A Study on Sheep Fat oil as Biodiesel and its Performances, Emission and Combustion Characteristics with help of Transesterification Process.

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Abstract :
The objective of the investigation is to evaluate the adequate production and implementation of sheep fat oil as biodiesel and examine the importance of biodiesel over the engine Performance, Emission and combustion component. The effort is carried out in a sole cylinder water cooled DI Diesel engine with Eddy current Dynamometer, Biodiesel composed from transesterfication procedure and thermo-physical properties of biodiesel and their blends from the procedures were analyzed. The experiment fuel were prepared in the ratio of STB 25, STB 50, STB 75 and STB 100 which produce the blend ratio of sheep fat oil biodiesel and the vacation diesel fuel. The experimental results reveal a insignificant decrease in brake thermal efficiency when correlate to that of sole fule. In this examination, the emission test were conducted with the help of AVL DI Gas analyzer, in which CO HC and Smoke density are negligible increased on the alternative hand and NOx are appreciably decrease when correlate to that of sole fuel. Cylinder pressure and Heat Release Rate. were also performed with benefit of AVL DI Gas Analyzer.

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

NOMENCLATURE

BP	Brake power, kW
BTE	Brake thermal efficiency in %
SFC	Specific Fuel Consumption ,kg/kW h
CO	Carbon monoxide, % vol.
HC	Hydrocarbon, ppm
NO*x*	Oxides of Nitrogen, ppm
STB	Sheep fat oil Transesterification Blend

I. INTRODUCTION

Biodiesel is described as fatty acid methyl or ethyl esters from vegetable oils or animal fat as an alternative fuel of diesel. It is renewable, biodegradable, nontoxic oxygenated fuel [1, 2]. Even though many reaches pointed out that it might help to decrease green house gas emissions, improve income distribution and promote sustainable rural development [3-6]. The primary cause is being deficient in o new knowledge about the influence of biodiesel on diesel engines. For instance, the reduce of engine power, as well as he increase of fuel consumption for biodiesel, is not as a large amount as anticipated; the early research conclusions have been reserved, it is more prone to oxidation for biodiesel which may result in mysterious gums and sediments that can plug fuel filter, and thus it will influence engine durability [7,8]. In the automotive sector, the high oxides of nitrogen (NOx) and HC emission from the diesel engine are its main problems with respect to air pollution. In this perspective, the reductions in HC and CO emissions from the engine can be obtained by use of biodiesel. But, NOx emissions are slightly increased for the biodiesel blended diesel fuel [9-13]. High viscosity, surface tension and density of biodiesel influence atomization by increasing the mean fuel droplet size which in turn increases the spray tip penetration. Many researches have found that viscosity and density is the lowest on mean droplet size and consequently to get better fuel atomization viscosity should be the first alternative of a fuel’s physical property to be decreased [15-17]. The above mentioned problem can be solved by blending biodiesel with diesel fuel which will decrease the viscosity of fuel. Introduce some literature review related to animal fat oil biodiesel and also performances and emission analyzer.

II. Biodiesel Production and Property Analysis

2.1 Transesterification

The reaction mechanism for alkali catalyzed transesterification was formulated as three steps Transesterification is the process of conversion of the triglyceride with an alcohol in the presence of a catalyst to form esters and glycerol. Animal fat oil is subjected to chemical reactions with alcohol like methanol or ethanol in the presence of a catalyst. Since the reaction is reversible excess methanol is required to reduce the activation energy, there by shifting the equilibrium to the product side. The triglyceride present in the animal fat oil is converted into biodiesel ethyl esters. Both the compounds are biodiesel fuels in different chemical combinations. The mechanism of transesterification reaction scheme is illustrated by Figure1. Transesterification of sheep fat oil produces ester whose properties are comparable with those of 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.

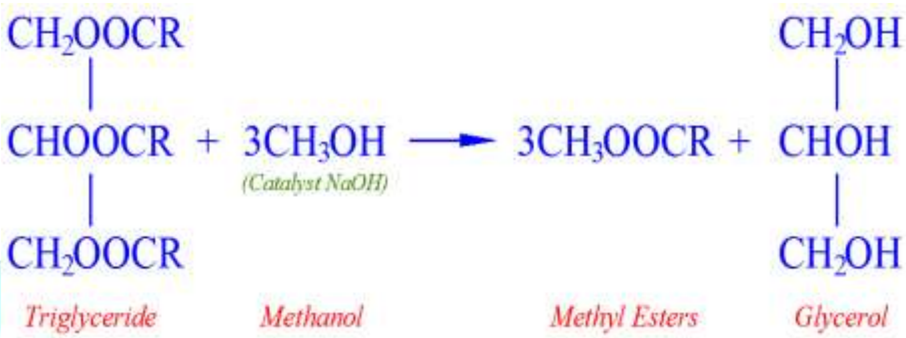

Figure 1. Mechanism of transesterification process.

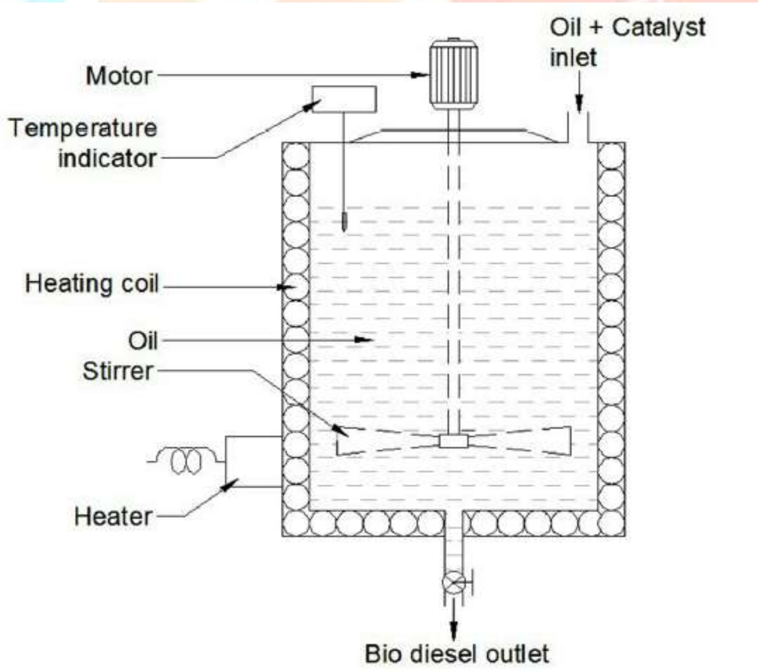

Figure 2. Schematic diagram of Biodiesel Plant

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

Table 1. Properties of Diesel and Biodiesel

III. Experimental Setup

The diesel engine used for research is Kirloskar TV1, single cylinder, water cooled engine coupled to eddy current dynamometer with computer boundary. The detailed specification of the engine is shown in Table 2. A data acquisition system is used to gather and analyze the combustion records like in-cylinder pressure and heat release rate during the research by using AVL transducer. The exams are conducted at the rated speed of 1500 rpm. In every test, exhaust emission such as nitrogen oxides (NOx), hydrocarbon (HC), carbon monoxide (CO) and smoke are measured. From the initial measurement, brake thermal efficiency (BTE) and specific fuel consumption (SFC) with respect to brake power (BP) for different blends are calculated. The blends of biodiesel and diesel used were B25 and B50. B75 and B100 means 25 % biodiesel fuel and 100% of diesel fuel by volume. In order to study the effect of biodiesel blends on the engine combustion and emission characteristics, the injection timing was kept constant at 23° TDC. The effect of biodiesel blends was studied and results were compared with sole fuel diesel.

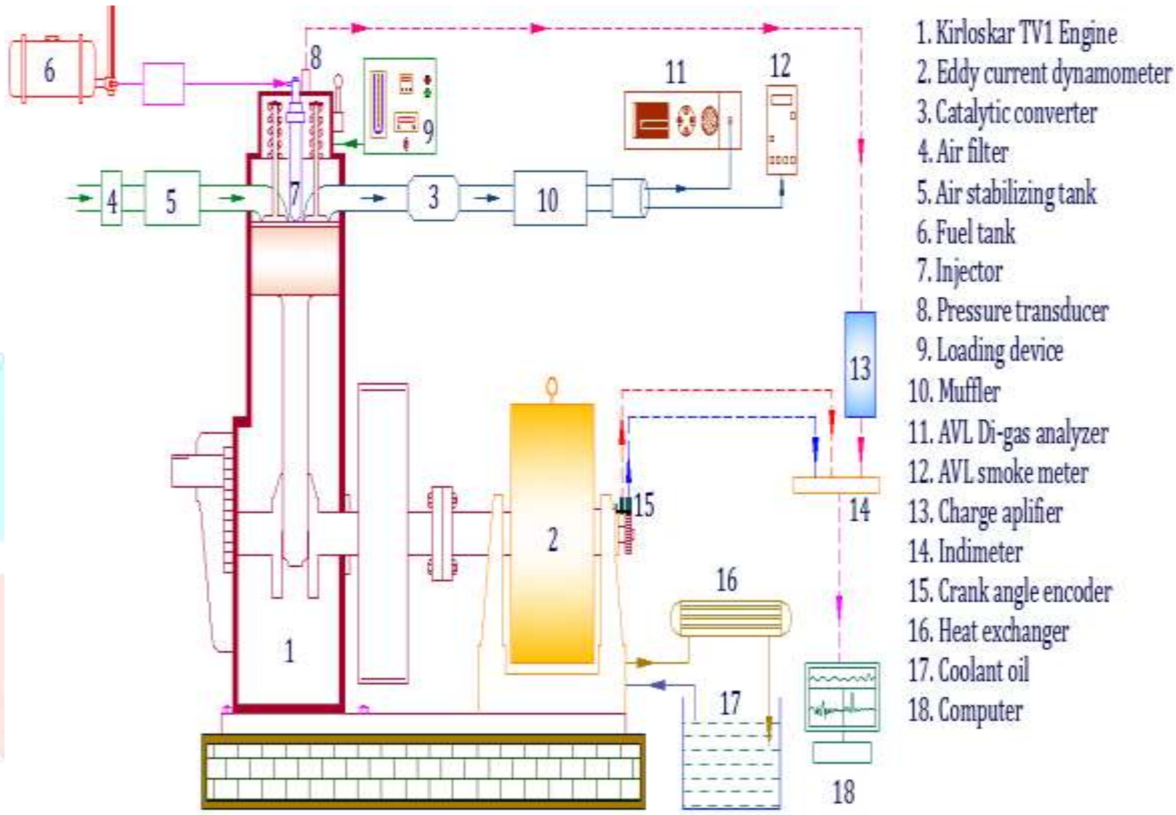

Figure 3. Schematic diagram of the experimental setup.

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

Table 2. Specification of test engine.

IV. Result and Discussion

4.1 BRAKE THERMAL EFFICIENCY

The effect of Sheep fat oil Biodiesel mixture on brake thermal efficiency is exposed in Figure 4. It can be seen from the figure that Brake thermal efficiency in overall reduced with the increasing quantity of biodiesel in the test fuels. The brake thermal efficiency for all the samples was less than that of sole fuel by about approximately 0.8% to 2.5% for all the samples in the maximum load of 5.2 kW. This is due to the effect of biodiesel blend in the processes respectively.

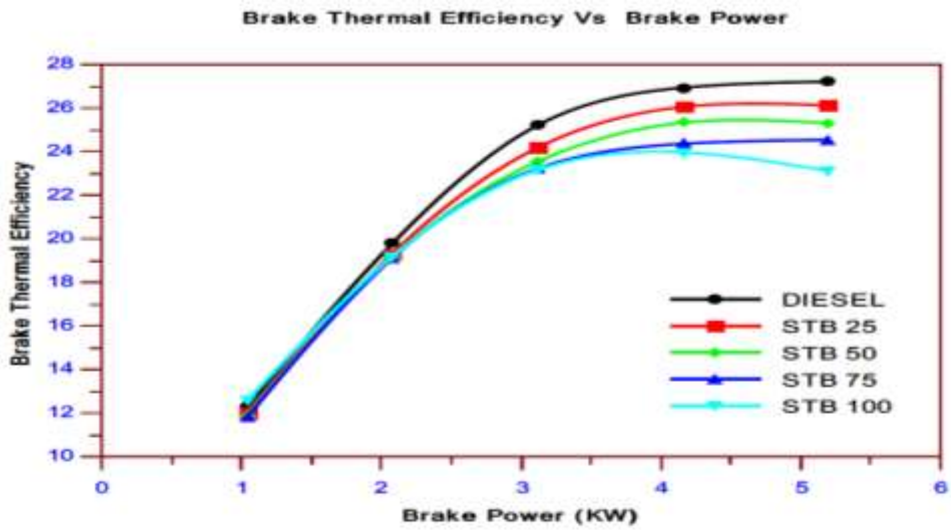

Figure 4. Brake thermal efficiency against Brake power.

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 its mixtures, the % CO emissions where greater than that of lone fuel. The least % CO emissions have been obtained for the STB 25 with 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.

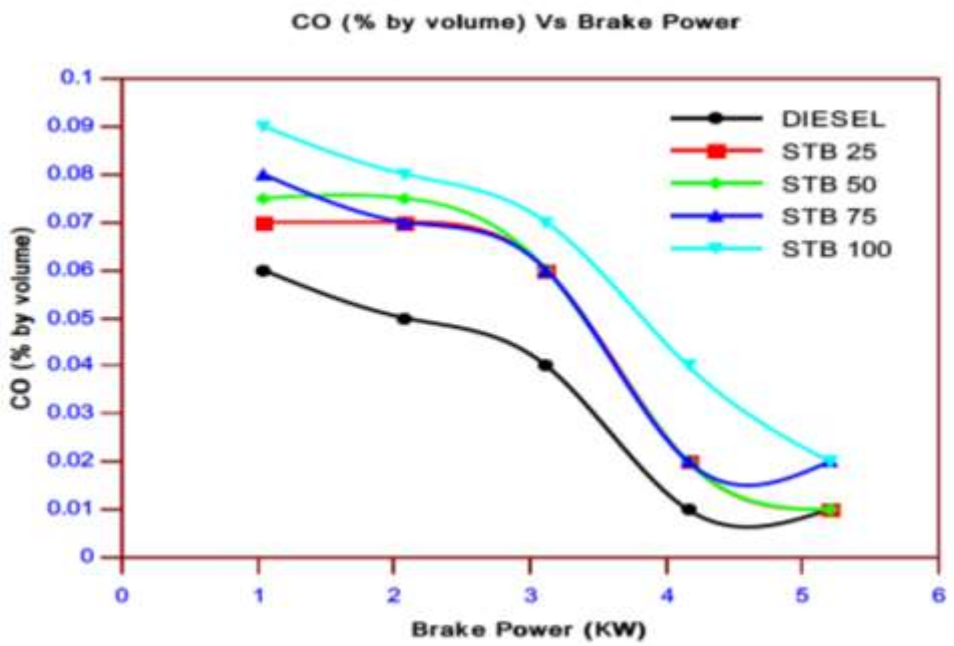

Figure 5. % CO emission against Brake power.

4.3 HC EMISSIONS

The effect of the Sheep fat oil biodiesel blend on hydrocarbon emission is exposed in Figure 6. It is observed that the HC emission is minimum for sole fuel with a value of 16 ppm at maximum load on sole fuel. The HC emission is greater when matched to that of the sole fuel for all the samples. There is marginal decrease of HC emission for all the samples. But for the STB 100 HC emission is increased effectively when compared to other samples. This may be due to the oxygen comfortable of the biodiesel mixtures in the processes respectively.

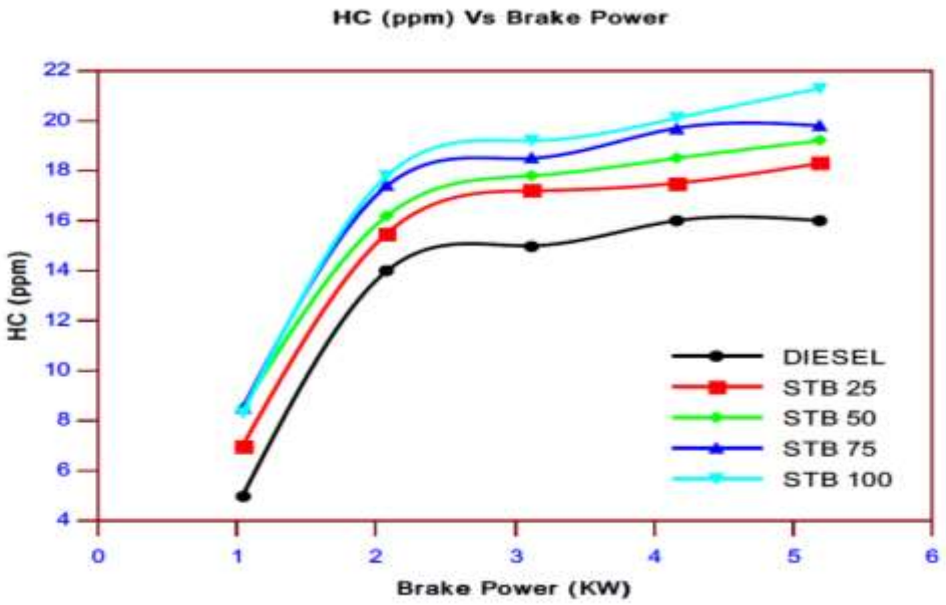

Figure 6. HC (ppm) emission against Brake power.

4.4 NOx EMISSION

The effect of the Sheep fat oil biodiesel blend on NOx emission is exposed in Figure 7. for the biodiesel and its mixture the NOx emission where minus than that of sole fuel. The NOx emission is minimum for STB 25 with a value of 562 ppm at 20% of load. Similarly for STB 100 at maximum load is 512 ppm of 100% load which is less when compared to all other samples at maximum load. This is due to the result of oxygen contented in the biodiesel mixture in the processes.

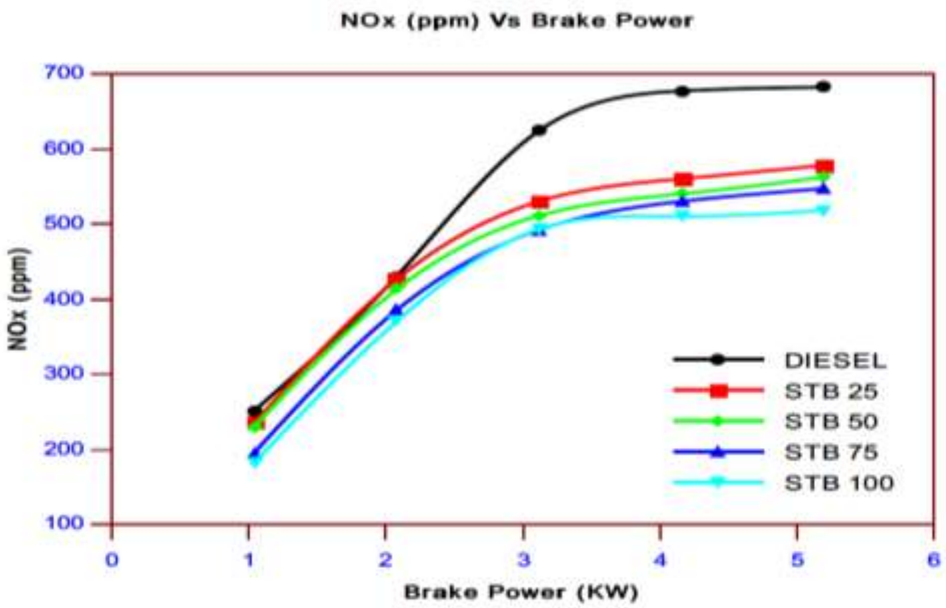

Figure 7. NOx (ppm) emission against Brake power.

4.5 SMOKE EMISSION

The effect of the Sheep fat oil biodiesel blend on smoke emission is exposed in Figure 10. for the biodiesel and its mixtures the smoke emission is higher when compared to the sole fuel. It is observed for all the examples the smoke emission is greater than that of sole fuel. The maximum smoke value is 54.8 HSU STB 100 at maximum load in the processes.

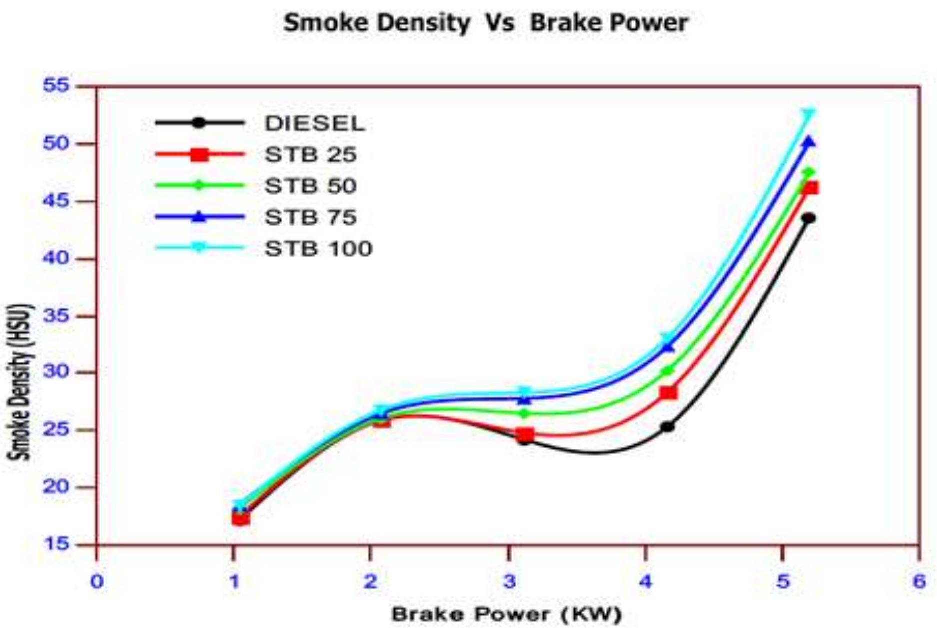

Figure 8. Smoke Density against Brake power.

4.6 Combustion Characteristics

4.6.1. Cylinder Pressure

The difference in-cylinder pressure beside crank angle is exposed in Figure 11. The topmost pressure for the Sheep Fat oil biodiesel and its blends is lesser than that of the diesel fuel due to the poor atomization, which decelerates the combustion and cause for the lower cylinder gas pressure. However, the variation between the STB 25 and diesel fuel is marginal. It is experimental that the occurrence of topmost pressure is advanced with the accumulation of Sheep fat oil biodiesel, which supplies oxygen and promotes the complete combustion of fuel. The maximum in-cylinder pressure 59.732 kg/kW-hr (Sheep fat oil at STB 25) was found in the case of diesel fuel and it was 61.241 kg/kW-hr for fuel.

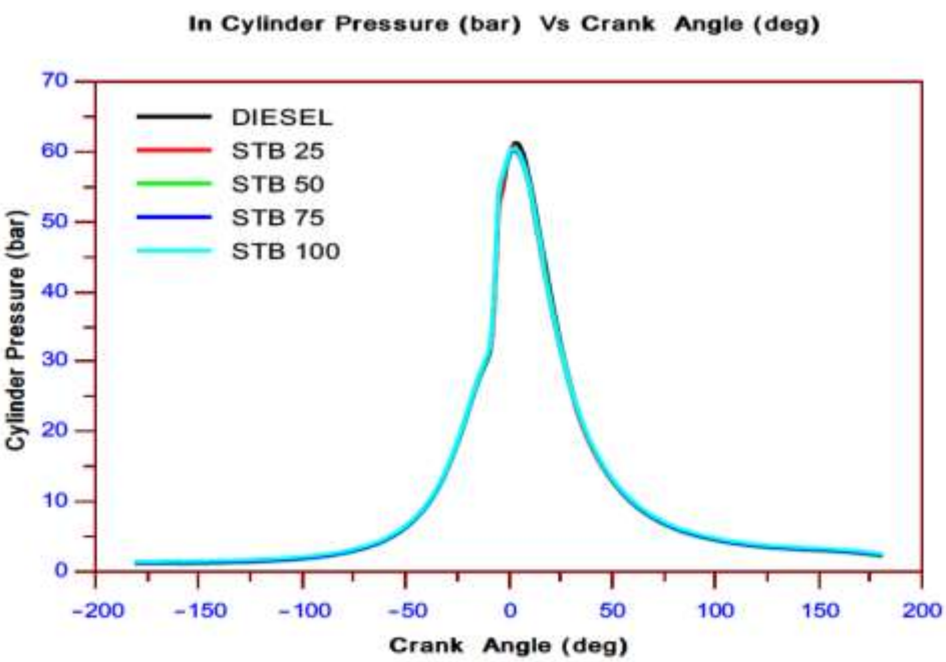

Figure 9. CylinderPressure against Crank Angle.

4.6.2. Heat Release Rate

The adding of Sheep fat oil biodiesel blend advances the happening of the peak heat release rate when comparing with the diesel fuel and the variation of heat release rate through the crank angle is shown in Figure 12. After the combustion starts, the heats release rate growths and reaches to the extreme value. The addition of Sheep fat oil biodiesel reductions the ignition delay and accelerates previous start of combustion, which results in the lower heat release rate and progression of the peak heat release rate. The maximum heat release rate is observed as 117.233 kJ/m^{3}deg & 119.235 kJ/m^{3}deg for the diesel fuel, whereas it is 123.752 kJ/m^{3}deg for the STB 100.

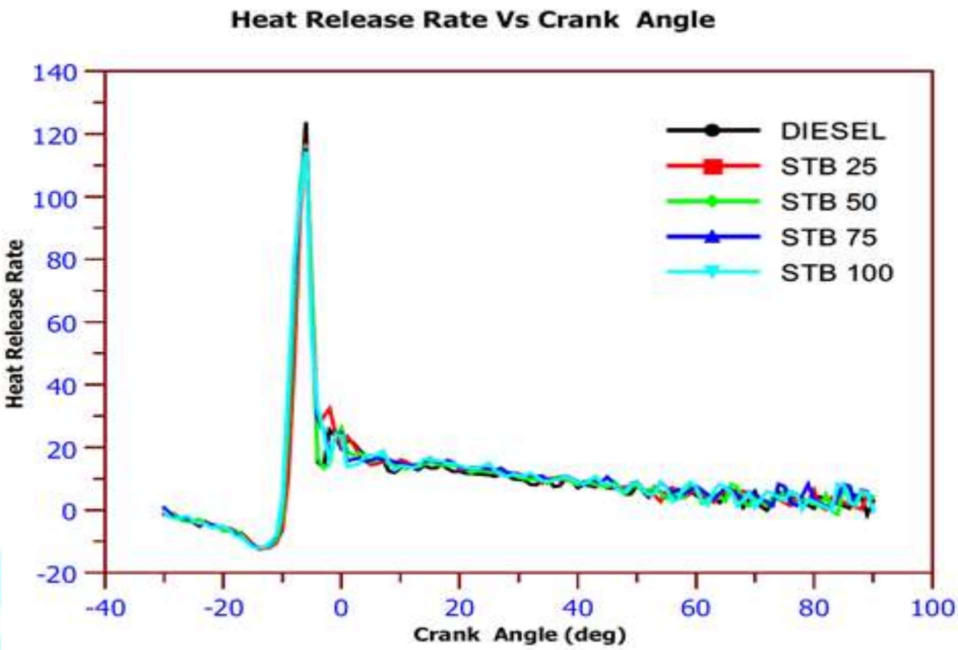

Figure 12. Heat Release Rate against Crank Angle.

V. Conclusions

The Sheep fat oil biodiesel (STB 25) and its blends with sole fuel, STB 50, STB 75 and STB 100 were investigated and the results were compared with diesel and reported in this project.

1. The brake thermal efficiency is marginally decreased for the biodiesel and its blend in the processes.
2. The emission analysis for the biodiesel and its blend gave the best result when compared to the sole fuel in the processes.
   - ☆ The CO emission is increased by 0. by volume at 20% of load for STB 25 gave the best result when compared to the sole fuel in the processes.
   - ☆ The HC emission is reduced by 23.8 ppm at 100 % of load for STB 100 gave the best result when compared to the sole fuel in the processes.
   - ☆ The NOx emission is reduced by 518 ppm at 100% of load for STB 100 gave the best result when compared to the sole fuel in the processes.
   - ☆ Smoke density is increased by 54.2 HSU at 100% of load for STB 100 gave the best result when compared to the sole fuel in the processes.
   - ☆ Cylinder Pressure is decreased by 61.241 kg/kW-hr for the sole fuel & STB 100 at 100% of load the value is 58.477 kg/kW-hr.
   - ☆ Heat Release Rate is decreased by 123.752 kJ/m^{3}deg for the sole fuel & STB 100 at 100% of load the value is 112.358 kJ/m^{3}deg.

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