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A Study on Compression Ignition Engine Using Mahua Oil Methyl Esters

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ABSTRACT

In this paper, a diesel engine using Mahua-diesel blend as an alternate fuel is considered for analysis. Different characteristics parameters of Mahua oil are calculated. First, Mahua oil is converted to Mahua oil methyl esters (MOME) by means of a process known as transesterification. Different performance parameters of single cylinder diesel engine with the blends such as B5, B10, B20, and B30 are calculated along with the standard diesel and then graphs are plotted. Then, the parameters obtained by the above tests are compared with the base line data by using diesel. Then, the optimum Mahua oil blend-B10 is obtained. This chosen blend show best performance with increase in efficiency and decrease in brake specific fuel consumption. Results obtained shows that Mahua oil methyl esters can be an effective alternate fuel for C.I. engine.

Keywords: CI Engine, Brake power, Compression ignition engine, MOME (Mahua oil methyl esters).

1. INTRODUCTION

India is among the fastest developing countries with good GDP growth and more youth population the fuel consumption in the country has been increased rapidly in the past three decades. The consumption is from the automobile sector, industrial sector, and agricultural sector. This consumption, in turn leading to the depletion of the fuels like diesel, petrol and coal. It has been proved that more than half of the pollution has been contributed by the vehicle emissions. Petrol and Diesel contains 85-87% of carbon in their composition which is the main cause for pollution. These emissions contain carbon monoxide and toxic gases which are resulting in ill health of the people. So we thought this is the correct moment to develop an alternate fuel for the petrol and diesel. There have been many investigations going on alternate fuels at present with Sunflower, Soya bean, Peanut, Neem etc. In this present report we selected Mahua as a substitute component for the preparation of bio diesel as it is easily available and cheaper in cost compared to many more oils. We are blending the vegetable oil with diesel instead of directly injecting it into engine because vegetable oil consists of strong fatty acids which causes engine to break down and also in knocking. We follow a special process called transesterification process to remove these bonds and to make oil usable.

2. MATERIALSANDMETHODS

Mahua oil sample is collected from Mahua seeds through Mechanical press process. As the crude oil consists of several impurities, it hasto be purified using Serigraphy papers. A sample of Mahua oil is taken into a beaker and preheated up to 55-60^{0}C using magnetic stirrer for removal of water vapors. Transesterification process is carried on the preheated oil. The transesterified oil is collected in a Separation funnel and allowed it to settle for 36-48 hrs. After removal of unsaturated and saturated fatty acids from separation funnel, the obtained oil is further treated with hot water for complete purification.

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Figure 1 Heating Process

Figure2 Separation process

Figure3 Triglyceride separation

Figure4 Hot Water bath

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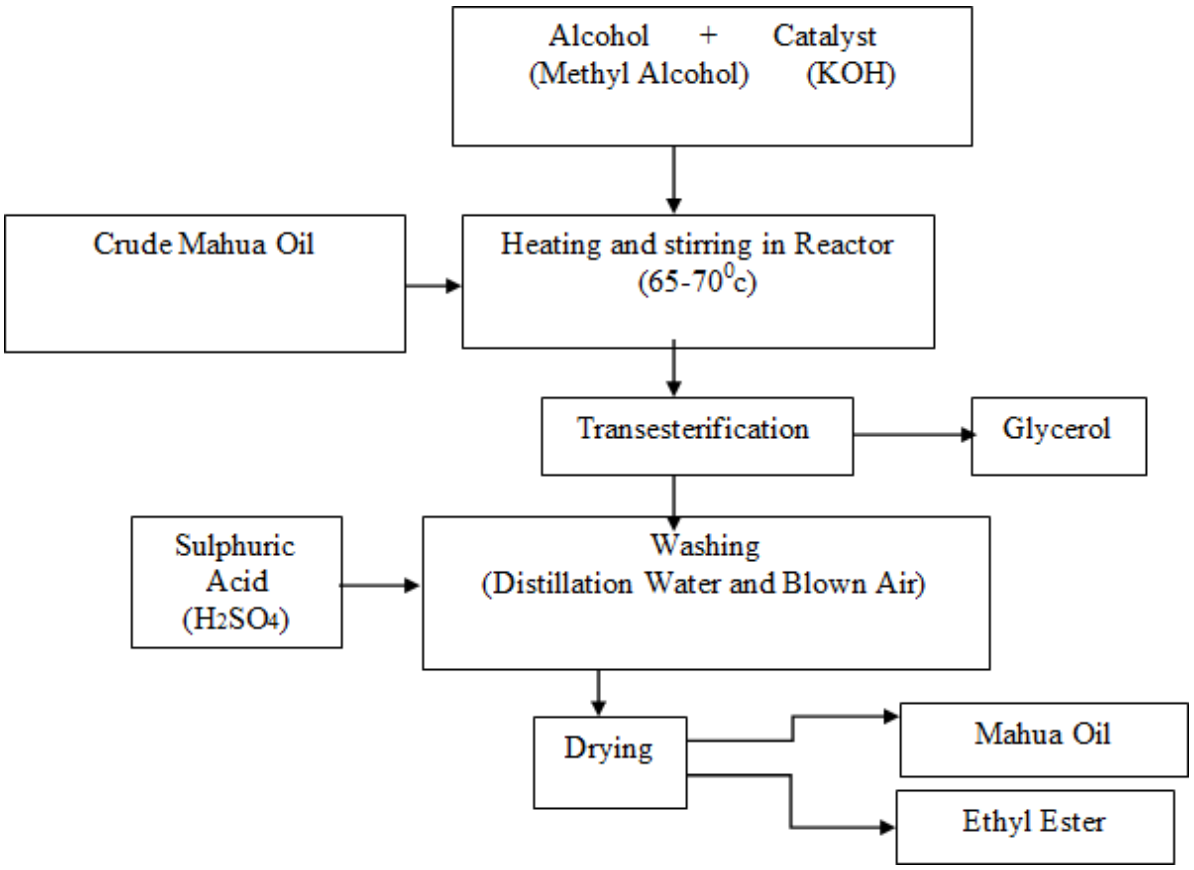
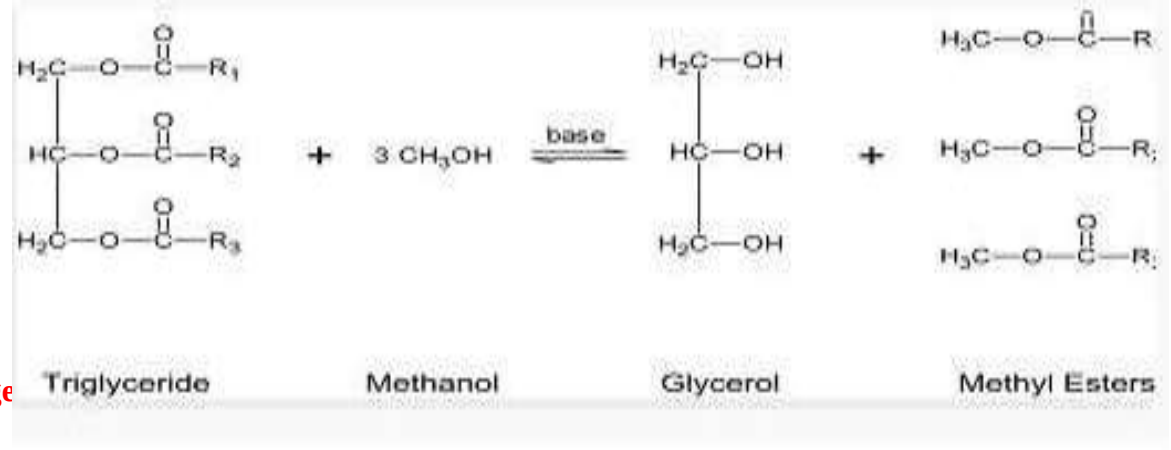
3. TRANSESTERIFICATION PROCESS

The vegetable oils contain strong fatty acids and methyl esters which are not suitable inproduction of bio diesel. Transesterification process is carried with methanol and acid or base as a catalyst. Methanol is used because it reacts with triglycerides in the vegetable oil to form glycerol and methyl esters (bio diesel). Methanol is used because of its low cost and its effective reaction with triglycerides. The common catalyst used are Potassium hydroxide (KOH) and Sodium hydroxide (NaOH) as these are easily available bases and base catalyst gives more prominent reaction. During Transesterification process the mouth of the lid has to be closed in order to restrict Methanol vapors



Mahua oil is preheated up to 55-60^{0}C. For 300ml of Mahua oil 75ml of Methanol is used along with 5.5gms of Potassium Hydroxide (KOH). KOH pallets are made in to powder and mixed with Methanol until it is completely dissolved. This solution is mixed with preheated Mahua oil again up to 60-65^{0}C with top of the heating beaker sealed with Aluminium foils in order to cease Methanol Vapors.



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4. PROPERTIES OF MAHUA OIL BY OBSERVATION

Table1 Denotes the comparison of various properties between Mahua and Diesel.

Properties	Units	Diesel oil	Mahua Oil	IS Limits for Grade A and B diesel
Specific Gravity		0.828	0.904	
Kinematic viscosity at 40° Celsius	C&T	2.44	37.18	2.0 -7.5 at 38°C Grade A
CalorificValue	Mj/kg	44.03	38.963	
Pour Point (°C)		-5	15	6 max grade A 12-8max grade B
Flash Point (°C)	°C	47	238	55 min grade A 66 min grade B
Carbon Residue	%	0.033	0.4215	0.2max grade A 1.5 max grade B
Water Content	°C	Trace	Trace	0.05 max grade A 0.25 max grade B
Ash Content	%	0.006	0.021	0.01 max grade A 0.02 max grade B

5. PREPARATION OF MAHUA SEED OIL BLENDS

Mahua oil is blended with Diesel in the proportions B5 (5ml MOME+95ml Diesel), B10 (10ml MOME + 90ml Diesel), B20 (20ml MOME + 80ml Diesel) and B30 (30ml MOME + 70ml Diesel) as shown in fig below.

Figure5 Diesel and Mahua oil blends

6. DIESEL ENGINE EXPERIMENTAL SET UP

Experimental setup consists of water cooled single cylinder vertical diesel engine coupled to a electrical loading dynamometer as shown in fig below. A fuel measuring system consists of fuel tank mounted on a setup, burette and a three way cock. Air consumption is measured by using pipe which is fitted with an orifice and a U-tube manometer that measures the pressure inside the tank.

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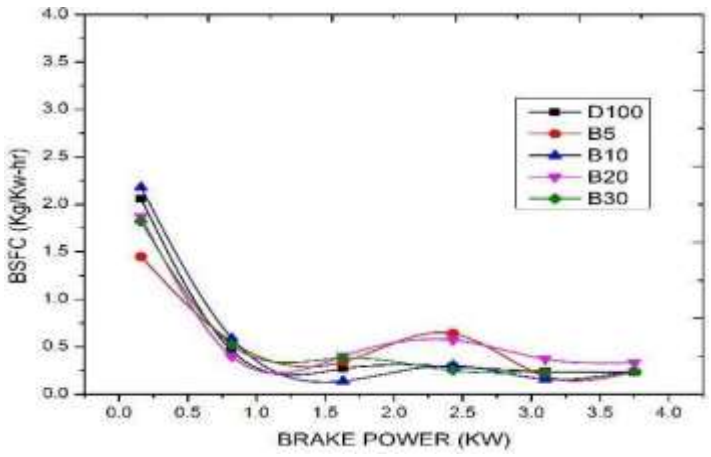
Figure 6 &7 Computerized Diesel Engine set up

Table2 Specifications of Diesel Engine Test Rig

Make	Kirlosker
No. of cylinders	1
Strokes	4
B.H.P	5KW
Cooling	Water cooled
Dynamometer	Eddy Current
Bore	80mm
Stroke	110mm
Speed	1500rpm
Compression ratio	16.5:1
Type of Ignition	Compression Ignition
Method of start	Crank shaft

7. RESULTS AND DISCUSSION

The variation of Brake Specific Fuel Consumption with Brake Power is given in belowgraph.



Graph1 Brake Specific fuel Consumption vs. Brake Power

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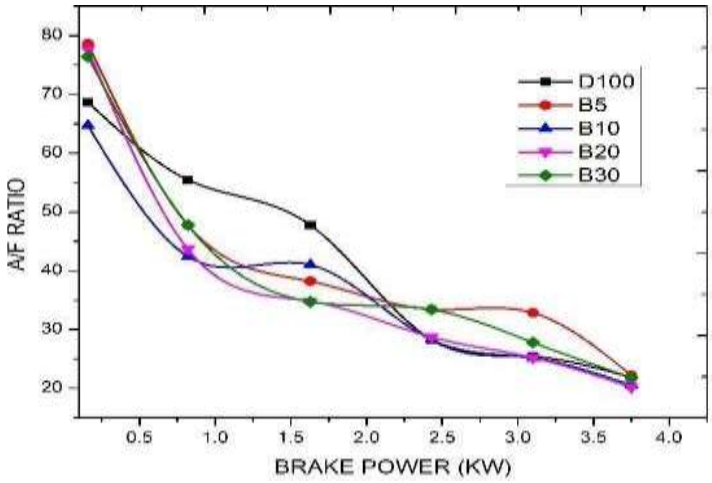
As the Brake Specific fuel consumption is one of the main variables to measure engine performance. The low B.S.F.C. value leads to low fuel consumption and the blend that has low B.S.F.C. value will be the suitable blend. From the observation we found the B-10 blend to be suitable among all other.

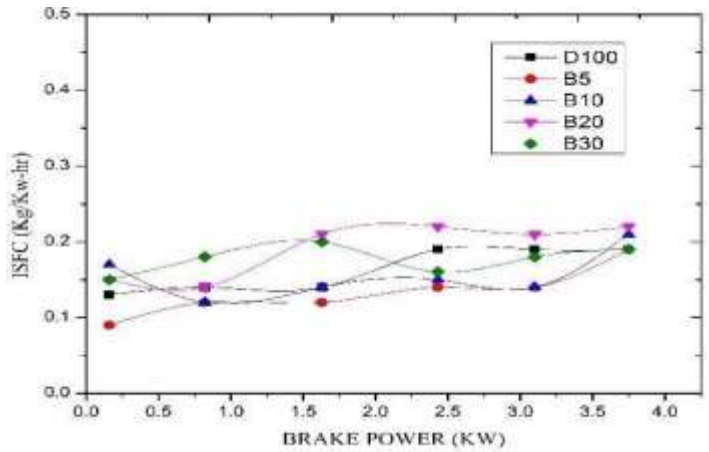
The variation of Air Fuel ratio with Brake Power is given in graph below.



Graph2 A/F Ratio vs. Brake Power

The Air Fuel ratio denotes the amount of air in kg, required for 1 kg of fuel to combust.The lesser the air fuel ratio the efficient will be the engine. The blend with less air fuel ratio compared to output power is selected. From the observation we found the B-10 blend to be suitable among all.

The variation of Indicated Specific Fuel Consumption with Brake Power is given in graph below.



Graph3 Indicated Specific fuel consumption vs. Brake Power

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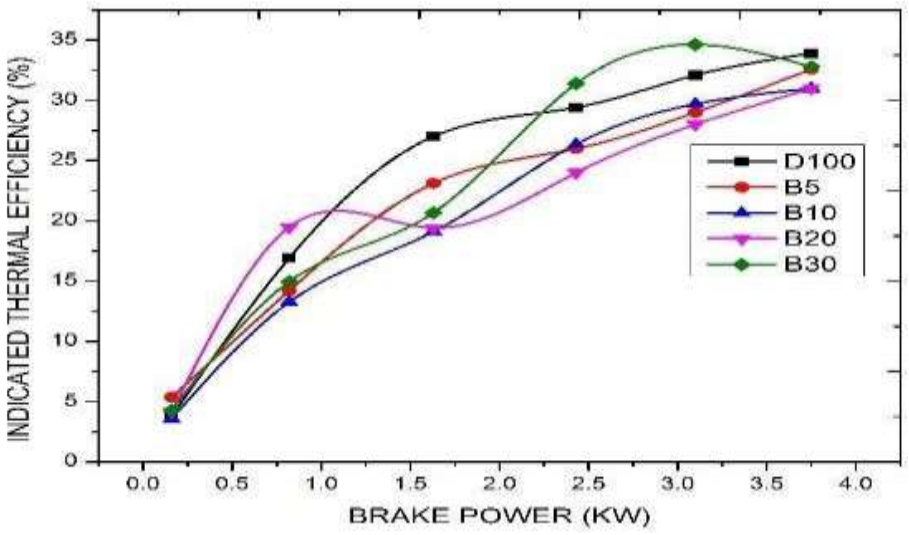
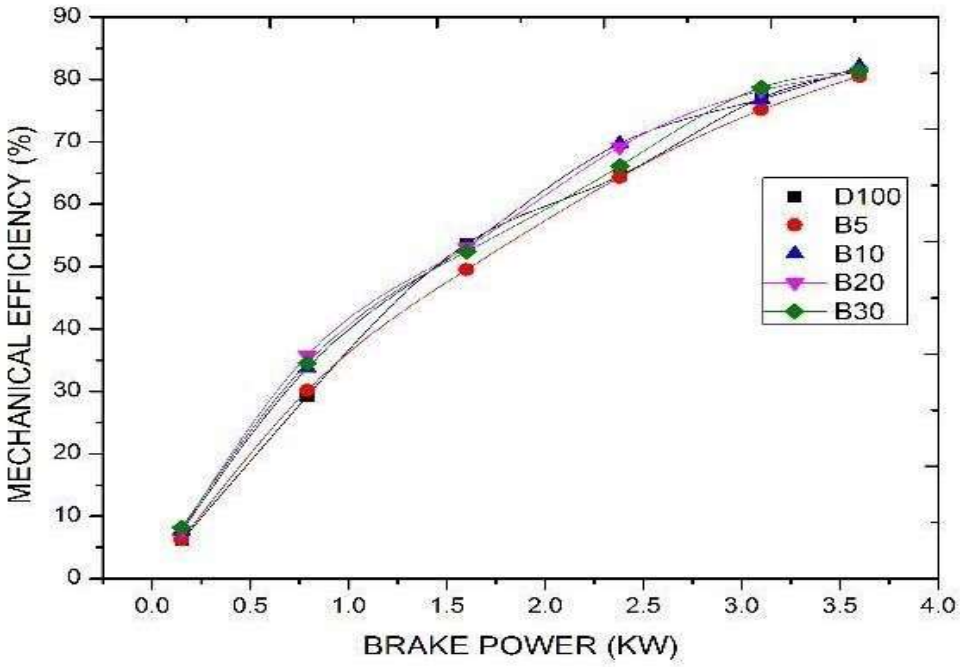
The variation of Indicated Thermal Efficiency with brake power is given in below graph



Graph4 Indicated Thermal Efficiency vs. Brake Power

Indicated thermal efficiency is defined as the ratio of Indicated power to the input fuel power. The greater the value of value of the Indicated thermal efficiency the better the blend will be. From the entire above considerations B-30 blend is better when compared with results of blends and diesel.

The variation of Mechanical Efficiency with Brake power is given in below graph



Graph5 Mechanical Efficiency vs. Brake Power

The Mechanical efficiency is the vital parameter in calculating the performance of engine.The higher the Mechanical efficiency, the proper the engine is working. The blend which has good efficiency compared to diesel will be selected. From the above graph B-10 blend is better when compared with results of blends and diesel.

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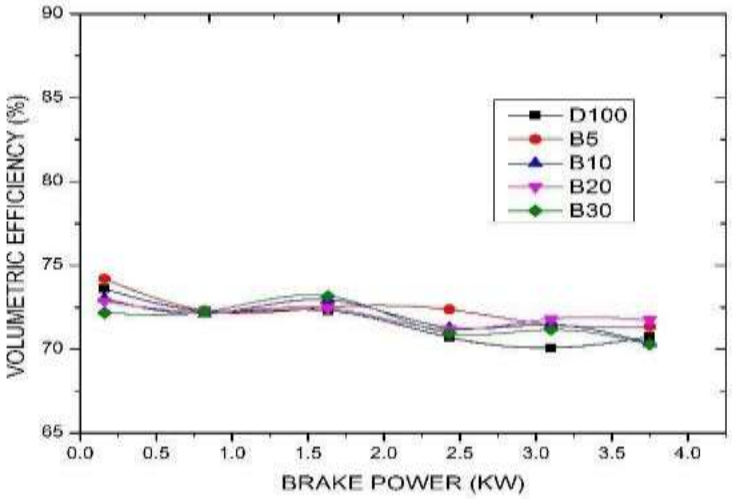
Thevariation ofVolumetricEfficiencywithBrakePowerisgivenin belowgraph



Graph6 VolumetricEfficiencyvs.BrakePower

The volumetric efficiency denotes that how freely the volume flows in to the cylinder. It determines viscosity factors of the oil. The blend with reasonable volumetric efficiency is selected. From the above results B-10 blend is better when compared with results of blends and diesel

8. CONCLUSIONS

With regard to the above experiments carried on the internal combustion diesel engine with diesel blended Mahua oil the following considerations have been drawn.

- The primary conclusion is that Mahua oil blended with diesel can be used as an alternate fuel.
- At initial conditions all the diesel blends along with pure diesel have the higher B.S.F.C. values but on increasing the load the B.S.F.C. values get decreased. B-10 which recorded the least value is selected as the suitable blend.
- The blend B-10 has shown the commendable results in the Air fuel ratio over other blends.
- In Indicated specific fuel consumption blends B-5 and B-10 has shown the almost similar results.
- In Indicated thermal efficiency blend B-30 has shown the better results even compared to the diesel.
- BlendsB-10 and B-20 have shown nearly the same results in Mechanical efficiency investigation.
- In Volumetric efficiency investigation blends B-5, B-10 and B-20 have shown the similar results.

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