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Making A Small Batch of Biodiesel From waste cook Oil

Aya Khaled, Esraa Ahmed, Salma Hossam, Salma Tarek and Zamzam Raafat

Supervisor: Mohamed Mostafa Mahmoud-Assistant Professor, Inorganic Chemistry

Ain Shams University, Faculty of Education, Bachelor of Science and Education Preparatory and Secondary Program, Chemistry (English)

Abstract

As crude oil prices rise in everyday life, the need to develop economically attractive alternative fuels increases. Biodiesel produced from used cooking oil is an example of replacement material. This paper involves clear idea and view about production of biodiesel from used cooking oil, which was obtained from various domestic sources . Methyle alcohol, with potassium hydroxide as a catalyst, reacts with used oil in a transesterification reaction to produce fatty acid methyl ester (FAME) with glycerol as a byproduct. The characteristics of our sample including density, viscosity, and heat of combustion are tested and contrasted to those of petrodiesel, making the product an integral biofuel. The paper will also involve blending or mixing biodiesel with petrodiesel and comparing their characteristics . The target of this paper is to utilize used cooking oil to transform it into biodiesel, as well as utilize glycerol for other purposes, such as soap making.

Key Words: **Biodiesel, used cooking oil, (UCO), Transesterification, Potassium Hydroxid**

1. Introduction

Today we face some problems such as energy deficiency, pollution problems and increasing fuel prices. Used fuels are known to pollute the air with emissions of sulphur dioxide, carbon dioxide and other gases. (Anonymous, Biofuels for transportation.2006) This has led to increased work into an alternative renewable energy source. Recently, biodiesel has become one the most suitable fuel for use in diesel engines consisting of dried monoalkyl fatty acid esters from vegetable oils and microalgae oil. Biodiesel is non-toxic and biodegradable. It is also a green fuel and does not contribute to the carbon dioxide emission because this fuel is made from agricultural materials. (M. Thirumarimurugan M.,et. Al., 2012) (Banerjee.N., et. Al., 2014) (Kantara W.A., et .al .,2013) For use in diesel engines consisting of dried monoalkyl fatty acid esters of vegetable oils, microalgae oil, and animal fats.(Wail M.,et. al .,2012) (Farooq M.,et .al., 2015) (Colin J., et. al .,2015) (Hasan Ali Md., et. Al., 2015) (Taghizade J.2016) (Barnwal B.K., et. al .,2005). Biodiesel has a high flash point and is so it is classified as non-hazardous and can be used alone or mixed with Petro diesel in any ratios. (Demirbas M.F., et. Al., 2006) India produces 30% of the total petroleum fuel required for its usage and the other 70% is imported. (Jaichandar S.,et. al.,2011) (Alnuami, W.,et. Al., 2014) Clearly, mixing 5% biodiesel with existing diesel fuel could save millions of dollars. (Nantha K.,et. Al., 2014)

2. Theoretical Framework

Methods of production

1. Direct use of blending

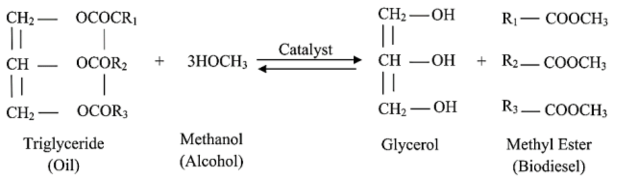
This process does not need any chemical reactions, where vegetable oils are mixed or blended with Petro diesel to decrease the Viscosity of it. Direct use of vegetable oils in Petro diesel engines is not suitable and needs some chemical modifications before its usage. (Fukuda H., et. Al., 2001) It has been found that the energy consumption of these oils is equal to diesel fuel. The oil to diesel ratio of 1:10 – 2:10 was suitable. Finally, it was found that direct oils or oil blends were not suitable to use as diesel fuel. (Ma F.,et. Al., 1999)

2. Thermal Cracking (Pyrolysis)

It is a thermal disintegration of organic compounds in the absence of oxygen and presence of a catalyst. Pyrolysis is an alternative name to thermal cracking. The disadvantages of this method are that the thermal cracking or pyrolysis equipment is expensive, where pyrolysis requireds equipment to distillation and separation of the different fractions. In pyrolysis process, a transformation of organic compound into another organic compound by using of heat and a catalyst. In the case of conversion of animal fats and vegetable oils, triglycerides play a significant role, and thus thermal cracking reactions are a good technology for production of biodiesel, but the disadvantages must be taken into account.(Maher KD.,et. Al., 2007).

3. Transesterification

The process of a triglyceride (fat/oil) reacting with an alcohol in the presence of KOH or NaOH as a catalyst to produce esters and glycerol is known as the transesterification reaction. (Sree R., et. Al., 2009) (Meher LC., e.t al., 2006) (Cerveró PJM., et. Al., 2008) The characteristics of the biodiesel can then be influenced by the type of fatty acids. (Kouzu M.,et. al.,2011) (Dalai AKMG., et .al., 2006)(Haas MJ., et .al., 2005) When alcohol and fatty acids combine, monoalkyl esters—biodiesel and crude glycerine—are produced. KOH or NaOH is utilized as a catalyst and either methyl or ethyl alcohol—which yields methyl esters or ethyl esters—is the alcohol used in the majority of production procedures. For the production of biodiesel ethyl ester, KOH has been proven to be optimal; for the methyl ester, any strong base can be utilized. (Min Allah F Um.,et. al .,2018)A common product of the esterification process is Rape Methyl Ester (RME) produced from crude rapeseed oil reacted with methanol. The reaction is below the chemical process for methyl ester biodiesel.(ping Y., et .al .,2018)(Bobadilla M.C.,et .al .,2017)There are three main methods used to produce biodiesel from oils and fats: (1) Alkali-catalysed transesterification of the oil, (2) acid-catalysed transesterification of the oil, (3) transformation of the oil to its fatty acid and then to biodiesel. Almost all biodiesel is produced using alkali catalysed transesterification process because it is the most saving process that demands only low temperatures, pressures and produces a 98% transformation yield. For this reason, only this process will be characterized in this project. (Abdul Raqeeb M., et. al.,2015) (Pathak M., et. Al., 2015) The chemical reaction is shown below:



Because alcohol and fat or oil react reversibly, alcohol must be added in large amounts to move the reaction to the right, or towards the forward reaction, and guarantee full conversion to the ester. (Mukherjee S.,2014) (Gashaw A., et. al.,2014) If the ester and glycerol layers separate after the reaction time, the esterification reaction is deemed successful. (Abdullah N.H., et. al.,2013) Glycerol, the heavier product, precipitates and can be purified for use in other sectors, such as medicine, cosmetics, soap, etc. (Sharaf J., et. al.,2013)

4. Feedstock of Waste cooking oil.

Used cooking oil is collected from fried foods that require large amounts of oil because they require the food to be fully immersed at temperatures in excess of 180°C. Accordingly, high temperatures cause changes in its chemical and physical composition, as well as in its sensory properties, which affect the quality of food and oil.(Prafulla D. P., et. al.,2012) Reusing household oil has a significant risk to the health of consumers, as this depends on the type of food being fried. "This absorbs between 5% and 20% of the oil used, which can significantly increase the number of dangerous compounds absorbed by the food.” In the alkaline catalysis process, high purity and high yield of biodiesel are achieved in short periods of time ranging from 30 to 60 minutes. (Guzatto R., et.al.,2011) Used cooking oil is usually black in colour, has a strong odor, and does not contain a significant amount of solids due to filtration. (Carlos A., et.al.,2011)

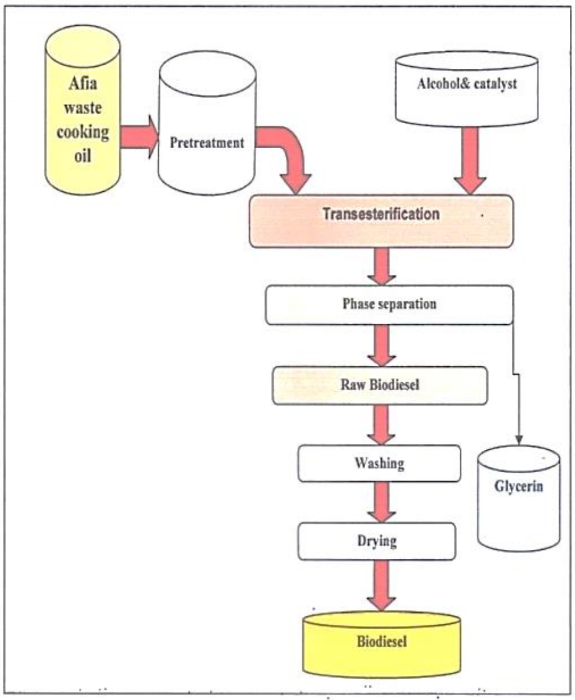


Fig. 1. A flow diagram for the production of biodiesel.

(Gerpen V.,et.al.,2004)

3-Methods of Research and the tools used

1. Equipment’s, apparatus, and chemicals

1- Hot plate
2-Separating funnel,
3-Thermometer,
4- Stand for separating funnel
5- Analytical balance
6-Conical flask and filter papers
7. Oswalled Viscometr
8. Pyknometer
9. Calorimeter
10. Burette
11. Pipette
12. Conical flask
13-graduated cylinder
14-funnel
15-Waste cooking oil (WCO)
16-KOH
17-Distilled water
18-Phenolpthalein Indicator
19-Isopropyl alcohol
20-Methyle alcohol

Experimental:
Steps are used to convert used cooking oil(UCO) to biodiesel
1- Filtration
2- Titration
3-Calculation the amount of additional basic catalyst
4- Manufacture of potassium methoxide
5-Manufacture of raw biodiesel
6-Separation of the mixture
7-Biodiesel washing

1-Filtration

1-Used cook oil which collected from domestic sources is filtered using a filter paper as shown in below fig2.

Fig.2: Filtration of Used cooking oil

2-Titration

UCO is typically more acidic than clean oil. When meals containing water are cooked in heated oil, some of the water interacts with triglyceride molecules, forming free fatty acids (FFAs) (Figure 1). FFAs are molecules of fatty acids that are not linked to glycerol. These acids react with the principal catalyst to generate soap (Figure 2), resulting in less catalyst available to convert triglycerides into biodiesel. The outcome is a less complete transesterification reaction.

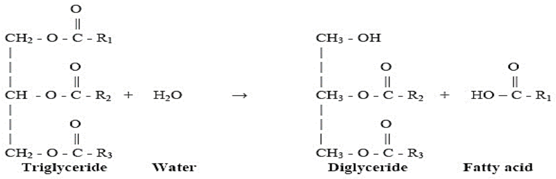


Fig. 3: Hydrolysis of triglycerides to form free fatty acid.

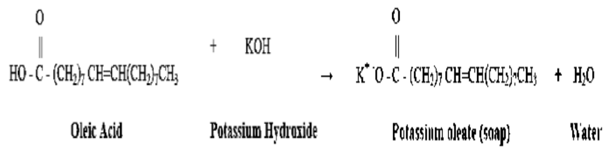


Fig.4: Soap formation from oleic acid (FFA)

However, FFAs can be neutralized by adding an extra base catalyst, preventing them from interfering with the transesterification reaction. In this situation, FFAs are purposefully transformed to soap. To calculate the amount of extra catalyst required, the acid content of the WCO must be established. This can be accomplished by calibrating. Titration determines the concentration of acid in a known volume of WCO by neutralizing it with a reference (or titrant) solution of known basic content in the presence of a pH indicator. Conveniently, the number of milliliters of reference solution necessary to neutralize the analyte corresponds precisely to the additional grams of base required per liter to neutralize FFAs in UCO. This process is as follows:

3. Calculating the amount of excess base catalyst

Biodiesel Ingredients and proportions
Using Used Cooking Oil
mL methanol = 0.2 x L of oil /1000
=0.2 x (200/1000)/1000 = 40 ml
g KOH = (7 g KOH + T) x L of Oil
= (7+3) x 0.2 = 2 g
Where T: Average burette readings

4. Manufacture of potassium methoxide. (Hossain A.B.M.S.,et.al.,2010)

1-Measure 40 mL of methanol in the fume hood. Pour the methanol into a flask.
2) Using a scale, weigh 2 grams of KOH lye.
3) Pour the KOH into the beaker over the methanol and shake until thoroughly dissolved. The reaction between the base and methanol is exothermic (it produces heat and pressure).

5. Manufacture of raw biodiesel. (Dias J.M., et.al.,2008), (Arjun B.,et.al.,2008)
1) Use a graduated cylinder to measure out 200ml of old oil.
2)Add the used oil to the beaker holding potassium methoxide.
3)Shake the mixture thoroughly for at least 10 minutes.

6. Separateion of the mixture. (Marchetti J.M., et.al.,2008)
After 24 hours, the mixture should start to separate. The glycerine that has separated from the triglycerides is denser than biodiesel and will settle at the bottom of the container.
- You should start to see separation of the mixture after 24 hours.
- glycerol separates from the reaction will be heavier than biodiesel and will settle at the bottom of the separating funnel while biodiesel which is lighter float at the top of separating funnel. Fig.5

Fig.5: Separation Process

7. Biodiesel washing
Gently pour distilled water over the surface of the biodiesel in the separatory funnel. You will notice water moves down along the separating funnel. Because of the polarity of the water molecules, they will withdraw the remaining catalyst, glycerine, soap, and methanol out of raw biodiesel,

leaving a cleaner biodiesel Fig.6. If the water entry force is too great, it may lead to the decomposition of free fatty acids, which will react with the base to form soap.

Fig.6: Biodiesel Washing

Test of transesterification

Burning Test

We submerge cotton in bath of UCO and biodiesel product then burn them and turn stopwatch Fig.7

Fig.7.UCO stopped burning at 30 minutes and biodiesel stopped burning at 9 minutes.

2-Quality Test

We put a little bit of biodiesel on a plan and put a little bit of water in corner on plan.

Biodiesel is not bubbling at all the water bubbling but biodiesel smoking.

Fig.8: Quality Test for Biodiesel

Biodiesel smokes and doesn't bubbling that mean it's low water content.Fig.8

4. Results of Research

Biodiesel yield (%)=100×(174/180).

$$\text{Biodiesel yield } (\%) = \frac{\text{weight of biodiesel}}{\text{weight of oil}} * 100 \quad = 96.67\%$$

Table.1. Physical properties

Fuel	Density g/mL	Viscosity mm^2/s at 40 C°	Heat of combustion Kj/g
UCO	0.9	12.67	-
Biodiesel	0.87	5	33
B_{50}	0.83	4	38
Diesel	0.80	3	40

Some important physical fuel characteristics were determined. The fuel characteristics of diesel, biodiesel CO and B_{50} (biodiesel: diesel with volume ratio 1:1) are shown in the table (1). We found that the densities of UCO and biodiesel were higher than diesel and B50.Tests showed that UCO and biodiesel have a higher viscosity than diesel and B_{50} fuel. High viscosity can damage the fuel pump, but the viscosity of B50 and diesel was within standards and could be used directly without any modification. The calorific value of B50 and biodiesel was slightly lower than that of diesel fuel.(Yıldızhan S.,et.al.,2017)

5. Interpretation of Results

The high viscosity of biodiesel is caused by greater interparticle forces, namely dipole interactions, due to the molecule's polarity. This puts the biodiesel chains closer together, increasing the liquid's thickness or viscosity. Furthermore, because biodiesel molecules are often longer than Petro diesel molecules, there are higher dispersion forces between the biodiesel hydrocarbon chains, causing them to come together. Longer chains also cause more crosslinking, which enhances viscosity. The lubricating characteristics of a material improve as its viscosity increases. This is because biodiesel molecules have a stronger intermolecular attraction than petrochemical molecules. Longer carbon chains provide stronger dispersion forces. Dipole-dipole attraction is caused by the presence of a polar ester functional group. This puts the biodiesel chains closer together, meaning there is a greater mass of molecules in a given volume. (The School For Excellence 2019)

6. Conclusion

It is concluded that biodiesel can be produced from any waste cooking oil samples using methanol and potassium hydroxide as a catalyst. Methanol to waste cooking oil ratio 1:5 is the optimum ratio.
Blended biodiesel B50 is the nearest fuel to diesel in viscosity and calorific value.

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