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Experimental Investigation of Production of Biodiesel from Neem oil and its Study of Performance Characteristics through Load Test

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Abstract

Here our aim is to reduce the conventional diesel usage by neem oil biodiesel. The vegetable oil cannot directly be applied on diesel engine because of higher viscosity, flash point and fire point. So it should be converted into biodiesel first. This paper involves the production of biodiesel from neem oil by transesterification process and its load test. Before load test we determined the flash point and fire point of neem biodiesel. The load test was done on single cylinder 4 stroke diesel engine. After the performance curves were plotted.

Keywords: *Neem biodiesel, Transesterification, Flash point, Fire point, BTE, SFC, BP, Torque*

1. Introduction

Biodiesel is the fuel that is produced from organic matter in a short period of time. The formation for conventional diesel needs higher period of time. But in the case biofuel, it takes only two hours. And also the biodiesel can be blended with common diesel. The blend is the mixture of diesel and biodiesel. And the ratio of diesel and biodiesel can be varied. The variation will affect the output also. Developing countries like India spends more money for buying fuels from other countries. If we can produce it in our own country, we can save the money and it will be a great help for poor countries. The main fact is that the production of biodiesel from neem oil can help the Neem farmers. They can achieve more profit from it. It will lead more peoples to farming. And also the new job opportunities can be provided. While considering the environment the pollution due to the conventional fuels increasing day by day. It affects all the species in the earth. It is sure that biodiesel can reduce it in a big amount. It is nontoxic, essentially free from Sulphur. Biodiesel burns cleaner than any other fuels. It is biodegradable and nonflammable due to higher flash point. So the biodiesel has a great future. Some of the countries are already changed usage of diesel to biodiesel. The bio fuel diesel blend can be used in diesel engines without more modifications. Biodiesel improves lubrication between cylinder and piston. And also it reduces wearing of fuel pumps. Thus the efficiency of engine improves. Research about biofuels use in engines is still progressing today. Here the biodiesel from Neem oil is produced through a chemical reaction called transesterification process. In this chemical reaction the Neem oil is converted to methyl ester and glycerol. Methyl ester is the chemical name of biodiesel. Glycerin is produced from glycerol. And it is the main ingredient of production of soap. Thus the production of biodiesel is the production of glycerin also. Thus the profit is double. The production rate of biodiesel can be varied with some parameters in the transesterification process.ie the rate of production of biodiesel can be varied with temperature and molar ratio of methanol and Neem oil. The reaction is speed up with a base catalyst. Mainly NaOH or KOH. In this study the break thermal efficiency, torque and specific fuel consumption are mainly checked in various loads. The load test was done on 4 stroke single cylinder diesel engine of ape.

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The engine is modified to load testable form by setting the brake drum and rope brake dynamometer to the engine. The engine fixed to a frame which was designed using solid edge software. A Fuel consumption is checked by connecting burette to fuel inlet pipe. After the production, biodiesel was blended with common diesel. The blends taken are B10(10% Neem methyl ester and 90% of common diesel), B20 and B30. After load test the different curves were plotted. By studying the curves, the conclusions are made. Neem is a family member of "maliaceae" which grows all regions in India especially in south Indian states. It reaches 14 to 19 meters in height with a girth of up to 2 to 2.5 meters. Its molecular weight is high. The seeds of neem contain about 40% of oil. So it is more suitable for biodiesel production compared to other seeds. The color of neem oil is generally in light to dark brown. The taste is bitter and it has a strong odor.

2. Production of biodiesel

The Neem oil contains high amount of free fatty acids. Here the production procedure is transesterification. In transesterification the triglyceride(oil) is converted to methyl ester(biodiesel) and glycerol under the presence of a base catalyst. In general

VEGETABLE OIL + METHANOL ⟶ BIODIESEL + GLYCEROL
Base catalyst

This was performed in Environmental Science Lab MG University Kottayam, Kerala, India. At first one 1 liter of Neem oil is kept in a beaker. After 120ml of methanol and 16gm of NaOH was added. And placed the beaker on a magnetic stirrer. The solution stirred at 75°C temperature for two hours. After reaction the, content in beaker poured to separating funnel and kept it for at least 8 hours. After the settlement of glycerin, biodiesel separated from the separating funnel. The amount of biodiesel was .90ml.

Before separation

After separation

2.1 Biofuel advantages

- Production time is less
- Renewable energy source
- It burns cleaner than any other fuels
- Biofuel is Sulphur free
- Easy to develop
- Biofuel is biodegradable
- It is non toxic
- Pollution rate is less
- It provides lubrication for engine parts
- Gives better emission characteristics due to the presence of oxygen

Flash point and fire point values

Flash point and fire point determination test was conducted on cleave land open cup apparatus. And the values are as follows

Property	Neem oil	Neem biodiesel	Diesel
Flash point	250°C	150°C	53°C
Fire point	209°C	160°C	59°C

3. Experimental setup

Experiment were conducted on single cylinder 4 stroke, constant speed, compression ignition diesel engine. The rated speed of engine was 3600 rpm. The readings were taken at each load for the calculation of torque, break power, specific fuel consumption and break thermal efficiency.

ISSN 2348 – 7968

3.1 Experimental procedure

Before starting the engine test engine oil level and other proper conditions of the engine were checked. And engine was started at lower speed. After the engine speed, gradually increased to 3600rpm.At the same time different blends were taken. That are B10, B20 and B30.The first reading was taken at zero load with diesel. After the loads were applied at six levels. And the experiment repeated with different blends. The engine speed at all load levels adjusted to 3600rpm.At each load and each blend the fuel consumption time for 10cc fuel was noted using stop watch. And also dynamometer readings were taken. The blending of diesel and biodiesel was done by measuring beaker. In the case of B30, it contains 30% of Neem oil methyl ester and 70% of common diesel. Other blends were taken by the same procedure and used for the load test of engine.

3.2 Engine specifications

Engine	4 stroke
Type	Single Cylinder, Diesel Displacement 395 CC
Max Power	8.0bhp @ 3600rpm
Max Speed	55 kmph
Compression Ratio	8.5:1
Cooling	Forced air Cooled
Fuel Consumption	36±4 km/ltr

3.3 Maximum load calculation

Maximum Load , $W = \frac{60 \times B.P}{2 \times \pi \times N \times Re \times g}$

Where,

B.P = Brake power

Re = Effective brake drum radius = (R + r) =0.062m

R= Radius of break drum

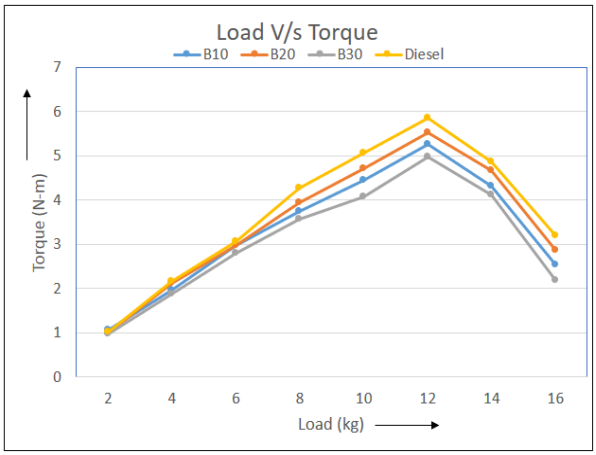
r=Radius of rope

g = Aaccelaration due to gravity = 9.81m/s²

$$W = \frac{(60 \times 746 \times 8)}{(2 \times \pi \times 0.062 \times 3600 \times 9.81)} = 26.01kg$$

4. Engine Performance

4.1Torque



The relationship between the load and torque for various fuels is shown in Figure. It was observed that torque increases with increases in load due to increase in fuel consumption with increase in load. Torque increased to the maximum and after it decreases for all the fuel samples. This is due to higher Cetane number of biodiesel, higher calorific value of diesel. Fuel with higher proportion (B30) of biodiesel gave less torque due to lesser energy released attributed. It's because of lower calorific value of the NOME. Both torque and brake power increased with increase in load due to increase in fuel consumption with increase in load.

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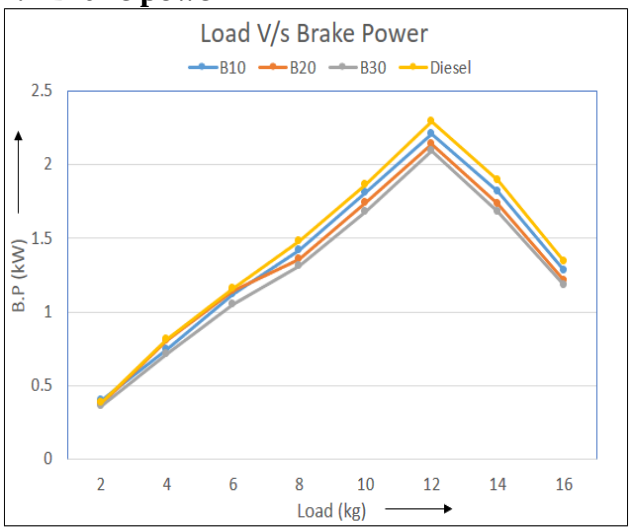
4.2 Brake power



The effect of load on brake power for different fuels is presented in Figure. As the load increases, brake power increases. Brake power of diesel is higher than that of all blends. This is due to the higher calorific value of diesel. Viscosity has a major role in the behavior of biodiesel. Fuel viscosity influences fuel injection and combustion. High fuel viscosity reduces fuel injection efficiency and leads to power losses in engine. As the concentration of biodiesel in fuel blends increases, the lubrication increases in different engine parts. The frictional wastage of power decreases. At the initial stage the power was increased. But after a certain value the power was decreased. This is due to the further increase of the biodiesel content in the blend
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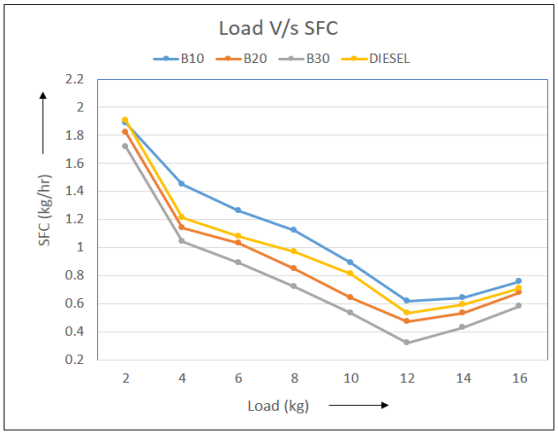
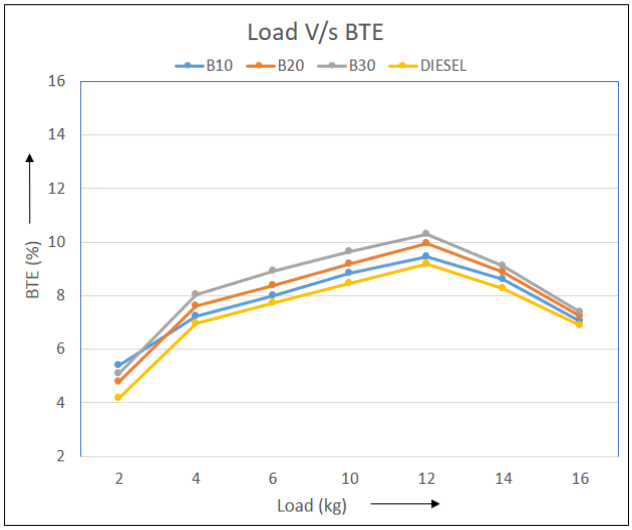
4.3 Specific Fuel Consumption(SFC)



The SFC indicates the efficiency of the engine in the usage of fuel to give an output. If the value SFC is lower, then it is main advantage of that fuel. That indicates the engine used less fuel to produce the same amount of work. This figure, shows the variation of specific fuel consumption of different blends at different loads. Because of higher mass flow rate of fuel to the engine the SFC increases. As load increases, SFC decreases to a minimum. The improvement in SFC was due to better combustion of the fuel, this is due to the presence of oxygen in the blend. Oxygen helps for better combustion of fuel.

4.4 Brake Thermal Efficiency



Thermal efficiency is the ratio between the power output and the energy introduced by fuel injection.BTE indicates the output generated by the engine by the fuel supply. This fuel is then converted to heat. The variation of BTE with loads is shown in Figure. For all blends, BTE increases with increase in load except B10, attributed to the increase in power with increase in load. The initial increase in BTE due to complete and higher combustion rate of fuel.

5. Conclusions

- The biodiesel presence does not cause any harm for the engine.
- When the load increases, B20 shows a considerable increase in torque comparing with the other blends.

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- Increase in break power of B10, B20 was almost nearer to diesel.

- The BTE and SFC of B30 was much better while comparing with other blends and diesel & B30 can be selected as more efficient.

- The compression ratio of engine must be changed due to the higher value of flash point and fire point.

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