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Experimental Analysis on Performance Improvement of Diesel Engine Utilizing Alternate Fuels

K.Simhadri[1], P. Sai Chaitanya[2], G.V.D. Mohan[3]
[1, 2, 3] *GMR Institute of Engineering and Technology*

Abstract: *Energy is the prime mover of economic growth and is vital to the sustenance of a modern economy. India ranks sixth in total energy consumption and needs to accelerate the development in this sector to meet its growth aspiration. Hence alternate fuels are needed to be produced. Present paper deals with preparation of bio-fuel from Vegetable oil, Mahua oil and Blending of vegetable oil with mahua oil. There by conducting Performance tests for alternate fuels, comparing the efficiency and cost estimation. From the experimentation it is found that the optimum performance is achieved with Blended Bio-diesel at 70:30 ratios of palm and mahua Bio-diesels in comparison with conventional diesel considering engine performance parameters.*
KeyWords: *Blending, Mahua oil, Sustenance*.

I. Introduction

Biodiesel is an environmentally- friendly, renewable energy source that has better lubricating properties and much lesser emissions than today's lower sulfur diesel fuels. Biodiesel addition reduces fuel system wear, and in low levels in high pressure systems increases the life of the fuel injection equipment that relies on the fuel for its lubrication. Biodiesel gives more complete combustion thus increasing the engine energy output and partially compensating for the higher energy density of petro-diesel.

Use of methanol carburization: The pure biodiesel has high flash point and auto ignition temperature due to this there will be accumulation of fuel in the engine and causes an ignition delay, due to this the output power will decreases comparatively to the diesel. So alcohols can be used as inducted fuels in engine cylinder during the suction stroke. At the compression stroke, due to higher temperatures the methanol particles will ignite. This creates multiple combustion points distributed in the cylinder resulting in a more complete air to fuel burn. So using biodiesel along with methanol will reduce ignition delay and the Nox emissions can also be reduced.

Palm oil as biodiesel: Palm oil (also known as dende oil, from Portuguese) is an edible vegetable oil derived from the mesocarp (reddish pulp) of the fruit of the oil palms, primarily the African oil palm Elaeis guineensis, and to a lesser extent from the American oil palm Elaeis oleifera and the maripa palm Attalea maripa. Palm oil can be used to produce biodiesel, which is also known as palm oil methyl ester. Palm oil methyl ester is created through a process called transesterification. Palm oil biodiesel is often blended with other fuels to create palm oil biodiesel blends. Palm oil biodiesel meets the European EN 14214standard for biodiesels. The world's largest palm oil biodiesel plant is the Finnish operated Neste Oil biodiesel plant in Singapore, which opened in 2011.

Mahua as biodiesel: Mahua, Madhuca longifolia of the family Sapotaceae, is a medium to large tree with a wide round canopy. Mahua is a slow-growing species, attaining a mean height of 0.9–1.2m at the end of the fourth year but may attain a height of up to 20 m. The variety latifolia is common throughout the Indian sub-continent, including Bangladesh. It is of deciduous nature and thrives in dry tropical and sub-tropical climates. As a plantation tree, mahua is an important plant having vital socio-economic value. This species can be planted along the roadside and canal banks on a commercial scale and in social forestry programs, particularly in tribal areas. The seed kernel contains about 50% oil. The oil yield by screw pressing is 34–37% and the fresh oil from properly stored seed is yellow in colour.

Following table compares some of the physical and chemical properties of diesel, canola oil andmethyl esters. Vegetable oils have higher density than diesel, but lower energy content (gross calorific value). Vegetable oil has lower carbon content than diesel, which means lower CO2

emissions per liter of fuel burnt, CO2 emission per kilometer travelled may not be lower. However, due to the lower energy content of vegetable oil and a higher portion of multibonded carbon compound.[1,2,3]

Table1. Comparison of typical properties of diesel, mauha methyl ester,palm methyl ester and various other methyl esters

Properties	Diesel	CME	JME	PME	MME
Density (Kg/m^3)	853	840	869	822	877
Calorific value (Kj/kg)	43000	39312	38300	38800	36700
Viscosity (cst)	2.75	3.7	4.38	5.36	5.55
Flash Point (^0C)	50	107	170	172	171
Cetane number	45	55	50	50	48

Methanol, also known as methyl alcohol, wood alcohol, wood naphtha or wood spirits, is a chemical with formula CH3OH. It is the simplest alcohol, and is a light, volatile, colorless, flammable, liquid with a distinctive odor that is very similar to but slightly sweeter than ethanol (drinking alcohol).[4]

At room temperature it is a polar liquid and is used as an antifreeze, solvent, fuel, and as a denaturant for ethanol. It is also used for producing biodiesel via Transesterification reaction.

II. Preparation Of Biodiesels And Characterisation

Transesterification is the general term used to describe the important class of organic reactions, where an ester is transformed into another ester through interchange of alkyl groups and is also called as alcoholysis. Transesterification is an equilibrium reaction and the transformation occurs by mixing the reactants. However, the presence of a catalyst accelerates considerably the adjustment of the equilibrium.

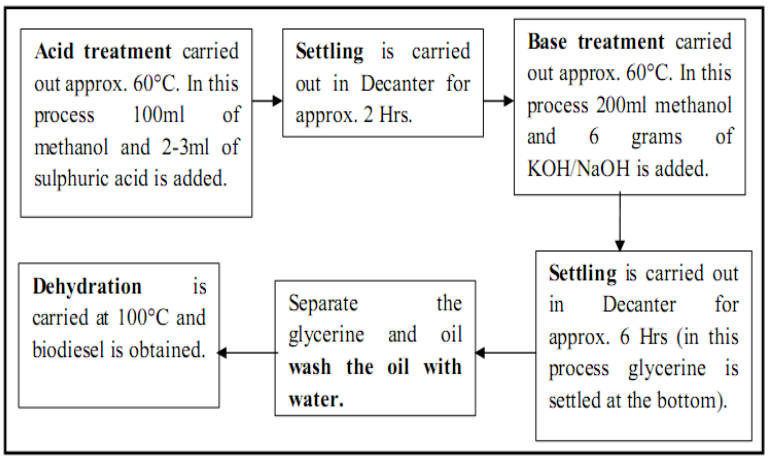

Fig.1 Block Diagram for Transesterification Procedure

Cost Estimation for preparing Palm and Mahua Bio-diesels:

For any fuel to use some of the following fuel characteristics are to be
Considered those fuel characteristics are as follows –

1. Efficiency of the fuel
2. Fuel Consumption.
3. Fuel Cost

Finally cost of 1 liter of palm biodiesel including manufacturing costs will become 115 rs/- .
Finally cost of 1 liter of Mahua diesel = 115 rs/- (including production costs)

Properties of Biodiesels:

The following table presents the different properties of biodiesel considered in this paper,

Table2. Characteristic Properties of PME,MME,Blended Diesel and Diesel

Properties	PME	MME	Diesel	Blended Diesel
Flash point (°C)	110	192	50	168
Fire point (°C)	116	197	56	173
Calorific value (KJ/kg)	37,270	36700	43,000	37,700
Viscosity at 33°C (mm^2/sec)	3.96	6.17	3.8	5.925
Density	834	880	827	850

III. Experimentation

Performance tests are made on a engine mainly to determine how much of our fuel is required for smooth running of an engine at the particular speed and load, i.e. these tests are used to find the efficiency of engine and to compare the performance of engine for different fuels at different conditions like varying load, varying speed etc.

Some of the factors are considered while performing tests on an engine they are-

1. Maximum power or torque available at each speed.
2. Range of power output at constant speed for stable operation of engine.
3. Brake Specific fuel consumption at each operating condition within useful range of operation.

Fig2. .Engine used to perform the performance tests

By performing these performance tests on engine we are going to find following parameters they are-

1. Brake Power.
2. Mass of fuel consumed.
3. Brake Specific Fuel Consumption
4. Brake thermal Efficiency.
5. Air fuel ratio
6. Equivalence ratio

Experimentation includes performance tests on Engine to measure the parameters relating to our Biodiesel. These tests are performed on a "Rope Brake Dynamometer".

Table3. Engine Specifications

Engine	Four Stroke single cylinder diesel engine.
Make	Kirloskar-AV1
BHP	5 HP.
RPM	1500
Fuel	Diesel.
Bore	80 mm.
Stroke	110 mm.
Starting	Cranking.

Procedure for experimentation:

1. Power supply given to the engine
2. Initially without any load the values are found
3. Now Load is applied at the end of the rope.
4. Note the readings of the spring i.e. Load applied-weight of hanger.
5. Find the manometric difference and time taken for certain amount of fuel consumption
6. Similarly readings are noted for different loads at constant speed.
7. Then calculate the efficiencies using the formulae's and find the average.
8. This is how process parameters are calculated for our biodiesels on an Engine.

IV. Results And Discussion

Performance charts are those which compare the performance parameters which are found on the engine for those produced diesels.

These charts mainly drawn basing on the brake power Vs other parameters some of these charts are drawn between the following-

1. Brake Power Vs Brake Thermal Efficiency.
2. Brake Power Vs Mass fuel consumption.
3. Brake Power Vs Brake specific fuel consumption.
4. Brake power Vs Air Fuel Ratio

Figure 3 represents the mass of fuel consumed for different fuels with respective to brake power. The consumption of PME with respect to the BP is higher than diesel. Similarly the consumption of MME with respect to the BP is higher than PME. But the consumption of Blended biodiesel with respect to the BP is lower than diesel up to half load and higher for remaining loads. So compare to others, engine running with Blended Biodiesel consumes less mass of fuel.

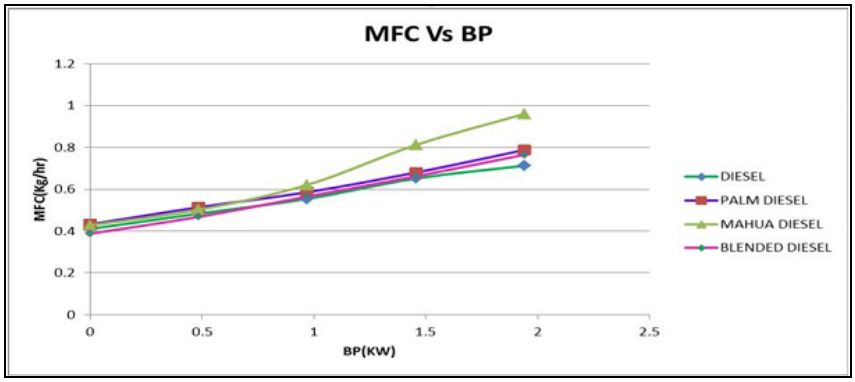

Fig3. MFC vs BP

Figure 4 represents the variation of brake specific fuel consumption for different fuels with respect to brake power. The engine consumes more PME than diesel for generating 1 KW of BP for 1 hour. So running cost of the engine using PME is little more than using diesel. Similarly the engine consumes more MME than PME . So running cost of the engine using MME is little more than using PME. But engine consumes less Blended biodiesel up to half of the load and more for remain load. so compare to the others running cost of engine using Blended Biodiesel is better .

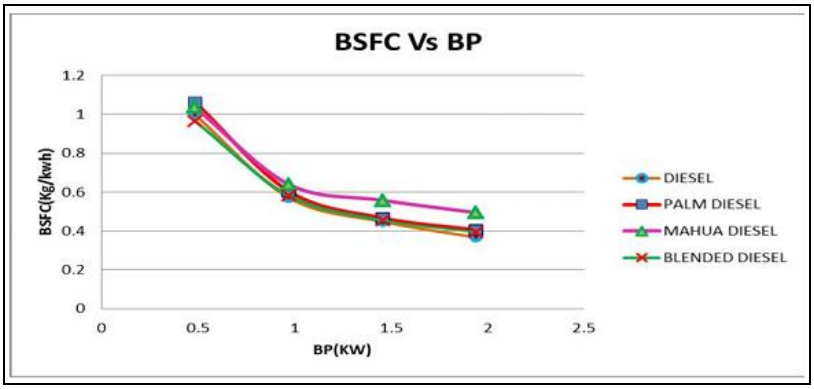

Fig4. BSFC vs BP

Figure 5 represents the variation of brake thermal efficiency for different fuels with respect to brake power. There is a increase in BTHE of the engine up to ¾ load by using MME when compared to diesel. There is also increase in BTHE of the engine by using Palm and Blended Biodiesels. Hence, there is a better utilization of indicated power for generating 1KW of BP using these bio diesels. Hence frictional losses are less using these bio-diesels. But compare to others the engines running with Blended Biodiesel is having minimum frictional losses.

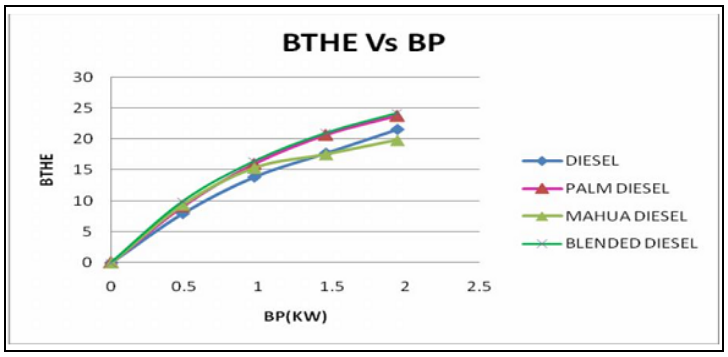

Fig5. BTHE vs BP

Figure 6 represents the variation of air fuel ratio for different fuels with respective to brake power. There is a increase in AFR of the engine using Mahua bio-diesel (up to half load) when compared to diesel. But there is a increase in AFR of the engine using Palm and Blended Biodiesels up to full load. Hence for 1 kg of bio-diesel consumed fuel required for combustion is less. So fuel consumption of Blended Biodiesel is less compare to others.

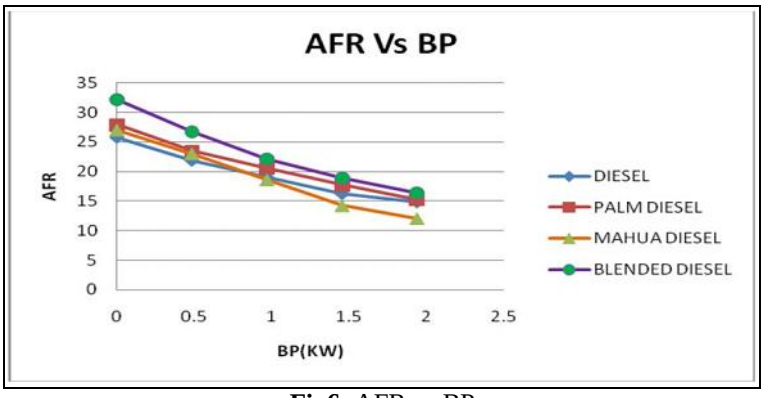

Fig6. AFR vs BP

V. Conclusions

From the experiments conducted the following conclusions can be drawn,

1. The biodiesel produced showed viscosity; specific gravity and calorific value are well
2. within the range of diesel oil and all the properties satisfy the B.I.S standards of biodiesel.
3. Flash and fire points of biodiesel are comparatively higher for biodiesel, thus the risk
4. of fire hazards gets reduced and handling and storage of biodiesel is safer.
5. Bio –diesel can be used in the existing engine without any modifications to the existing engine except fuel tank.
6. From figure 3, compared to the other fuels, engine run with Blended Biodiesel takes less mass of fuel
7. From figure 4, compared to the other fuels running cost of engine using Blended Biodiesel is better.
8. From figure 5, compared to the other fuels the engine run with Blended Biodiesel is having minimum frictional losses.

Finally, it is found that the optimum performance is achieved with Blended Bio-diesel at 70:30 ratios of palm and mahua Bio-diesels in comparison with conventional diesel
considering engine performance parameters.

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