Volume-5, Issue-2, Feb - 2016 • ISSN No 2277 - 8160
IF : 3.62 | IC Value 70.36

Research Paper | Engineering

Determination Of Optimum Reactiontemperature For Biodiesel%Yield From Rice Bran Oil

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ABSTRACT

The determination of optimum reaction temperature for biodiesel yield from oil was studied. The oil was transesterified using two catalysts sodium hydroxide (NaOH) &Potassium hydroxide (KOH) in methanol to obtain Rice bran oil Methylester(biodiesel). For the optimum reaction temperature, the biodiesel production was carried out at three temperatures (55,65,750C) and at eight reaction times30, 60,90,120,150,180,210,240 min and catalyst weight kept constant (1.25 grams).From the experimental observations comparative investigation carried out for the two catalysts, at three temperatures (55,65,750C)and at eight reaction times(30, 60, 90,120,150,180,210,240 min).Optimum Temperature is obtained at 65◦ C, with KOH as catalyst at which maximum %Yield is obtained and is 95%, while agitator speed kept constant.

KEYWORDS : Transesterification, biodiesel production, biodiesel yield, rice bran oil, reaction time, reaction temperature.

INTRODUCTION

Fuel and energy crises and the concern for the depleting world's non-renewable energy resources have led to a renewed interest in the quest for alternative fuels[1]. Majority of the world energy needs are supplied through petrochemical sources (coal and natural gases) with the exception of hydro-electricity and nuclear energy. Of all these sources that are finite, the current usage rates are expected to be depleted in a couple of decades. Non-renewable energy sources such as petroleum are related to several drawbacks including; increased green house gas emissions, high cost of processing the crude petroleum and energy demand during the process etc. This has provided the incentives to seek alternative sources for the fossil-based fuels[2]. Biodiesel is a fuel produced from the reaction of vegetable oil and fats with alcohol in the presence of a catalyst usually alkali (NaOH, KOH etc.).

Biodiesel is becoming an increasingly acceptable alternative to fossil diesel because of the narrowing gap between worldwide oil production and consumption increasing reality of the Hubbert peak and the imperatives for carbon-neutral fuels[3].Biodiesel is biodegradable, non-toxic and has low emission profiles when compared to fossil fuel and its usage will allow balance between agriculture, economic development and the environment[4] . Biodiesel is produced through a chemical process known as transesterification. Transesterification of vegetable oils with low molecular weight simple alcohols (methanol,ethanol, propanol, butanol andamyl alcohol) has been established as the best option to reduce the high viscosity, low volatility, heavy engine deposits and toxic substance formation associated with the direct useof vegetable oils[5,6].A wide variety of feedstock have been identified as suitable for biodiesel production including; soybean, canola, sunflower, safflower, Jatropha ,curcas, peanut, tiger nut, coconut etc[7,8]. However, some of these oil sources are commodities whose prices are strongly dependent on the International market.

The fatty acid profile of some of the oils is presented in Table

Fatty Acid	Sun flower	Rice bran	Palm	karanja	Rape seed	Soya-bean
Lauric (12:0)	–	0.1	0.1	–	–	
Myristic (14:0)	–	1	1	–	–	
Palmitic (16:0)	6.7	15	42.8	8.9	4	11
Stearic (18:0)	3.7	1.9	4.5	8.1	2	4
Oleic (18:1)	19	42.5	40.5	52.3	62	24
Linoleic (18:2)	69.9	39.1	10.1	21.8	22	54
Linolenic (18:3)	0.7	1.1	0.2	–	10	7
Arachidic (20:0)	–	0.5	–	3	–	–
Behenic (22:0)	–	0.2	–	3.1	–	–
Lignaoceric (24:0)	–	–	–	2.8	–	–

MATERIALS AND METHODS

Materials

MAJOR INGREDIENTS

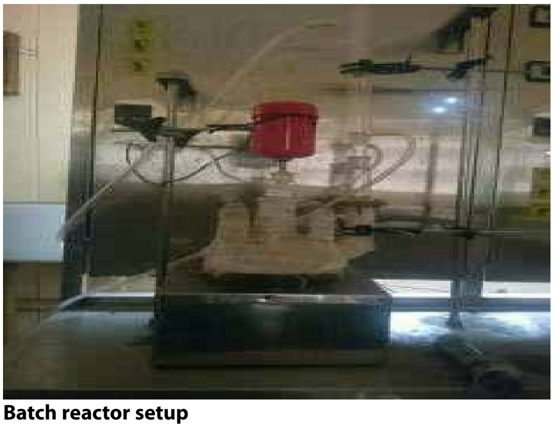
Oil: The double refined Rice bran oil is procured from local retail shop.

The primary ingredient is oil or fat. This may be waste vegetable oil which may be collected from homes or restaurants or virgin oil for better efficiency in the production of biodiesel. For the present work we used "Rice bran oil".

Alcohol: The second ingredient is alcohol.Methanol is mostly used in application of recycled vegetable oil. When processing new oil, it is often possible to use ethanol, but it is difficult to handle so we use methanol.It is known that methanol is very dangerous material, as is ethanol. Avoid inhaling and skin, eye contact, always wear gloves suitable for this substance, always wear eye-protection and face-mask, work in a well-ventilated room.

Catalyst: The last ingredient is the catalyst. Either KOH or NaOH may be used. The advantage of KOH is that the residual glycerin is much less toxic than when NaOH is used. KOH dissolves much more readily than in methanol as well. However, an advantage of NaOH is that it is very simple and cheaply available and easy to handle. It is found to use KOH with a purity of95% .NaOH of that purity is hard to find, but 92% to 85% of NaOH purity is available. It will also give better product.

EXPERIMENTAL SETUP



Batch reactor setup

EXPERIMENTAL PROCEDURE
Vegetable oil of 250 ml is measured in the measuring jar and is added into the batch reactor. Desired temperature is set in digital indicator Meanwhile, alcohol 50 ml is taken into a 100 ml round bottomed flask and desired weight of catalyst is taken and added into the flask and the flask is continuously shaked until the crystals of catalyst disappear.Then the methoxide solution is added into the reactor and the stirrer is switched on. Then the heater is switched on and the stop watch started. Oil is heated to desired temperature and maintained at that temperature using a temperature controller.The reaction is continued up to the desired time. The reactor is switched off and the stop the watch after the completion of desired time. The product is collected into a separating funnel from the bottom of the reactor and allowed to settle for a period of 12-24 hours. After settling down we can see two layers of liquids in separating funnel where the bottom product is glycerine because of its density which is thick brown in color and the top product is biodiesel which is pale yellow in color are separated into two different flasks and biodiesel (FAME) weight is noted down,and the biodiesel samples added to the bottles and labelled.

For instance Experiment at 30 Min,55^{0}C.
Vegetable oil of 250 ml is measured in the measuring jar and is added into the batch reactor.Desired temperature 55^{0}C is set in digital indicator.Meanwhile, alcohol 50 ml is taken into a 100 ml round bottomed flask and desired weight of catalyst (1.25grams) is taken (digital weighing balance) and added into the flask and the flask is continuously shaked until the crystals of catalyst disappear.Then the methoxide solution is added into the reactor and the stirrer is switched on.Then the heater is switched on and the stop watch started. Oil is heated to desired temperature 55^{0}C and maintained at that temperature using a temperature controller. The reaction is continued up to the desired time (30min).The reactor is switched off and the stop watch stopped after the completion of desired time (30 min).The product is collected into a separating funnel from the bottom of the reactor and allowed to settle for a period of 12-24 hours.

After settling down we can see two layers of liquids in separating funnel where the bottom product is glycerine because of its density which is thick brown in color and the top product is biodiesel which is pale yellow in color are separated into two different flasks and biodiesel(FAME) weight is noted down,and the biodiesel samples added to the bottles and labelled. The above experimental procedure is repeated and experiments are conducted at different Reaction times (60,90,120,180,210,240 minutes) with a step size of 30 minutes and at different temperatures(65,75^{0}C) at the catalyst weight of 1.25gr (NaOH/KOH) to determine optimum temperature.

METHODS:
Bio-diesel production can be done through four ways. They are
1. Direct use and blending
2. Thermal heating and pyrolysis
3. Micro emulsions
4. Transesterification

TRANSESTERFICATION
In the transesterification of different types of oils, triglycerides react with an alcohol, generally methanol or ethanol, in the presence of a catalyst; generally used catalysts are NaOH or KOH, to produce long chain alkyl esters and glycerin.

Transesterification is the displacement of alcohol from an ester in a process similar to hydrolysis, except than alcohol is used instead of water. The process has been widely used to reduce the high viscosity of triglycerides; the transesterification process can be done in a number ways. They are

1. Base catalyzed method
2. Supercritical process
3. Ultra- and high-shear in-line and batch reactors
4. Ultrasonic reactor method
5. Lipase catalyzed method

The general reaction shown below is

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Vegetable oil + Methanol ⟶ Biodiesel + Glycerol

Base-catalysed transesterification method
The transesterification reaction is base catalyzed. Any strong base capable of deprotonating the alcohol will do (e.g. NaOH, KOH, Sodium methoxide, etc.). Commonly the base (KOH, NaOH) is dissolved in the alcohol to make a convenient method of dispersing the solid catalyst into the oil. The ROH needs to be very dry. Any water in the process promotes the saponification reaction, thereby producing salts of fatty acids (soaps) and consuming the base, and thus inhibits the transesterification reaction. Once the alcohol mixture is made, it is added to the triglyceride. The reaction that follows replaces the alkyl group on the triglyceride in a series of steps.

The overall process is n normally a sequence of three consecutive reversible reactions. In first step the triglycerides react with one mole of alcohol and are converted into diglyceride. In the second step the diglyceride again react with one mole of alcohol and are converted into monoglycerides. And in the last step the monoglycerides react with the third m ole of alcohol to produce glycerin and ester. So the stoichiometric relation between alcohol and oil is 3:1

In the alkali process sodium hydroxide (NaOH) or potassium hydroxide (KOH) is used as catalyst along with methanol or ethanol. Initially, during the process, alcoxy is formed by the reaction of the catalyst with alcohol and the alcoxy is then reacted with any vegetable oil to form bio-diesel and glycerol.

Glycerol being denser settles at the bottom and bio-diesel can be decanted. This process is the most efficient and least corrosive of all the process and the reaction rate is reasonably high even at low temperatures of 60^{0}c.there may be risk of free acid or water contamination and soap formation is likely to take place which makes the separation process difficult.

Supercritical process
An alternative, catalyst-free method for transesterification uses supercritical methanol at high temperatures and pressures in a continuous process. In the supercritical state, the oil and methanol are in a single phase, and reaction occurs spontaneously and rapidly. The process can tolerate water in the feedstock; free fatty acids are converted to methyl esters instead of soap, so a wide variety of feedstock can be used. Also the catalyst removal step is eliminated. High temperatures and pressures are required, but energy costs of production are similar or less than catalytic production routes.

Ultra- and high-shear in-line and batch reactors
Ultra- and High Shear in-line or batch reactors allow production of biodiesel continuously, semi- continuously, and in batch-mode. This drastically reduces production time and increases production volume.

The reaction takes place in the high-energetic shear zone of the Ultra- and High Shear mixer by reducing the droplet size of the immiscible liquids such as oil or fats and methanol. Therefore, the smaller the droplet size the larger the surface area the faster the catalyst can react.

Ultrasonic-reactor method
In the ultrasonic reactor method, the ultrasonic waves cause the reaction mixture to produce and collapse bubbles constantly. This cavitation provides simultaneously the mixing and heating required to carry out the transesterification process. Thus using an ultrasonic reactor for biodiesel production drastically reduces the reaction time, reaction temperatures, and energy input. Hence the process of transesterification can run inline rather than using the

time consuming batch processing. Industrial scale ultrasonic devices allow for the industrial scale processing of several thousand barrels per day.

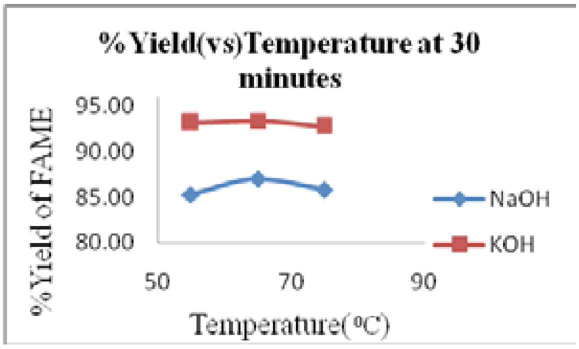
Lipase-catalyzed method
Large amounts of research have focused recently on the use of enzymes as a catalyst for the transesterification. Researchers have found that very good yields could be obtained from crude and used oils using lipases. The use of lipases makes the reaction less sensitive to high FFA content which is a problem with the standard biodiesel process. One problem with the lipase reaction is that methanol cannot be used because it inactivates the lipase catalyst after one batch. However, if methyl acetate is used instead of methanol, the lipase is not in-activated and can be used for several batches, making the lipase system much more cost effective.[13]

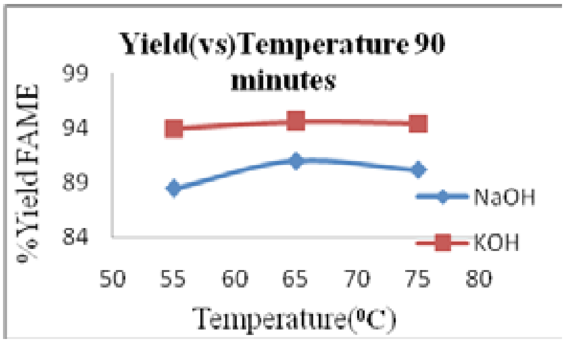
Advantages of base catalyzed over others:
The production of biodiesel and alkyl esters is well known. There are three basic routes to ester production from oils and fats:

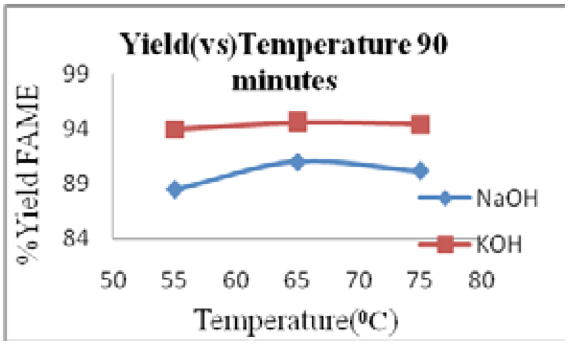
- Base catalyzed transesterification of oils with alcohol
- Direct acid catalyzed esterification of the oil with methanol
- Conversion of the oil to fatty acids, and then to alkyl esters with acid catalysis.
- The majority of alkyl esters produced today is done with the base catalyzed reaction because it is most economic for several reasons:
- Low temperature (150°F) and pressure (20Psi) processing.
- High conversion (98%) with minimal side reactions and reaction time.
- Direct conversion to methyl ester with no intermediate steps.
- Exotic materials of construction are not necessary.

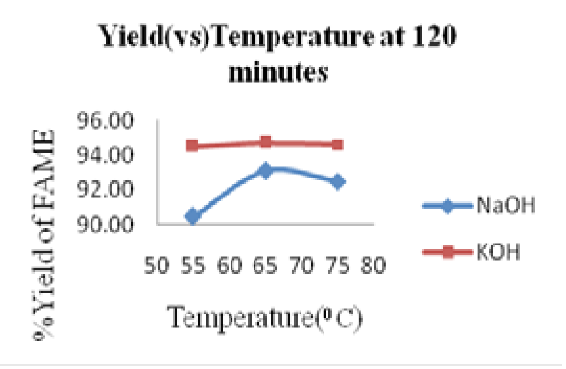
Carbonyl carbon of the triglycerides molecule, which results in the formation of a tetrahedral intermediate. The reaction of this intermediate with an alcohol produces the alkoxide ion in the second.

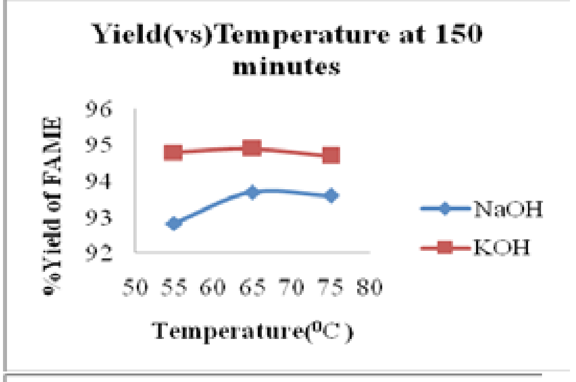
RESULTS AND DISCUSSION:
Experiments are conducted at eight reaction times (30,60,120, 150,180,210,240 min) and at three different temperatures 55°C, 65°C, 75°C with the two catalysts NaOH & KOH. Comparative investigation carried out on% Yield of FAME with temperature with NaOH& KOH as catalysts, results say that with increase in temperature, the Yield% of FAME (KOH) is higher than that of %Yield of FAME (NaOH) when time is constant. 'Comparison of % Yield of FAME (NaOH) with FAME(KOH) says that %Yield of FAME (KOH) greater than FAME(NaOH) at 55, 65,75° C and at different reaction times as shown in the graphs. Optimum Temperature is obtained at 65° C, with KOH as catalyst at which maximum %Yield is obtained, which is 95%.This could be explained in the view point of KOH strong base than NaOH and solubility of KOH in methanol more than NaOH in methanol. Graphs are drawn between %Yield of biodiesel FAME(NaOH),FAME(KOH) with temperature. By keeping time constant temperature varied and the results are plotted[11,12,13].

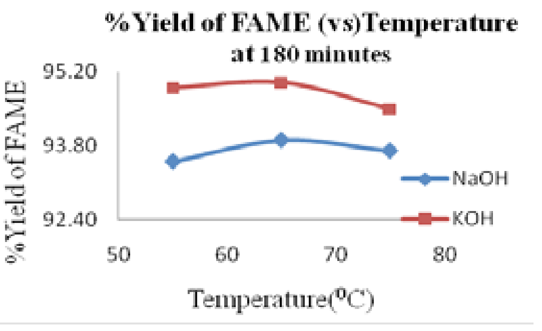


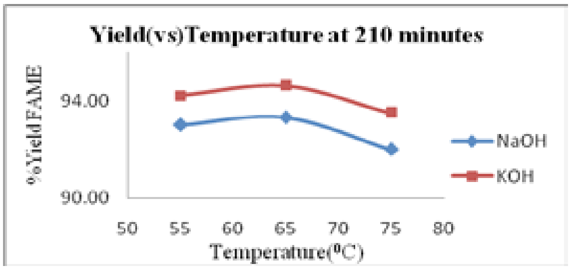


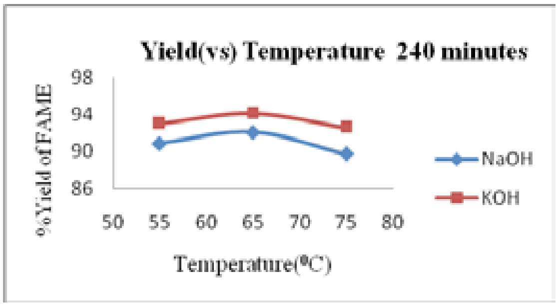












CONCLUSION

The study has shown the optimum reaction temperature is 65⁰Cfor a single stage transesterification of biodiesel from Rice bran oil using methanol and potassium hydroxide.% Yield, comparison of biodiesel and comparative studies using transesterification with other oils depends on several aspects including the type of catalyst(alkaline, acid or enzyme), alcohol/vegetable oil weight ratio, temperature, purity of the reactants (mainly water content) and free fatty acid content have an influence on the course of the transesterification.In the present work the following yield obtained at the following conditions. The results have shown 95%yield of biodiesel obtainable from Rice bran oil. Optimum reaction temperature is 65⁰C,at 180minutes and at the catalyst weight of 1.25 grams. This indicates that Rice bran oil is a good feedstock for biodiesel production. The effect of catalyst weight in the single stage and combination of these operating conditions will constitute further studies.

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