samples show a slight reduction in HC emission. However, as compared to other samples, the STB 100 exhibits a significant increase in HC emission. This may be attributed to the oxygen-comfortable biodiesel mixtures used in the processes.

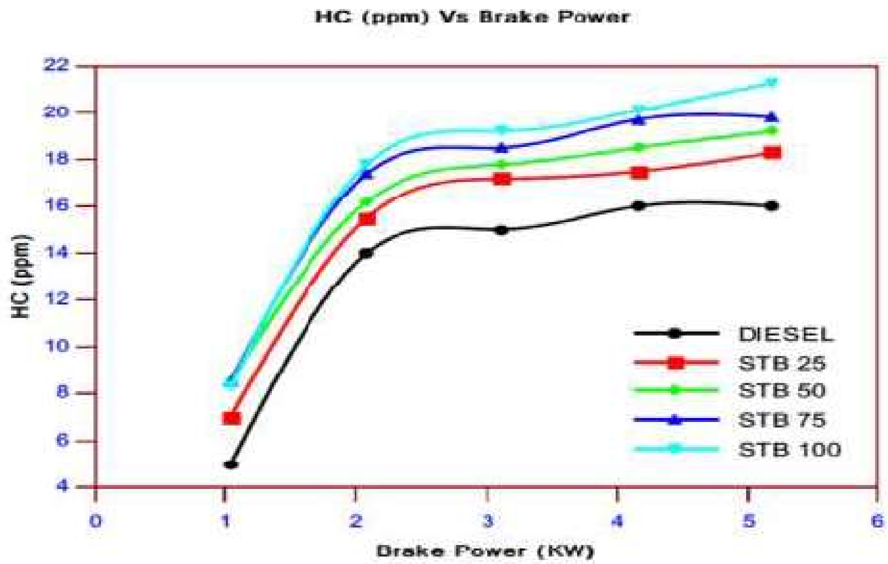

Figure 6. HC (ppm) emission against Brake power.

4.4 NOx EMISSION

Figure 7 shows the effects of the Sheep fat oil biodiesel blend on NOx emissions. The NOx emissions of biodiesel and its mixtures were lower than those of sole gasoline. STB 25 emits the least amount of NOx, with a value of 562 ppm at 20% load. Similarly, at full load, STB 100 has 512 ppm of 100 percent load, which is lower than all other samples at maximum load. This is due to the presence of oxygen in the biodiesel mixture during the manufacturing process.

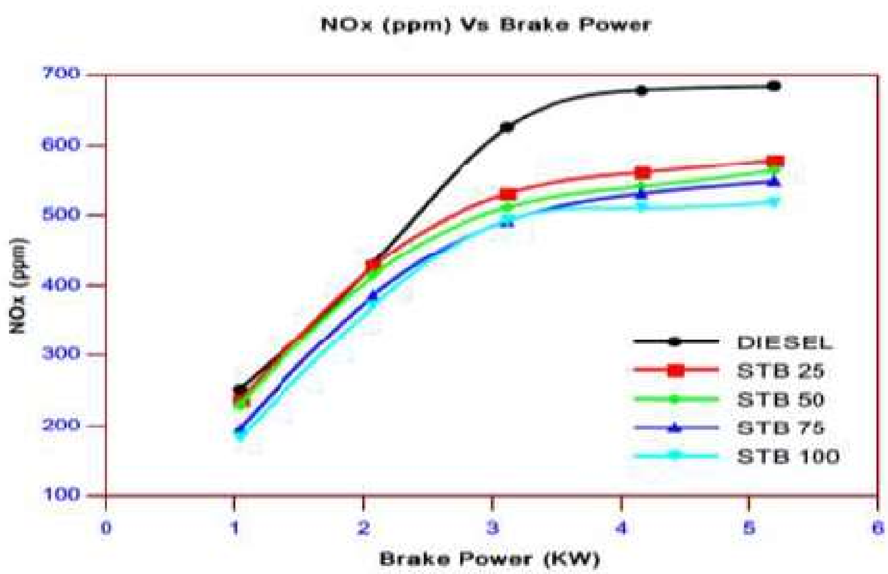

Figure 7. NOx (ppm) emission against Brake power.

4.5 SMOKE EMISSION

Figure 10 shows the effect of the Sheep fat oil biodiesel blend on smoke emissions. As compared to the single petrol, smoke emissions from biodiesel and its mixtures are higher. The smoke emission is greater than that of the single fuel in all of the cases. At full load in the systems, the maximum smoke value is 54.8 HSU STB 100.

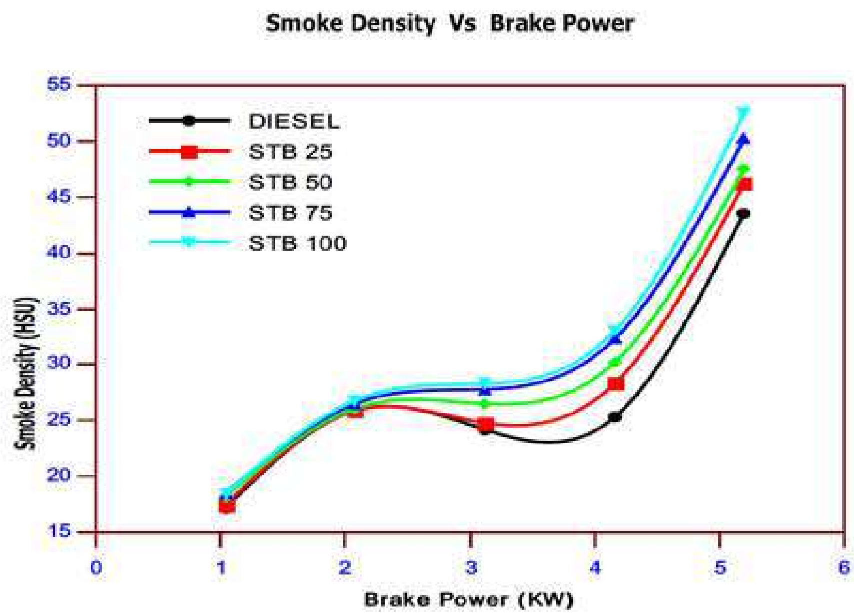

Figure 8. Smoke Density against Brake power.

4.6 Combustion Characteristics

4.6.1. Cylinder Pressure

Figure 11 shows the difference in in-cylinder pressure in relation to crank angle. Due to weak atomization, which slows combustion and causes lower cylinder gas pressure, the topmost pressure for Sheep Fat oil biodiesel and its blends is lower than that of diesel fuel. The difference between the STB 25 and diesel fuel, on the other hand, is negligible. The incidence of topmost pressure is experimentally advanced with the accumulation of Sheep fat oil biodiesel, which provides oxygen and promotes full fuel combustion. The maximum in-cylinder pressure 59.732 kg/kW-hr (Sheep fat oil atSTB 25) was found in the case of diesel fuel and it was 61.241 kg/kW-hr for fuel.

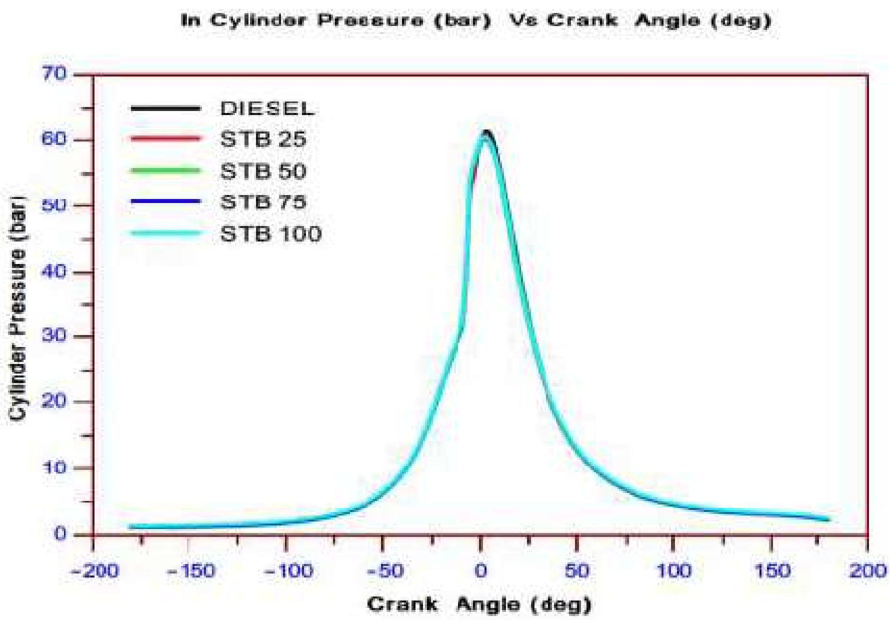

Figure 9. CylinderPressure against Crank Angle.

4.6.2. Heat Release Rate

As compared to diesel fuel, adding Sheep fat oil biodiesel blend accelerates the occurrence of the peak heat release rate, and the difference of heat release rate through the crank angle is shown in Figure 12. After the combustion process begins, the rate of heat release increases until it reaches its maximum value. With the addition of Sheep fat oil biodiesel, the ignition delay is shortened and the previous start of combustion is accelerated, resulting in a lower heat release rate and a quicker progression of the peak heat release rate.The maximum heat release rate is observed as 117.233 kJ/m3deg & 119.235 kJ/m3deg for the diesel fuel, whereas it is

123.752 kJ/m3deg for the STB 100.

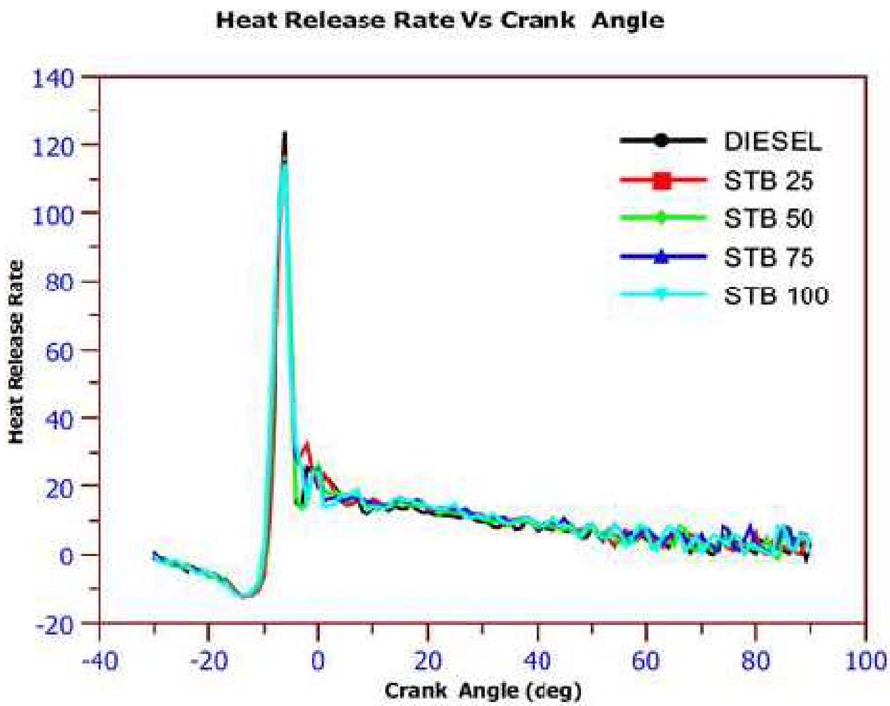

Figure 12. Heat Release Rate against Crank Angle.

V. Conclusions

The results of a study of sheep fat oil biodiesel (STB 25) and its blends with sole fuel (STB 50, STB 75, and STB 100) were compared to diesel and published in this project.

1. The thermal efficiency of the brakes is slightly reduced by biodiesel and its blend in the processes.
2. As compared to the single fuel in the processes, the emission analysis for biodiesel and its blend produced the best results.

CO2 emissions have increased by 0. As compared to the sole fuel in the processes, STB 25 gave the best results by volume at 20% of load.

When compared to the sole fuel in the process, STB 100 gave the best performance, reducing HC emissions by 23.8 ppm at 100% load.
When compared to the sole fuel in the systems, NOx emissions were decreased by 518 ppm at 100% load for STB 100. As compared to the other STBs, STB 100 recorded the best results with a smoke density increase of 54.2 HSU at 100% load.

The processes' sole source of energy.

For the single fuel, the cylinder pressure is reduced by 61.241 kg/kW-hr, while for STB 100 at 100% load, the value is 58.477 kg/kW-hr.

kilogrammes per kilowatt-hour

For the sole fuel, the Heat Release Rate is reduced by 123.752 kJ/m3deg, while for STB 100 at 100% load, the value is 112.358 kJ/m3deg.

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