IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 3 Issue 2, February 2016.
www.ijiset.com
ISSN 2348 – 7968

Production Of Biodiesel From Palm Oil Through Tranesterification

C.Bharadwaj Kumar
Research Scholar, Dept. of Chemical Engineering
S.V.U.C.E. Sri Venkateswara University
Tirupati, Andhra Pradesh, India
Cbkumar007@gmail.com

Dr.G.Prabhakar
Professor, Dept. of Chemical Engineering
S.V.U.C.E. Sri Venkateswara University
Tirupati, Andhra Pradesh, India
Prabhakarg14@gmail.com

Abstract— Biodiesel, a supplemental compound to petro-diesel, is made from renewable biological sources such as vegetable oils and animal fats. It is biodegradable and non-toxic has low emission profiles and so is environmentally friendly. Use of blends of petro and bio diesel is a partial solution to minimize the ill effects of carbon oxide emissions. Fats and oils are primarily water-insoluble, hydrophobic substances sourced from plant and animal kingdom. They are made up of one mole of glycerol and three moles of fatty acids and are commonly referred to as triglycerides. Fatty acids vary in carbon chain length and in the number of unsaturated bonds. In the present study, transesterification of palm oil as a function of three different critical parameters is presented and discussed.

Keywords— Biodiesel, Renewable biological sources, alternative fuel, transesterification.

I. Introduction

Biodiesel is a cleaner burning fuel than diesel and a suitable supplement and possible replacement. It is made from non-toxic, biodegradable, renewable resources such as virgin and used cooking oils and animal fats. Fats and oils are chemically reacted with alcohols to produce chemical compounds known as fatty acid methyl esters (biodiesel). Glycerol, widely used in pharmaceuticals and cosmetics along with several other applications, is produced in the reaction as a by-product. The cost of the biodiesel is a critical issue, that needs to be resolved, for commercialization of the procedure and the product. Use of cooking oil as raw material, efficient conduct of transesterification process and separation of glycerol and biodiesel hold the key to lower the cost of biodiesel.

There are four primary ways to make use of oil as biodiesel, direct use and blending, micro emulsions, thermal cracking and transesterification. Transesterification process is carried out by treating vegetable oils like sunflower, groundnut and coconut etc. with methanol or ethanol using alkali catalyst (NaOH, KOH). If the production of biodiesel with KOH, the unsaturated fatty acids of the vegetable oil largely determines the extent of possible reaction. The higher the unsaturated fatty acid content, the higher will be the extent of transesterification reaction, the higher will be the glycerol formation but lower will be the biodiesel yield.

The main advantage of using biodiesel is it's renewably, better quality exhaust gas emissions it's biodegradability and given that there is no carbon present in it. It does not contribute to rise in level of carbon dioxide in the atmosphere and consequently to the greenhouse effect.

Fuel is a combustible substance containing carbon as a main constitute which on burning gives larger amounts of heat, which can be used economically for domestic and industrial purposes. Wood, charcoal, kerosene, petrol, diesel, producer gas, oil gas etc. are some of the fuels.

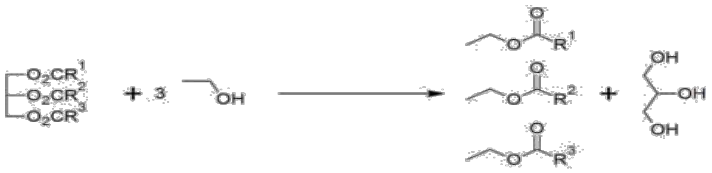
II. Material & Methods

A. Objective:

The objective of this work is to determine the optimum yield conditions for palm oil using methanol and NaOH as catalyst.

- Experiments were conducted with different oils using NaOH as catalyst to produce biodiesel with methanol in batch process with 250 ml of oil, 50 ml methanol and 1.25 grams NaOH..
- In order to get the optimum yield conditions for these oils experiments were conducted varying the parameters like temperature, time and weight of catalyst .

The general reaction shown below is



Vegetable oil + Methanol ⟶ Biodiesel + Glycerol

B. Experimental Procedure

Batch production of fatty acid methyl ester from vegetable oil for use as bio diesel fuel. The essential part of the process is the transesterification of TRIGLYCERIDE (TG) to FATTY ACID METHYL ESTER (FAME). The oils and fats belong to the family of lipids. Typically, fats come from animal source and oils from plant source. Fats and oils are formed primarily of triglyceride molecules. The TG molecule is basically a triester of glycerol (a triol) and three fatty acids (long alkali chain carboxylic acids). Mono and di glycerides can be obtained from TG by substituting one or two fatty acid molecules with hydroxyl groups.

Methodology:

- To test the sustainability of vegetable oil by titrating with NaOH
- Preparation of methoxide

ISSN 2348 – 7968

- To transesterify the triglycerides using base catalyst to get methyl ester (ME)
- Settling and separation of products (Biodiesel and Glycerin)

MAJOR INGREDIENTS

Oil:

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.

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 better to use NaOH with a purity of 96% or higher. KOH of that purity is hard to find, but 92% to 85% of KOH purity is available. It will also give better product.

EXPERIMENTAL DETAILS

Filtration of waste vegetable oil:

Filter the WVO to remove food particles or any unwanted particles. Warm it up a bit first to get it run freely, then heat it up to 45 degrees which is a moderate temperature. Also for better filtration use a double layer of cheese cloth in a funnel, or a canteen type coffee filter.

Removal of water content from WVO:

Heat the waste WVO first to remove any water content. Waste oil will probably contain water, which can slow down the reaction and cause saponification (soap formation). The less water content the better yield of biodiesel. During the removal of water we need to observe the bubbles forming in the oil being heated because bubbles formation gives the idea about water content.

Testing the sustainability of oil:

To determine the sustainability of oil i.e…., checking whether the oil is suitable for the production biodiesel. This is the most difficult step in the process, so we need to take necessary precautions in order to make this titration as accurate as possible.

1. Making of titre solution

Dissolve 1 gm of catalyst in 1 liter of distilled water, this solution is the titrant. NaOH is very difficult to dissolve. This can be best done by placing certain amount of water for instance say 50 ml distilled water in a transparent bottle, add one gram of NaOH to this water and shake continuously until the crystal disappear and mixing this solution with the remaining amount of water. Keep the titre solution in flask with tight cork to keep its concentration unchanged due to any atmospheric effects.

2. Titrate solution composition

- 10 ml methyl alcohol, (99% pure)
- Oil (heated to 45^0 C)
- Phenolphthalein solution (used as indicator)
- Catalyst (NaOH or KOH)
- Distilled water

3. Titration procedure

Take 10 ml of methyl alcohol in a glass flask or beaker. Heat the oil that is to be tested to a temperature of 45^0 C and mix 1 ml of it to the alcohol solution and mix it well until it turns into yellowish color. The amount of alcohol does not require much precision, but it is important that we should measure out exactly 1 ml of oil. An old trick is to suck in a bubble of air first into the hypodermic syringe and then the oil. This way you are able to read more precisely.

Add 2-3 drops of PH-indicator solution (phenolphthalein). Start carefully to add the titre to the solution and keep on shaking the flask. The solution color will turn to light pink, but will again turn to yellow again if you keep shaking. When the oil with alcohol remains pink for a period of 30 s, stop adding the solution. Make a note of the rundown value.

NOTE:

- If the titre value is below 3 ml then we can say that the oil is best suited for the preparation of bio-diesel.
- If the titre value is between 3-6 ml then the oil is suitable to turn it into bio-diesel.
- If the titre value is more than 6 ml implies poor quality, but the oil may still be suitable for the production of bio-diesel.

Methoxide preparation:

From standard literature for 250 ml of oil 50 ml of methanol and 1.25 gm of catalyst are to be mixed. So we take methanol and the catalyst into a flask, cork it and shake it until the crystals of the catalyst disappear. This mixture is known as methoxide.

Depending on the catalyst with which the methanol is mixed the methoxide is named,

- If NaOH is the catalyst then it is sodium methoxide.
- If KOH is the catalyst then it is potassium methoxide.

Transesterification process:

Filtered or virgin vegetable oil is taken into a batch reactor where it is heated to a temperature of 45^0 C. When this temperature is reached the methoxide mixture is poured into the reactor and the temperature is maintained at 45^0,55^0,65^0c and the solution is stirred continuously for in a

ISSN 2348 – 7968

well corked agitator reactor.

Settling and separation:

This well stirred batch is transferred into a settler vessel and it is allowed to settle for few hours (12 -24) and for large batches the settling time may vary up to one day. After settling we will observe two layers, top layer is biodiesel which is pale yellow in colour and the bottom layer is glycerine which is thick brown in colour.

These two layers are separated carefully with a separating funnel. Bio-diesel and Glycerine are transferred into two separate vessels with the help of a cork.

Soap residue:

This well stirred batch may have some soapy residues. These are the result of Na^+ ions from the sodium hydroxide (NaOH) reacting with the water that is remaining in the oil. This happens when the catalyst comes in contact with the water before it has the chance to react with the vegetable oil which in case the excess water should be boiled off from the oil before the start up of the reaction.

The part of the process where it's vital to keep all water out of the reaction is when making sodium methoxide. Keep the blender and all the utensils to which the catalyst comes in contact with. The chances of a good clean splitting of esters from glycerine with little soap by product are much better on a warm dry summer day than on a damp winter day.

Caution: Methanol, Methoxide (Methanol and catalyst mixture), and NaOH are dangerous chemicals. Before use always read the safety regulations provided and follow the instructions on the packaging. Always work n a well aired room and always wear a suitable face mask, gloves when working with these materials.

III. Results and Discussions

(1) As time increases from 30 to 210 minutes yield % increases to 82.11% and decreases from 240 minutes to 77.42%.

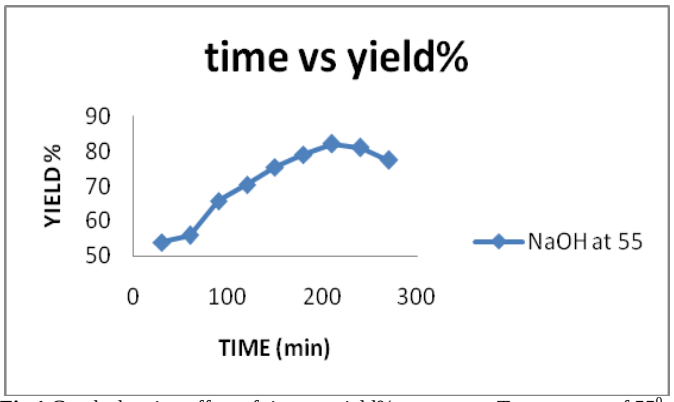


Fig.1. Graph showing effect of time on yield% at constant Temperature of 55^0c using sodium hydroxide catalyst

(2) As time increases from 30 to 210 minutes yield % increases to 84.32% and decreases from 240 minutes to 79.55%.

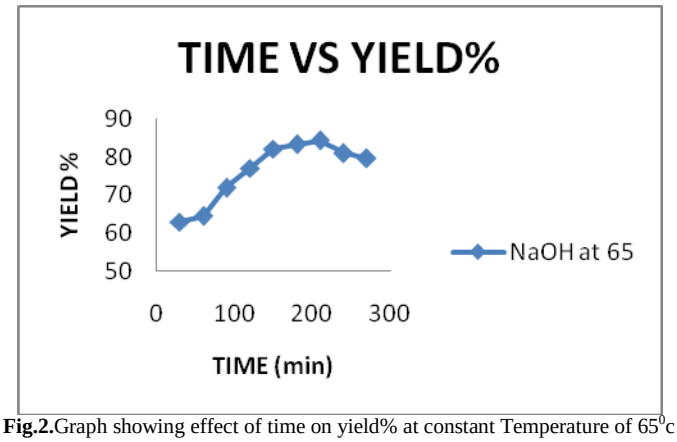


Fig.2. Graph showing effect of time on yield% at constant Temperature of 65^0c using sodium hydroxide catalyst

(3) As time increases from 30 to 210 minutes yield % increases to 84.06% and decreases from 240 minutes to 78.05%.

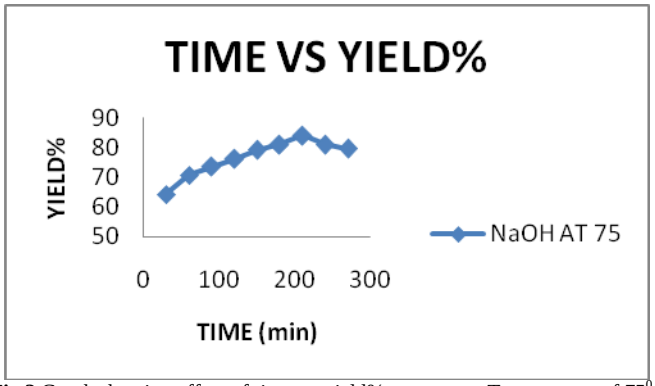


Fig.3. Graph showing effect of time on yield% at constant Temperature of 75^0c using Sodium Hydroxide catalyst.

(4) As time increases from 30 to 210 minutes yield % increases and decreases from 240 Transesterification mechanism includes the breaking of ester bond which favors at higher temperature. It is Evident that the yield of biodiesel is directly proportional to the temperature.From the graph we can say that the optimum yield of biodiesel is obtained at the reaction time of 3.5 hr and at a temperature of 65^0C, yield is 84.32%.

ISSN 2348 – 7968

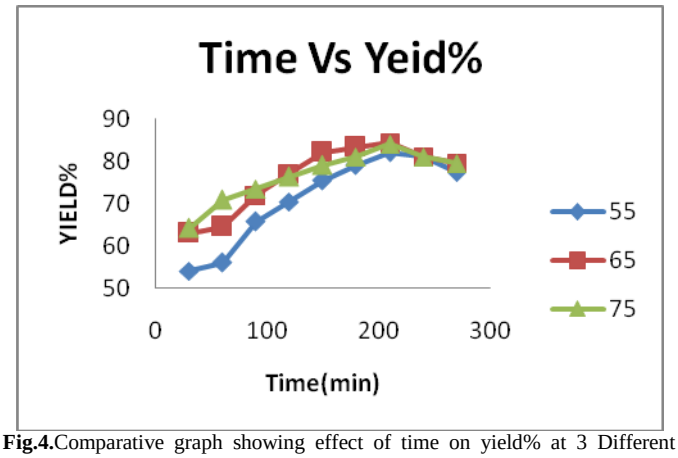


Fig.4. Comparative graph showing effect of time on yield% at 3 Different Temperatures of using sodium hydroxide catalyst

Summary

Biodiesel is an alternative to petro-diesel that can be used in any diesel engine with little or no modification .Biodiesel offer many advantages such as it is renewable ,nontoxic, biodegradable, reduce global warming gas emissions such as CO_2, sulphur dioxide are eliminated. It can be produced from many vegetable oils or animal fat feed stock. There are three basic routes to produce ester from oils and fats.

Base catalysed transesterification of oil with methanol Direct acid catalysed esterification of oil with methanol.

Conversion of oil to fatty oils, then to alkyl ester with acid catalysis.The majority of alkyl esters produced today is done with base catalysed reaction because it is most economic for several reasons.

Low temperature(45^oC) and high temperature of (95^0C) is used in the processing High conversion (94%) for castor oil with minimal side reactions and reaction time Direct conversion to methyl ester with no intermediate steps .Exotic materials of construction are not necessary.

The best yield conditions obtained in this work are as follows:

Optimum yield of 84.32% Palm oil which is obtained at a reaction time of 3.5 hr, temperature of 65^0C and using 1.25 gm of catalyst.

References

[1] O'Brien RD. Fats and oils processing. In: Fats and oils: formulating and processing for application. CRC Press, Boca Raton, Florida; 2004.

[2] Highina BK, Bugaje IM, Umar B. Biodiesel Production FromJatrophaCurcas Oil In abatch reactor using zinc oxide as catalyst. J. Appl. Phytotechnol. Environ. Sanitation.2012;1(2):61-66.

[3] Itodo IN, Oseni, MI, Wergba C. A comparative study of the properties and yield ofbiodiesel from Soy and groundnut oils. Nig. J. Solar Energy. 2010;21:124-127.

[4] Meher LC, Sagar DV, Naik SN. Technical aspect of biodiesel production by transesterification- A Review. Renewable Sustainable Energy Rev. 2006;10(3):248-268.

[5] Schwab AW, Baghy MO, Freedman B. Preparation and properties of Diesel fuel from vegetable oils. Fuel. 1987;66:1372–1378.

[6] Tesser R, Di Serio M, Guida M, Nastasi M, Santacesaria E. Kinetics of Oleic acid esterification with methanol inthe presence of triglycerides. Ind. Eng. Chem. Res.2005;44:7978-7982.

[7] Schuchardt U, Sercheli R, Vargas RM. Transesterification of vegetable oils: A review.J. Braz. Chem. Soc. 1998;9(1):199-210.

[8] Knothe G, Van Gerpen JH, Krahl J (Eds). The biodiesel handbook.Amer. Oil Chem.Soc. Press. Champaign, IL, USA; 2005.

[9] A. U. Ofoefule[1*], C. N. Ibeto[1], L. C. Ugwu[2] and D. C. Eze[3] Determination of Optimum Reaction Temperature and Reaction Time for Biodiesel Yield from Coconut (*Cocosnucifera*) OilInternational Research Journal of Pure and Applied Chemistry, ISSN: 2231-3443,Vol.: 4, Issue.: 1 (January-February).