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### Preparation of biodiesel from non edible extracts

Rajkumar. R<sup>1</sup>, Balakrishnan. S<sup>1</sup>

<sup>1</sup>Department of Mechanical Engineering, Nandha Engineering College, Erode - 638052

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#### ABSTRACT

Requirement of fuel is increasing as there is continues increases of automobiles. Fossil fuel availability is dwelling day by day. Biodiesel seems to be the solution for future since it is environmentally viable and readily available fuel. Several works have been carried out to produce biodiesel from edible oils and non edible oils and use it as a fuel for Compression Ignition (CI) engines. Non edible oils such as jatropha curcus, pongamia pinnata and edible oils, namely palm oil, sunflower oil, rapeseed oil and canola oil have been used to produce biodiesel fuel and lubricants. Biodiesel production from non edible oils is preferred compared to edible oils due to economic and social reasons and their availability. In this experimental work biodiesel is produced from the pongamia pinata by transesterification process and jatropha curcas oil by two-step transesterification process since Free Fatty Acid (FFA) content of this jatropha oil is found to be more than 3%. These processes result in conversion of about 93-96% of Pongamia Oil Methyl Ester (POME) and 90-95% Jatropha Oil Methyl Ester (JOME) from their respective oils. Important fuel properties of jatropha and pongamia oil methyl esters like viscosity, flash point, fire point, calorific value etc., were found out and compared to the properties of diesel.

**Keywords:** Biodiesel, CI engines, Pongamia pinnata, Jatropha curcus, JOME, POME, FFA, Transesterification, fuel properties.

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#### INTRODUCTION

Now days, due to reduction in resources of fossil fuels, increase in crude oil prices and increasing concerns for environment, the focus has been turned on again towards edible and non-edible oils and animal fats as an alternative fuel for IC engines. Biodiesel from edible and non-edible oils is biodegradable, renewable and non toxic and have higher flash point hence safe to transport and store.

Biodiesel is extracted from edible and non-edible oils by different methods among which a chemical process known as transesterification is most suitable method. Transesterification process gives high level of conversion of triglycerides to their corresponding methyl ester in short reaction time. Alkaline catalyzed transesterification is the promising area of research for biodiesel production from non-edible oils with less FFA content (< 3%).

These one-step transesterification processes use alcohol and an acid or base catalyst for production of biodiesel by chemical reaction. The alcohol may be methanol or ethanol. Methanol is more preferably used as it is shortest chain alcohol with single carbon atom and because of this it is more reactive with triglycerides than ethanol. Methanol also has some physical and chemical advantages and it is readily available at low cost. Methyl esters are produced at low temperature and pressure conditions and are non-corrosive and give methyl ester (80%) and glycerol (20%) as a by-product. Homogeneous base catalysts namely NaOH and KOH are the commonly used catalysts for biodiesel production by one step transesterification. NaOH is well accepted and widely used because of its low cost and high productive yield. H<sub>2</sub>SO<sub>4</sub> is the acid catalyst

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**Author for correspondence:**

Department of Mechanical Engineering, Nandha Engineering College, Erode - 638052

preferably used for acid esterification process which takes place at slower rate.

Pongamia pinnata and jatropha curcus are non-edible oils which are used mostly for production of biodiesel as an alternate for fossil fuels.

## TRANSESTERIFICATION

Transesterification is also called alcoholysis and it is the displacement of alcohol from an ester using another alcohol and an alkali catalyst similar to hydrolysis except that alcohol is used instead of water in transesterification. This process has been used to reduce the viscosity of triglycerides whose presence affects the CI engines performance [6]. If methanol is used in transesterification it is termed methanolysis. In the work pongamia and jatropha oils shown in Figure.2 extracted from their respective seeds shown in figure.1 are transesterified to obtain their respective biodiesels.

## STEPS FOR PRODUCTION OF BIODIESEL

Biodiesel production from refined pongamia pinnata oil consists of two-steps: Pre-treatment (Step-1) and alkali transesterification (Step-2) and for jatropha curcus oil, acid esterification is carried out before alkali transesterification since its FFA content is more than 3%. The parameters such as alcohol to oil molar ratio, catalyst amount, reaction temperature and reaction time were analyzed.

### Pre-treatment and separation

For a reaction to be successful, oil must be preheated above 100°C for 1 hour to remove the water and other impurities. A standard tritimity method is used in determining the FFA content in the oil.

## RESULTS AND DISCUSSION

### Properties of Biodiesel

**Table 1: Properties of biodiesels and diesel**

Properties	Pongamia oil	Jatropha oil	POME	JOME	Diesel
Density@ 15°C(Kg/m <sup>3</sup> )	991	918	885	880	836

### Acid esterification procedure

Jatropha curcus oil is processed with acid esterified before alkali transesterification process since it has FFA more than 3%. Here the preheated jatropha oil (1000 ml) is taken in a separate beaker. The mixture of concentrated H<sub>2</sub>SO<sub>4</sub> (1% w/w) with methanol (15% v/v) was heated at same temperature for 10 minutes and this mixture is added with the preheated oil(1000ml) in the beaker and the reaction mixture is stirred at 400 rpm for 60 minutes at 60°C. Then it was cooled and allowed to settle overnight. This mixture is then subjected to base catalyzed reaction, where all the residual acids are neutralized.

### Alkali transesterification procedure

Transesterification of preheated pongamia is done using oil using excess of anhydrous methanol and base catalyst. Methanol (200ml) with measured quantities of catalyst (NaOH-9grams) is dissolved by vigorous stirring and added to the beaker containing preheated pongamia oil (1000ml). The reaction mixture was stirred at 400 rpm for 60 minutes at 60°C as shown in Figure 3. Crude glycerin, which is the heavier part, is separated after complete settling in a separating funnel as shown in Figure 4. Then the separated ester (biodiesel) is washed for many times with water until the ester layer becomes clear as shown in Figure 5 and a mixture of Methanol (210ml) and NaOH (5grams) is added with the beaker containing acid esterified jatropha oil and transesterification process is carried out in similar way as of for pongamia oil for the production of jatropha methyl ester biodiesel. The resultant biodiesels are collected separately and stored for further studies.

<b>Kinematic viscosity @40°C(C.St)</b>	69.6	49.9	5.4	5.65	3.8
<b>Flash point (°C)</b>	241	240	182	170	56
<b>Fire point (°C)</b>	253	256	190	185	63
<b>Calorific Value (MJ/Kg)</b>	38.16	39.75	38.52	39.89	43.76
<b>Cetane Number</b>	47	45	62	50	54

## Density

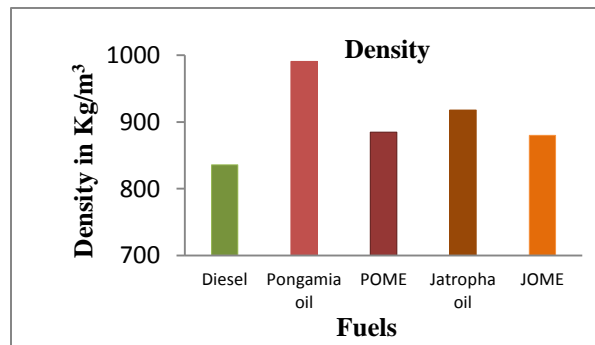


Chart 1: Fuels Vs Density

From the chart 1 it is seen that non-edible oils has higher density than diesel and after transesterification the methyl esters of those oils found to have a reduced density of 885(Kg/m<sup>3</sup>) and 880(Kg/m<sup>3</sup>) for POME and JOME which is closer to that of diesel.

## Kinematic Viscosity

High viscous liquids will have an adverse effect on engine fuel injection system thus resulting in

poor atomization which ultimately reduces the power of the engine and production of smoke [2, 8]. Non-edible oils has high kinematic viscosity than diesel and after transesterification the produced biodiesels are found to have kinematic viscosity of 5.4centistokes and 5.65centistokes for POME and JOME respectively which is nearly equal to that of diesel as shown in chart 2. This is the advantage of biodiesel over its source oil.

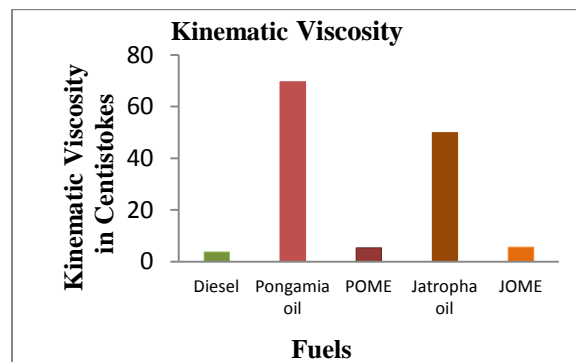
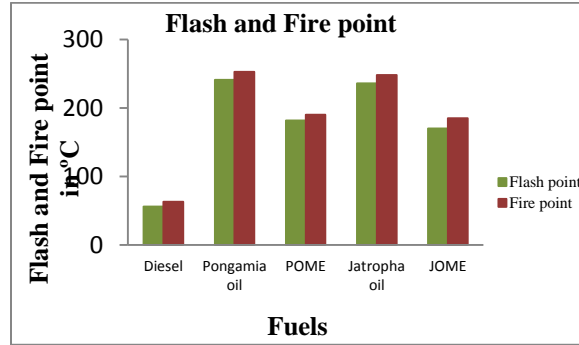


Chart 2: Fuels Vs Kinematic Viscosity

**Flash and Fire point**

Flash point helps to characterize the fire hazards of liquids and hence has been considered as an important property of fuel. Flash point of POME and

JOME biodiesel is high compared to diesel as shown in chart 3. Thus these biodiesels higher transport and handling safety than diesel.

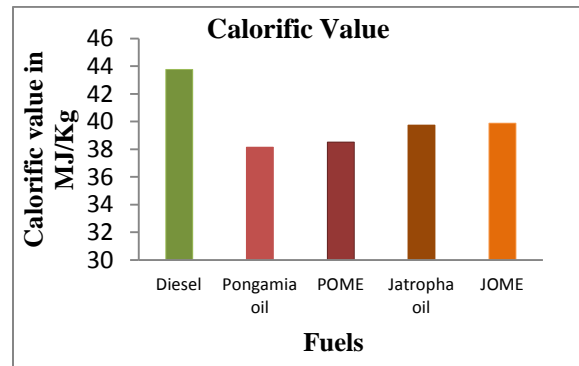


**Chart 3: Fuels Vs Flash and Fire point**

**Calorific Value**

Fuel with higher calorific value will have higher combustion rate. It is clear from the chart 4

that calorific value of JOME and POME found to be improved compared to its oil, but it is quite lower than that of diesel.



**Chart 4: Fuels Vs Calorific Value**

**Cetane number**

Biodiesels are found to have higher cetane number than that of diesel as shown in chart 5. And thus use of these biodiesels as an alternate for

diesel in CI engines will have improved performance, combustion and emission characteristics compared to diesel.

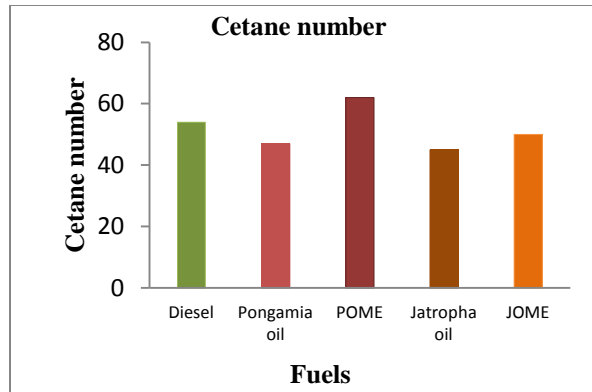


Chart 5: Fuels Vs Cetane number



Figure 1: Pongamia seed and Jatropa seed



Figure 2: Pongamia oil and Jatropa oil



Figure 3: Transesterification



Figure 4: Settling



**Figure 5: Bubble washing**

## CONCLUSION

Biodiesel production from non-edible oils is preferred compared to edible oils due to their availability and for their social and economic reasons. In this experimental work, biodiesel is produced from *Jatropha* and *pongamia* oils. Alkaline transesterification of *pongamia* oil resulted in a yield of 93-96% and two step acid esterification and base transesterification of *Jatropha* oil resulted in a biodiesel yield of 90-95%. The most important properties namely

density, kinematic viscosity, flash point, fire point and calorific value of the transesterified product (biodiesel) from these two non-edible oils (*pongamia pinnata* oil and *jatropha curcus*) compares well with accepted ASTM standards. They are biodegradable, non-toxic and has high flash point and thus safe to transportation and storage is safer and easy. Therefore from this work it can be stated that biodiesel produced from *pongamia* and *jatropha* oils will be a better alternative fuel for diesel in the future.

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