Production process of Biodiesel using Animal and Vegetable oils

Dawar Zaidi

Department of Mechanical Engineering,
Zakir Hussain College of Engineering and Technology, Aligarh Muslim University, Aligarh

***Abstract*: In this paper, production process of various biodiesel, made from source oils like Soya bean oil (edible), Mahua oil (non-edible), Animal fat and Waste frying oil (W.F.O.). were analyzed. At first, titration is done to know the exact amount of catalyst required. Then transesterification process is carried out where, firstly, preheating is done to evaporate the excess water in the source oil. Then, methanol and KoH are mixed in other container to form methoxide. After preheating the source oil & preparing methoxide, methoxide is added in preheated source oil. Then the mixture is left to settle down for 8-12 hours. The Glycerin settles down due to gravity and biodiesel settles on the glycerin which is separated afterwards. Then water is separated from biodiesel. For this biodiesel is taken in a separating container and same quantity of water is added gently in it and it is kept for 1-2 hours. The water settles down due to higher density and removes soap from biodiesel.**

***Keywords*: Biodiesel, FFA content, transesterification, methoxide**

1. INTRODUCTION

There are several methods of preparation of biodiesel from bio lipid. Some of the processes are given below:

- Trans-esterification process
- Super critical process
- Ultrasonic reactor method
- Ultra- and high-shear in-line batch reactors
- Lipase-catalyzed method

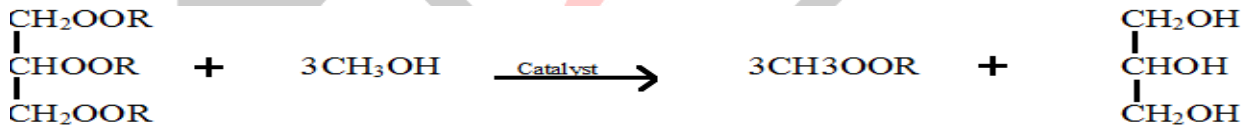
From all methods given above, Trans-esterification process was chosen, because of the availability of Trans-esterification process plant of 10 liters batch size.

CHEMICAL REACTION:

Biodiesel is produced by Trans-esterification process by mixing methanol and catalyst in source oil. The chemical reaction governing Trans-esterification process is given below:

Vegetable oil is transformed into biodiesel by transformation process. In which methanol reacts with vegetable oil in the presence of catalyst (NaoH/KoH) to produce biodiesel & glycerin.

The chemical reaction is given below:



Vegetable oil Methanol Biodiesel Glycerin

FFA CONTENT:

When the oil is kept for a longer time or at a high temperatures, the fatty acids detaches from the glycerol molecules. These fatty acid molecules are called free fatty acid (FFA) content.

These FFA content cause problem in biodiesel preparation such as

I. It uses more catalyst.
II. It cause formation of soap and water.
III. It lowers the yield of biodiesel.

Several researchers have reported that if FFA content is less than 4% then the problems listed above are negligible but if the FFA content is more than 4% then there are several methods of reducing the percentage of FFA in the oil, which is given below:

- Adding fresh low FFA oil
- Adding more catalyst to change FFA to soap (which is removed afterwards).
- Adding acid and methanol

Adding fresh low FFA oil is the easiest way but it can only be used for occasional high FFA batch.

Adding more catalyst to change FFA to soap is also easy solution but high quantity of feed stock will be lost in washing and separation of soap.

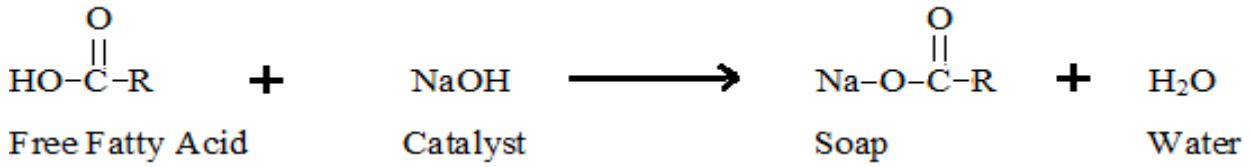
Adding acid and methanol will demand large quantity of methanol which will be very expensive for small scale production systems.

So, because of these limitations, method of adding more catalyst to change FFA to soap was used.

2. BIODIESEL PRODUCTION PROCESS

2.1. TITRATION:

To neutralize FFA present in source oil, extra catalyst is used and this titration is done to know the amount of extra catalyst needed.
The equation is given below:



For titration, a KOH solution with water is made by adding 1 gram of KOH with 1 liter of distilled water. Secondly, 1 ml of oil is mixed with 10 ml of methanol and some drops of Phenolphthalein are added. Now in this mixture KOH solution is added until it changes color. The mls of KOH solution used in titration are equal to no. of grams/liter of oil to react FFA.

CHEMICALS REQUIRED:

Source oil:
A 10 liter batch of every source oil i.e. Mahua oil, Soya bean oil, and animal fat oil, waste frying oil was required.

Methanol:
Methanol was used for Trans-esterification process of each source oil, the amount of methanol used was 20-25 % of volume of the source oil.

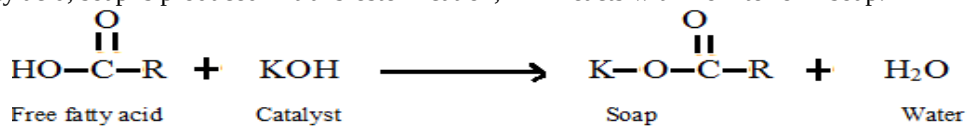
Catalyst (KOH):
KOH was used as a catalyst in the Trans-esterification process, the amount of KOH depends on the amount of source oil, ratios of saturated and unsaturated hydrocarbons and FFA content in the source oil.

2.2. TRANS ESTERIFICATION PROCESS:

(i) Preheating of source oil:
For Trans-esterification process, the source oil is firstly preheated in a container. The preheating may be taken between 50 to 55'c.
(ii) Methoxide preparation:
Now methanol and KoH are mixed in other container to form methoxide. The amount of methanol used may be 20-25% of volume of oil and the amount of KoH used is sum of basic amount of KoH used and amount of KoH used to react with FFA content. NaoH is dangerous for human skin and eyes and Methanol is highly inflammable. So care must be taken while using these chemicals.
To mix KoH in methanol, methanol is agitated and KOH is slowly poured in it. It takes about 20 minutes. When KOH particle are not visible in solution, then methoxide is ready to be added into the source oil.

(iii) Mixing of methoxide & oil:
After preheating the source oil & preparing methoxide, methoxide is added in preheated source oil. The mixture is simultaneously stirred and maintained at a temperature below the flash point of methanol (70'c). For the sack of safety it is taken between 60-65 'c. This process takes about 2-4 hours. Then the mixture is left to settle down for 8-12 hours. The Glycerin settles down due to gravity and biodiesel settles on the glycerin which is separated afterwards.
After this process, It is checked whether the oil is properly reacted or not. To perform this test 3 ml of biodiesel and 27 ml of methanol and kept for 5-10 minutes. If the deposits are more than 3 mm in the bottom of test tube then this indicates that the oil is not properly reacted otherwise the quantity of biodiesel produced is good.

(iv) Washing biodiesel:
Because of free fatty acid, soap is produced in trans-esterification, FFA reacts with KoH to form soap.



Some quantity of soap goes with biodiesel so biodiesel is washed gently to remove catalyst, soap and other impurities. There are three main methods of washing:

- Water washing
- Air bubble washing
- Air/water bubble washing

The best method is air/water bubble washing but due to practical limitations, water washing was used.

For this biodiesel is taken in a separating container and same quantity of water is added gently in it and it is kept for 1-2 hours. The water settles down due to higher density and removes soap from biodiesel. Then water is separated from biodiesel.

After this, it is checked for assuring that all the soap is separated from the biodiesel. To check this, we take small quantity (about 50 ml) biodiesel which we got after washing in a transparent beaker and add same amount of water in it, shake it and let it settle down for one hour. If the water which is settled down due to density difference is clear then there is no soap in biodiesel.

3. STORAGE:

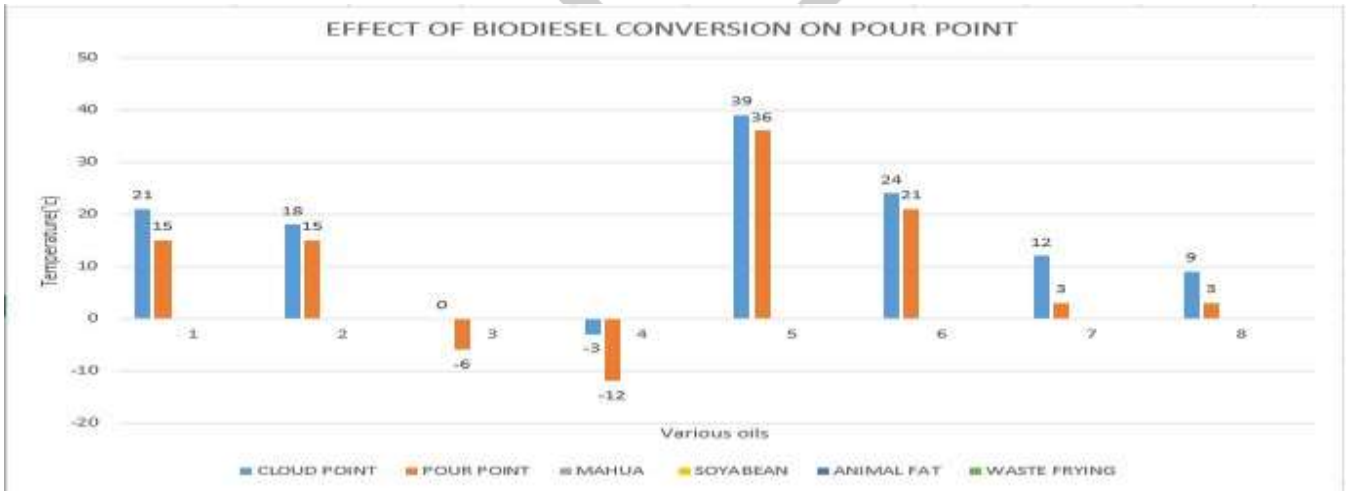
The biofuel reacts with oxygen because of being biodegradable and its viscosity increases after oxidation. Metals also increases the rate of degradation. Exposure to water and heat also degrades the biofuel
According to ASTM D675,

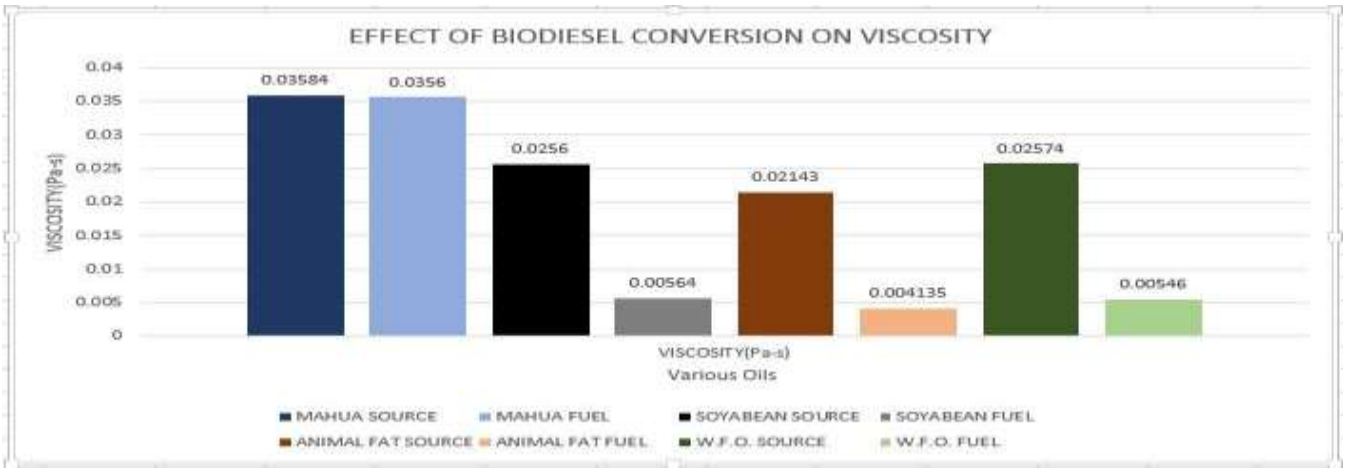
- It should be kept in Air tight container to avoid oxygen exposure.
- It should not be kept in metallic containers.
- Avoid Water exposure.
- Keep it in cool & dry place.
- It should be away from heat exposure.

4. RESULTS AND DISCUSSION:

PROPERTIES:

	MAHUA		SOYABEAN		ANIMAL FAT		WASTE FRYING		DIESEL
	SOURCE	FUEL	SOURCE	FUEL	SOURCE	FUEL	SOURCE	FUEL	FUEL
CLOUD POINT	21	18	0	-3	39	24	12	9	-12
POUR POINT	15	15	-6	-12	36	21	3	3	-16
FLASH POINT	>180	>180	>180	185	>180	>180	>180	185	74
DISTILLATION TEMP.		340		360		340		340	275
VISCOSITY(Pa-s)	0.04595	0.0456	0.0329	0.007225	0.0275	0.0053	0.033	0.006995	0.0045
DENSITY(g/l)	921.2	904.92	894.4	866.08	859.8	848.16	890.16	873.28	832





(i) The cloud point and pour point of each oil decreased after biodiesel production.
(ii) Flash point of all biodiesel oils are found to be above 180˚C.
(iii) Pour point of soya bean oil & animal fat decreases after biodiesel production.
(iv) Pour point of mahua source oil is same as that of mahua fuel oil. Similar trend is there for waste frying oil. This may be due to the reason that during experimentation observations were taken for 3˚C drop in temperature and any change less than this is not considered.
(v) Viscosity of all the produced biodiesels is found to be decreased due to the chemical change of fatty acids to mono-esters.
(vi) Distillation point of all the biodiesels is found to be satisfactory as per ASTM standards i.e. less than 360˚C.
(vii) Density of all the produced biodiesels is less than the source oils.

5. CONCLUSION:

From the above results, it can be concluded that:

i. Cloud point of Mahua biodiesel is found to be too high to be used as a biodiesel especially in cold weather conditions or in cold countries
ii. The viscosity change in Mahua biodiesel is found to be too low which again make it unsuitable as a diesel substitute so Mahua oil should not be used as a biodiesel. . However by using suitable additives & blending small percentages with diesel it can be used to enhance lubricating properties of conventional diesel.
iii. Similar trend for cloud point for Animal fat biodiesel is found but the viscosity changes are very significant so it can be used as a good biodiesel especially in summer seasons.
iv. Waste frying oil shows quite good properties after converting into biodiesel & it can be used as a good substitute.
v. The best results are shown by soya bean biodiesel as it almost satisfies all the parameters of ASTM D6751.

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