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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 aim of the study is to evaluate the effective production and utilization of Sheep fat oil as biodiesel and investigate the influence of biodiesel over the engine performance, Emission and combustion characteristics. The work is carried out in a single cylinder water cooled Di Diesel engine with Eddy current Dynamometer, Biodiesel produced from transesterfication process and thermo-physical properties of biodiesel and their blends from both the process were analyzed. The test fuel were prepared in the ratio of STB 25, STB 50, STB 75 and STB 100, which represent the blend ratio of Sheep fat oil biodiesel and the rest diesel fuel. The experimental results reveal a marginal decrease in brake thermal efficiency when compared to that of sole fuel. In this investigation, the emission test were conducted with the help of AVL Di gas analyzer, in which CO, HC and smoke density are marginal increased on the other hand and NOx are appreciably reduced when compared to that of sole fuel. Cylinder pressure and H.R.R. were also performed with help of AVL Di Gas Analyzer.

Index Terms- Sheep fat oil, Transesterification, Biodiesel, Oxides of nitrogen, Smoke.

I. INTRODUCTION

Biodiesel is described as fatty acid methyl or ethyl esters from vegetable oils or animal fats as an alternative fuel of diesel. It is renewable, biodegradable, nontoxic and oxygenated fuel [1, 2]. Even though many researches pointed out that it might help to decrease greenhouse gas emissions, improve income distribution and promote sustainable rural development [3-6]. The primary cause is being deficient in of new knowledge about the influence of biodiesel on diesel engines. For instance, the reduce of engine power, as well as the 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 researchers have found that viscosity and density are affect the atomization, whereas 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

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, thereby shifting the equilibrium to the product side. The triglyceride present in the animal fat oil is converted into biodiesel. Among the alcohols used for the transesterification reaction are methanol and ethanol. However, when methanol is processed, methyl esters are formed, whereas ethanol produces ethyl esters. Both these compounds are biodiesel fuels in different chemical combinations. The mechanism of transesterification reaction scheme is illustrated by Figure 1. 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 are summarized in Table 1.

Table 1 Properties of Diesel and Biodiesel Blends

CH_2OOCR				CH_2OH
$CHOOCR$	+ $3CH_3OH$	-------> $3CH_3OOCR$	+	$CHOH$
CH_2OOCR				CH_2OH
Triglyceride	*Methanol*	*Methyl*		*Esters Glycerol*

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

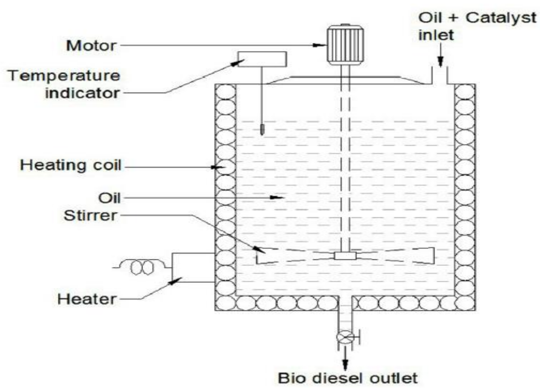

Figure 1: Schematic diagram of Biodiesel Plant

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	0.8651	865	42300

III. EXPERIMENTAL SET UP

The diesel engine used for experimentation is Kirloskar TV1, single cylinder, water cooled engine coupled to eddy current dynamometer with computer interface. The detailed specification of the engine is shown in Table 2. A data acquisition system is used to collect and analyze the combustion data like in-cylinder pressure and heat release rate during the experiment by using AVL transducer. The tests 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 STB 25, STB 50, STB 75 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.

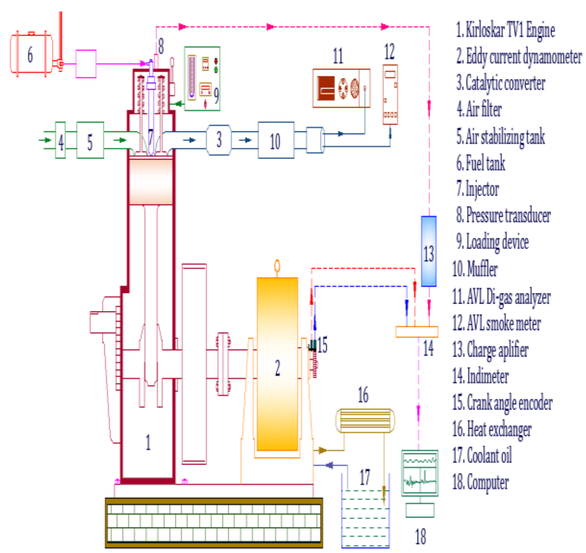

Figure 2 Schematic diagram of the experimental setup

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

A. Brake Thermal Efficiency

The effect of Sheep fat oil Biodiesel blend on brake thermal efficiency is shown in figure 3. It can be seen from the figure that Brake thermal efficiency in general reduced with the increasing proportion of biodiesel in the test fuels. The brake thermal efficiency for all the samples was less than that of sole fuel by about approximately 1.7% to 2.4% for all the samples in the maximum load of 5.2 kW. This is due to the effect of biodiesel blend.

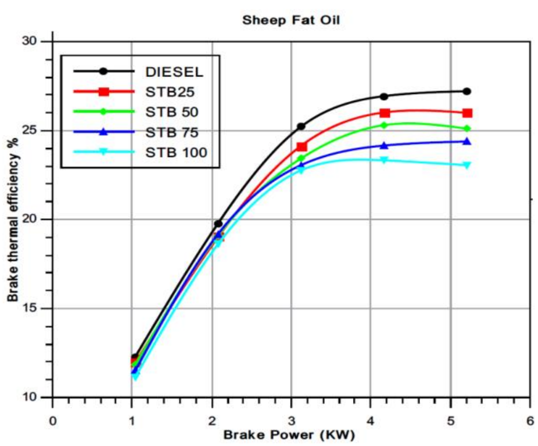

Figure 3 Brake thermal efficiency against brake power

B. Co Emission

The effect of the pork fact oil biodiesel blend on the CO emission is shown in figure 4 for the biodiesel and its blends, the CO emissions where less than that of sole fuel. The least CO emissions have been obtained for the STB 25 with the value of 0.19 % by volume at 100% load. The reduction of CO emission is due to the oxygen content on the biodiesel.

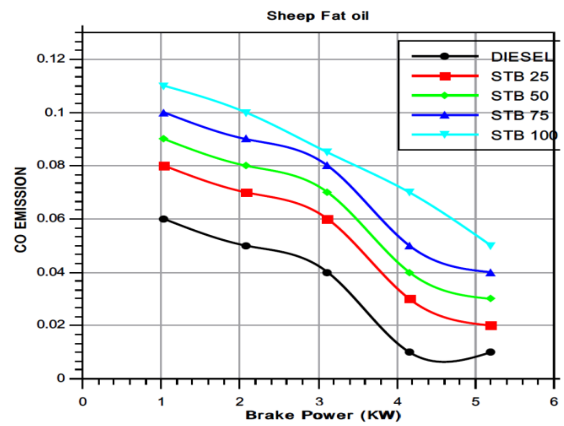

Figure 4. CO emission against Brake power

C. Hc Emissions

The effect of Biodiesel on hydrocarbon emission is shown in figure 5. It is observed that the HC emission is minimum for sole fuel with a value of 233 ppm at maximum load. The HC emission is lower when compared to that of the sole fuel for all the samples. There is marginal decrease of HC emission for all the samples. But for the B100 HC emission is increased effectively when compared to other samples. This may be due to the oxygen content of the biodiesel.

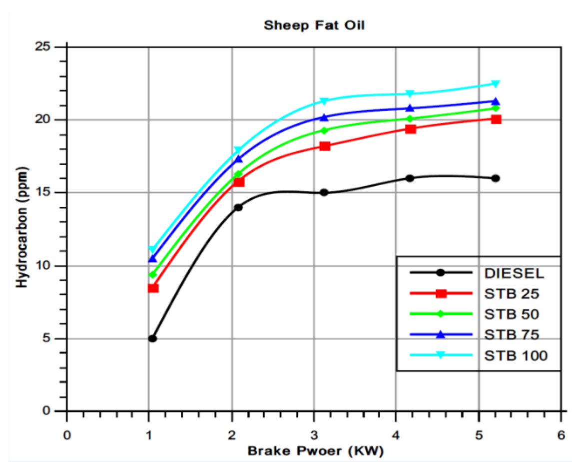

Figure 5. Hydrocarbon emission against brake power

D. Nox EMISSION

The effect of biodiesel on NOx emission is shown in figure 6. for the biodiesel and its blend the NOx emission where less than that of sole fuel. The NOx emission is minimum for B100 with a value of 647 ppm at 25%. Similarly for B100 at maximum load is 523 ppm which is less when compared to all other samples at maximum load. This is due to the effect of oxygen content in the biodiesel.

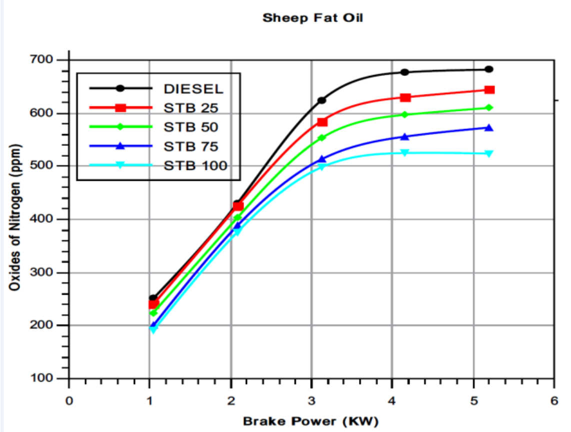

Figure 6. Carbon-monoxide emission against brake power

E. Smoke Emission

The effect of biodiesel on smoke emission is shown in figure 7. For the biodiesel and its blends the smoke emission is higher when compared to the sole fuel. It is observed for all the samples the smoke emission is higher than that of sole fuel. The maximum smoke value is 54.7 HSU for B100 at maximum load.

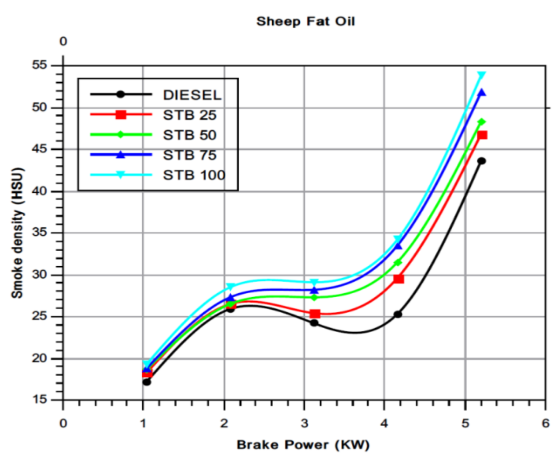

Figure 7. Smoke density against brake power

F. Combustion Characteristics

The variation in in-cylinder pressure against crank angle is shown in figure 8. The peak pressure for the Sheep fat oil biodiesel and its blends is lower 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 B25 and diesel fuel is marginal. It is observed that the occurrence of peak pressure is advanced with the addition of Java plum seed biodiesel, which supplies oxygen and promotes the complete combustion of fuel. The maximum in-cylinder pressure of 50.862 bar was found in the case of diesel fuel and it was 42.300 kJ/kg for B100 fuel.

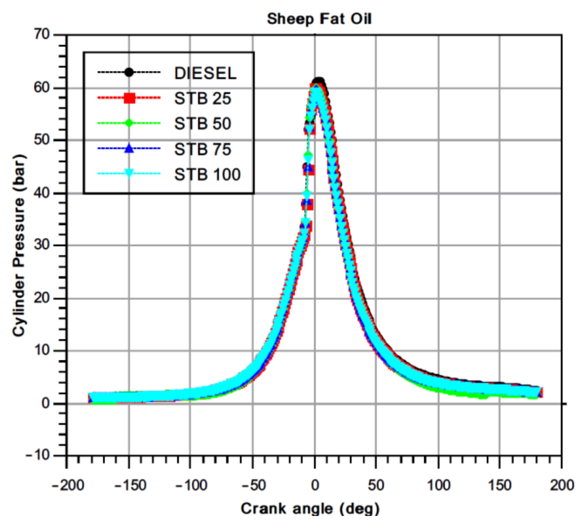

Figure 8. In-cylinder pressure against crank angle

The addition of Sheep fat oil biodiesel blend advances the occurrence of the peak heat release rate when comparing with the diesel fuel and the variation of heat release rate with the crank angle is shown in Figure 9. After the combustion starts, the heat release rate increases and reaches to the maximum value. The addition of Rabbit Fat oil biodiesel decreases the ignition delay and accelerates earlier 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 118.32 kJ/m3deg for the diesel fuel, whereas it is 94.32 kJ/m3deg for the B100.

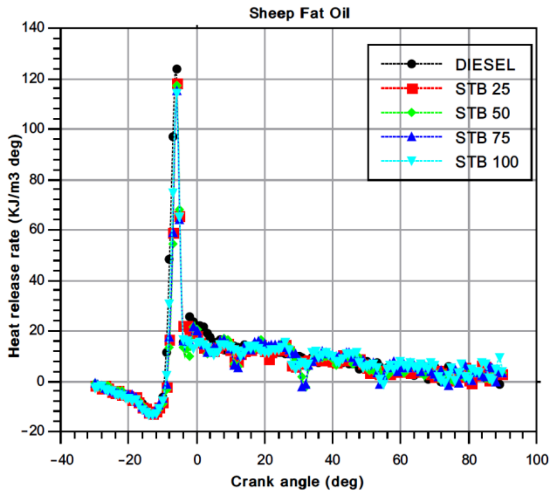

Figure 9. Heat release rate against crank angle

V. CONCLUSIONS

The Sheep fat oil biodiesel (STB 25) and its blends with sole fuel, STB 50, STB 75 and STB100 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.
2. The exhaust gas temperature is lower for B75 is 311°C at maximum load
3. The emission analysis for the biodiesel and its blend gave the best result when compared to the sole fuel.
   - The CO emission is increased by 0.88% by volume at 20% of load for B25
   - The CO2 emission is increased by 7.3 % by volume at 100% of load for B25
   - The HC emission is reduced by 87 ppm at 100 % of load for B100
   - The O2 emission is increased by 12.04% by volume at 100% of load for B100
   - The NOx emission is reduced by 841 ppm at 100% of load for B100
   - Smoke density is increased by 54.2 HSU at 100% of load for B100

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