# Transesterification of mahua oil for the production of bio-diesel, after treatment with turpentine oil to enhance the properties of bio-diesel.

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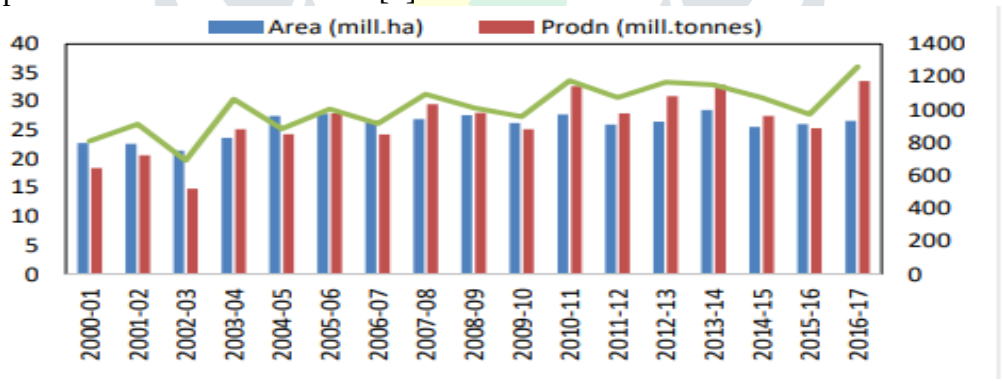
**ABSTRACT:**

This work represents method of producing biodiesel from Madhuca Indica (Mahua) oil after treating with turpentine oil. Extracted oil processed with $CH_3OH$ (methanol) in presence of Potassium Hydroxide in a transesterification process. Methyl ester produced from the transesterification process has significant properties, for instance viscosity, fire point, flash point, calorific value etc. These properties are checked and compared with the Indian standard biodiesel.

## INTRODUCTION:

Renewable and environment friendly energy need to be developed to meet the increasing demand of Non-renewable fuels for transportation. Vegetable oils are the suitable path. Lot of research is going on bio-diesel to make it more efficient [2]. Many investigations revealed that crude vegetable oil leads to many problems when it is used as a fuel in compression ignition engine. In CI engine lubricating oil layer starts thickening and lot of deposits are formulating, due to these main reasons' problems start arising at very early and the main reason for all these problems is viscous oils. Many solutions are there to reduce the viscosity, blending can be done, emulsification can also be done. But these solutions are not that efficient. There are several other ways to use vegetable oil by preparing monoester and this ester product is produced by the process of transesterification.[1]




**Graph 1:** Production of oil seeds in india in different years

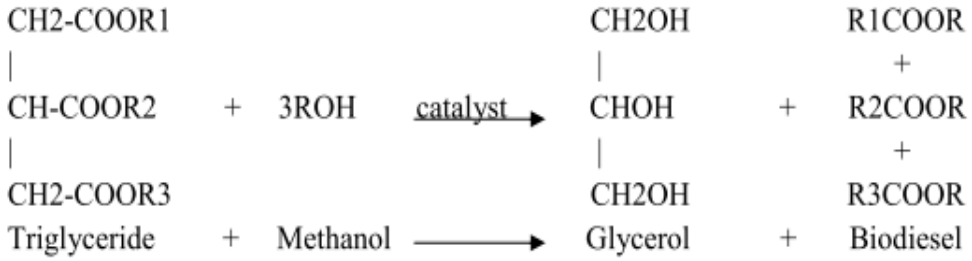
## PRODUCTION PROCESS MAHUA OIL METHYL ESTER (MOME):

### Esterification:

In this process any type of oil edible or non-edible oil is added with an ester group. Oil is having a heavy amount of Free Fatty Acid (FFA) [7]. If the FFA content is more than 5% then the oil will convert into the soap. If the amount is less than 5% then there is a possibility to prepare biodiesel from oil [3]. First step to convert this FFA content into the triglyceride. FFA having the main content of unsaturated fats and the carboxylic acids (-COOH) group. FFA having a long chain of carbon as mostly similar to the hydrocarbon chain in the fossils fuel [6]. It is beneficial for us to convert this FFA into the useful biodiesel because this is having properties like mineral diesel

**Transesterification:**

This step is the decision-making step in this step we convert the triglyceride into the useful methyl ester of the oil [4]. This reaction carried out with the methanol group in presence of a catalyst. Catalyst is the strong base of NaOH/ KOH as shown in the reaction




In this reaction triglyceride is sucessesfully converted into two contents methy ester or biodiesel and glycerol [5]. This methyl ester is having properties comparable to mineral diesel due to

- Lesser viscosity
- Boiling point is low
- Flash point is low

**PRODUCTION OF BIO-DIESEL FROM MADHUCA INDICA BLENDED WITH TURPENTINE:**

In India nonedible oils are the source for production of bio-diesel as the edible oils are costly and productions is also less as compare to the population. So, Mahua oil can be assumed as a good option to manufacture biodiesel. It is from the Sapotaceae family, it is a fast-growing tree to maximum of 20 meter high. The favorable conditions to grow the plant is tropical although can be found in arid places. In India it found mostly in North and Central parts and known by many different names. The whole mahua seeds contain 50–61 % oil, 16.9 % protein, 3.2 % fiber, 22 % carbohydrates, 3.4 % ash, 2.5 % saponins, and 0.5 % tannins [9]. Because of its high oil content, the production cost is less which is favorable for the bio-diesel manufacturing. However, the viscosity of Mahua oil is far more than mineral diesel, its fatty acid content is enough for the bio-diesel production. Its properties must be changed to become a successful diesel alternative.

**Mahua Oil:**

Mahua oil is collected from the oil seed in which 2kg seed is enough to produce the 1 litre of oil. The whole manufacturing process is carried over one litre of oil however multiple quantities can be used [8]. The chemical ingredients would vary as per the quantity of the oil. The development process is described below

- One liter of mahua oil is to be taken.
- 300-330 ml of $CH_3OH$ & 10 ml of concentrated Sulphuric acid is to be added to mineral oil.
- Mixture is kept at 60-70$^0$C temperature for 6 hours with regular stirring.
- In the next step, the hot mixture is left alone for eight hours to settle down.
- The mixture contains two separate layers
    - Bio diesel layer, because of less density it floats at top
    - Lower layer is remains of reactions which mostly consist of glycerin, gums etc.
- Lower layer is separated and upper layer is taken into another funnel for the further process.

- It is then mixed with hot water at $40^0$C to separate out the traces of glycerin. This solution kept for the 8 hours and this step is repeated for 3 times. Now the freshly prepared bio diesel is ready to treat with the turpentine oil

**Treatment with the mineral turpentine oil:**

The methyl ester of mahua oil is treated with turpentine oil to adjust the properties of bio diesel. In the bio diesel 10 ml of turpentine oil is mixed 90 ml mineral bio diesel and stirred for 15-20 minutes [10]. This mixture named sample 1 because only 10% by volume of turpentine is added. The properties of the fuel are then compared with the mineral diesel.

| Properties | Mahua Oil | MOME | MOME treated with turpentine oil | Mineral Diesel | Standard Value BIS:15607 |
|---|---|---|---|---|---|
| Density at $40^0$C (g/cm$^3$) | 0.906351 | 0.87584 | 0.870 | 0.830 | 860-900 |
| Specific Gravity | 0.91343 | 0.89485 | 0.869 | 0.828 | 0.851 |
| Flash Point ( $^0$C ) | 267 | 198 | 183 | 47 | 120 |
| Viscosity at $40^0$C (Cst) | 51.85 | 6.10 | 5.95 | 2.44 | 2.5- 6.0 |

**Table 2:** Shows the properties of fuel

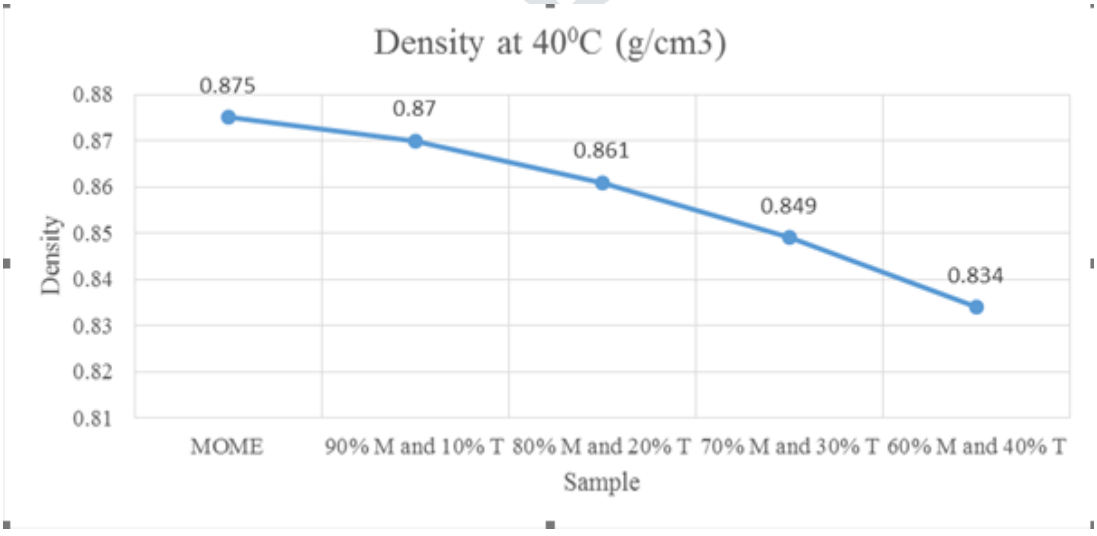
**RESULTS:**

**FUEL PROPERTIES:**

The properties are checked in the laboratory and it has been displayed in the table 2.

**Density:**

It is simply mass per unit volume. So, oil which has higher density carries more energy. Mahua oil has density 0.906 g/cm$^3$ at $40^0$C and transesterification reduces it to the 0.87584 g/cm$^3$ on further treatment with turpentine oil it reduces to far better conditions 0.870 g/cm$^3$. Mineral diesel having value of 0.830 g/cm$^3$. The graph 2 shows the variation of density with the increase of turpentine oil quantity in the mixture.



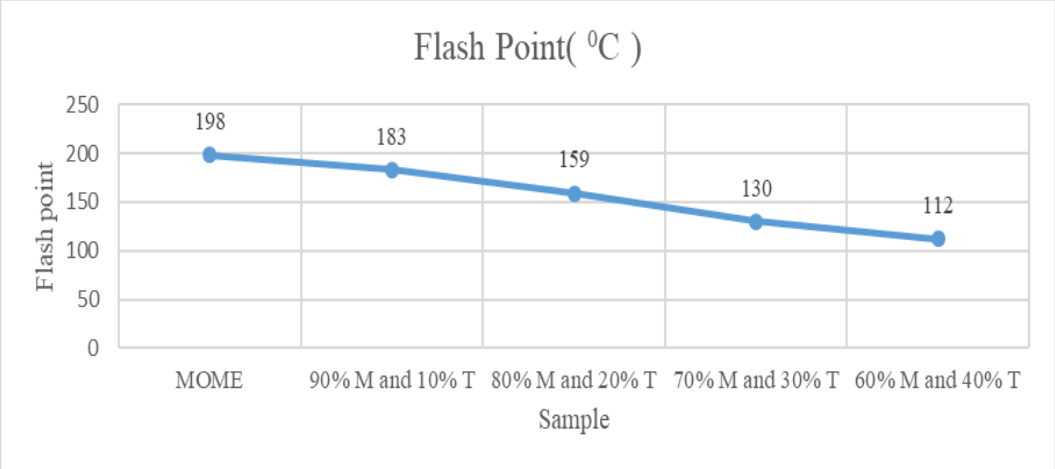

**Graph 2:** Trend of density with different composition of turpentine oil.

**Specific Gravity:**

It is the ratio of density of the substance to the density of reference material, in this case water is considered as reference liquid. As a result, the value of specific gravity continuously decreasing from the raw mahua oil, at 0.91343 to the MOME treated with turpentine oil to 0.869. Hence, treatment with turpentine oil shows better results for the preparation of bio diesel.

**Flash Point:**

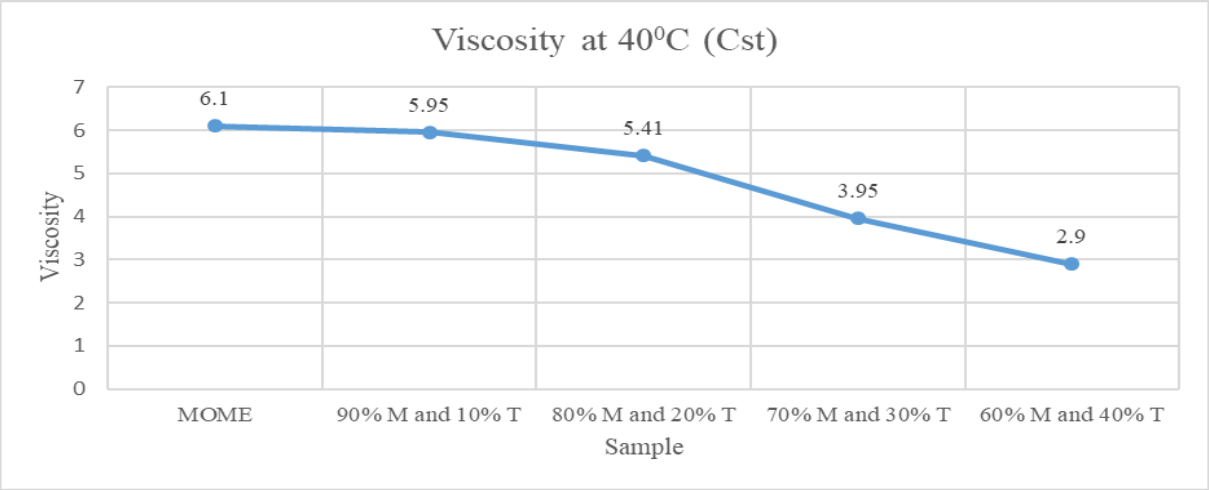
Temperature at which the fuel starts to produce flashes on increasing the temperature is called flash point. Highly volatile oil has less ignition temperature because it is inversely proportional to the ignition temperature. Raw mahua oil has 267 $^0$C flash point however after preparing MOME it reduces to the 198$^0$C. On turpentine treatment it reaches to 183$^0$C. It is much higher than the mineral diesel so it less volatile than diesel thus safe to store. The graph 3 shows the variation of flash point with increase in amount of turpentine oil with MOME.




**Graph 3:** Trend of flash point with different composition of turpentine oil.

**Kinematic Viscosity:**

It refers to the resistance to flow of liquid and it is determined by time taken by the oil to pass through a small specified orifice. Viscosity directly related to the flow of liquid, which affect the lubrication and atomization in the cylinder for the proper mixing and combustion of fuel. The viscosity must remain in the specified range which is 2.5-6.0 at 40$^0$C. Higher viscosity leads to poor combustion as it produces larger droplets for in the cylinder. Lower value of viscosity creates the lubrication problems. After the production process there is a huge decrement in the viscosity value and mixing with turpentine oil further decrease the viscosity value as shown in the table. The graph below shows the trend of viscosity with the increase in amount of turpentine oil in the mixture, which is viscosity decreases with the increased composition of turpentine.




**Graph 4:** Trend of viscosity with different composition of turpentine oil.

## CONCLUSION:

Freshly prepared mahua oil is converted into the Mahua Oil Methyl Ester (MOME) using KOH. The bio diesel produced from it then treated with mineral turpentine oil and the properties like viscosity, density, flash point and specific gravity of bio diesel changed significantly. Then the treatment is carried out with varying composition of turpentine oil with bio diesel and the results are compared with Indian Bio Diesel standards. Treatment with turpentine oil makes bio diesel of mahua oil in well accepted range of standards.

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