Available online at http://ijcpe.uobaghdad.edu.iq and www.iasj.net
Iraqi Journal of Chemical and Petroleum Engineering
Vol.20 No.4 (December 2019) 21 – 25
EISSN: 2618-0707, PISSN: 1997-4884

Biodiesel production from used vegetable oil (sunflower cooking oil) using eggshell as bio catalyst

Marwan Hussien and Hayder Abdul hameed

College of Engineering-University of Baghdad

Abstract

Bio-diesel is an attractive fuel fordiesel engines. The feedstock for bio-diesel production is usually vegetable oil, waste cooking oil, or animal fats. This work provides an overview concerning bio-diesel production. Also, this work focuses on the commercial production of biodiesel. The objective is to study the influence of these parameters on the yield of produced. The biodiesel production affecting by many parameters such s alcohol ratio (5%, 10%,15 %, 20%,25%,30%35% vol.), catalyst loading (5,10,15,20,25) g,temperature (45,50,55,60,65,70,75)°C,reaction time (0-6) h, mixing rate (400-1000) rpm. the maximum bio-diesel production yield (95%) was obtained using 20% methanol ratio and 15g biocatalyst at 60°C.

Keywords: Biodiesel, Waste cooking oil, Transesterification, Methyl esters; Renewable energy, Diesel, waste vegetable oil

Received on 12/03/2019, Accepted on 21/05/2019, published on 30/12/2019

https://doi.org/10.31699/IJCPE.2019.4.4

1- Introduction

Bio-diesel has become an integral part of the discussion of renewable energy sources. It was produced or refined from used vegetable oil, though each with different degrees of difficulty and involvement [1]. Bio-diesel can be used in diesel-fueled vehicles without any changesinto engines.

Moreover, bio-diesel can be mixed with petroleum's diesel to create different grade off fuel that arelabeled based on percentage of bio-diesel in the blends; for example, B10 is 10% bio-diesel, 90% petroleum- diesel. This means that in times of bio-diesel inadequacy, vehicless can use amix of fuel and still function the same way[2].

Bio-diesel has advantage in terms of its flexibility and applicability. It holds great potential as an alternatives fuel. Bio-diesel is created from aniemal or vegetables oil that is modiafied through a proacess called trans-esterification, during which triglycerides in the oil are coniverted to meethyl and fethyl esters and g-glycerin [3]. Bio-diesel effected on CO_2 emissions and reduced it. Biodiesel is studied because we need to reduce consumption of nonrenewable fossil fuels [4][1]. Biodiesel can be defined as fatty acid methyl esters (FAME) derived from the transesterificationof triglycerides (vegetable oils or animal fats) with alcohol and suitable catalyst. Biodieselcan be produced from different triglyceride sources such as vegetable oils (that can be edible, non-edible or wasteoils) and animal fats (mostly edible fats or waste fats) [11].

The idea of using alternative fuels has been widely spreading for many years now as a replacement for Fossil fuels. The importanceof this idea came from the large scale of utilization of Fossil fuels in mechanical power generation various sectors, like agriculture,commercial, domestic and transport, also the fact of the continuousrise in Fuels cost and their eventual vanish [12].

The advantage of Biodiesel is a renewable resource, biodegradable, nontoxic fuel,a high cetane number, good lubricity, less gas emissions, Sulphur free, carbon neutral and carbon dioxide (CO_2) is very small amount emission in the atmosphere. On the other hand, wastecooking oils are potential alternatives for diesel engines due to their nature [6][3].

The work of this research worked with many experiments to producing biodiesel from sunflower oil [5].Methanol is used as alcohols and eggshell is selected as catalyst.

2- Materials and Methods

2.1. Feedstock

Waste vegetable oil (WVO) way collected from the staff restaurant, in Al-Hilla. It was pre-treatment process by using two steps (filtration) and (dehydration) then it was filtered using filter paper (20µm) in order to remove impurity. After that it was dehydrated using a low pressure, in order to remove trace of water content present in oil. The characteristics of Waste vegetable oil were conducted by using TLC &GC (Baghdad University).

Corresponding Authors: Name: Marwan Hussien, Email: marwanhussien294@gmail.com , Name: Hayder Abdul hameed, Email: hayderabdul-hameed@yahoo.com

2.2. Transesterification Process

Experiments were conducted by using a reflux fitted system (Fig. **1** a, b) the mixture of wastevegetable oil, methanol and catalyst were added to a 2000ml necked flask and submerged in a water bath at seven different temperatures (45, 50, 55 ,60 ,65 ,70 75)°C. The catalyst loading for this project were taken as (5, 10,15, 20, 25) g with constant volume of oil of 1000 ml. and methanol ratioswere taken as (5,10,15,20,25,30,35) %.The rate speed of agitation is 700 rpm remained constant.

(a)

(b)

Fig. 1. a Reflux fitted system, b Reflux fitted system

2.3. Experimental procedure

Methyl ester was synthesized in a 2000ml boiling flask, four boiling flasks each flask having a different molar ratio and catalyst concentration while maintaining a constant temperature and agitation speed. The first experiment was kept at 60°C flasks with 15 g catalyst loading, and 20 % methanol and 1000 ml of waste vegetable oil, adding 1000 ml of waste vegetable oil in flask.

The reaction time was 6h. After collection of the mixture, the sample was left to cool down for 10-15min, after which the two-phase (glycerin and bio diesel) system was carefully separated. The bottom layer of the system consisted of glycerin, while the top layer was made up of a mixture of methyl esters, unreactive methanol and intermediates see Fig. **2**.

Fig. 2. Two phase glycerin and biodiesel produced

2.4 Product Estimation

The yield and conversion were calculated as follows:

$$Yield(\%) = \frac{Volume_{Biodiesel}}{Volume_{Oil}} \quad (1)$$

3- Results and Discussion

3.1. Biocatalyst loading effecting on yield

Fig. **3** shows the effect of Bio-catalyst loading on biodiesel yield, the figure shows low yield (70%) was obtained with high catalyst loading (25g of biocatalyst), which was insufficient catalyst to completion in the formation of methyl ester. Higher bio-diesel yield (96%) was observed at an optimum concentration of (15g) catalyst loading. While at (10&20) g catalyst the bio-diesel yield was lower. Reaction rates increased as reactants occupied more catalytic sites until saturation was reached.

3.2. Effect of Temperature

Fig. **4** shows the effect of temperature on bio diesel yield, the figure shows that the best bio-diesel yield was founded at 60°C with a yield 95% under optimal conditions (catalyst loading 15 g, 20% methanol). In this current research, when temperature of the reaction increased to 60°Cwas obtained optimum biodiesel yield.

Increasing the temperature beyond 60°C resulted in a decrease in the production because the reaction occurring beyond boiling point of methanol (64.7 °C) resulted in its continuous vaporization. Hence it remained in the gas phase in the reflux, causing a decreasein methanol in the reaction media [9].

3.3. Effect methanol molar ratio

Fig. **5** shows the effect of different methanol ratio on bio diesel yield, the figure shows that the best bio-diesel yield was observed at (20%) of methanol that is 95%.

The yield decreased significantly to70%, at a methanol ratio of 5%. This is due to the dilution effect of methanol and the interference between the high methanol ratio and the catalyst. There a subsequent increase in solubility and a decrease in the separation of glycerin and methyl ester [10].

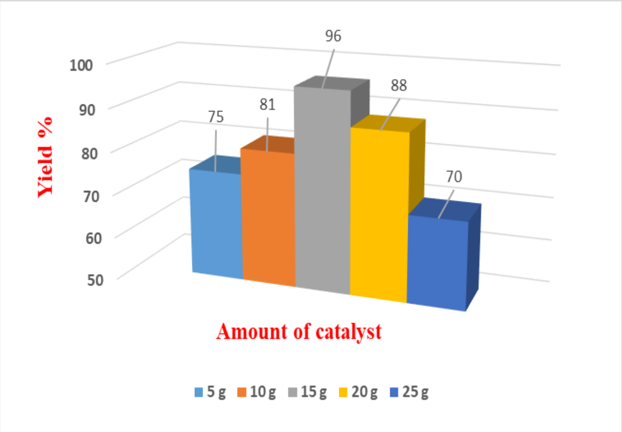

Fig. 3. Effect of catalyst loading (bio) on bio-diesel yield

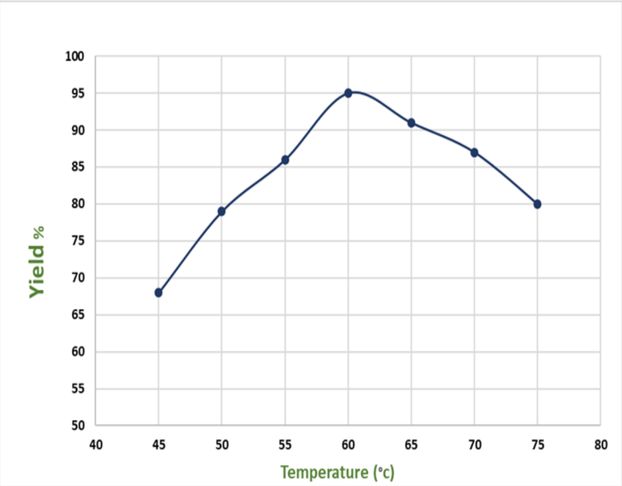

Fig. 4. Temperature effecting on bio-diesel yield

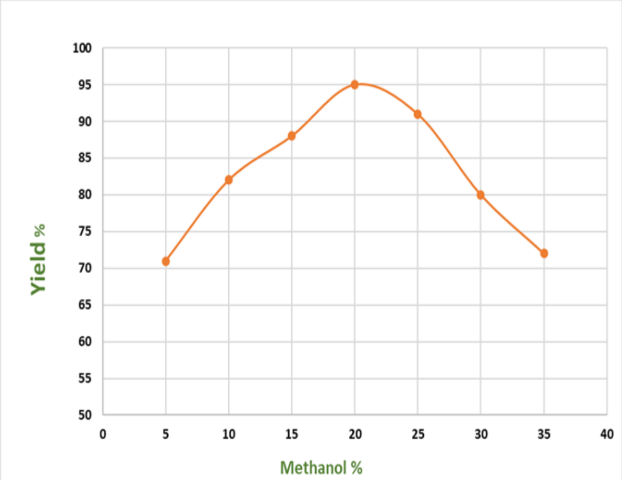

Fig. 5. Effect of methanol ratio on bio-diesel yield

3.4. Effected of Reaction time onbio-diesel yield.

Fig. **6** shows how the reaction time affected on bio-dieselyield when using biocatalyst (15 g), temperature 60°C and 20% methanol. The best yield 95%was obtained at 4 hours at catalyst (15 g) and methanol (20% vol.) as can be seen in figure 5. The bio-diesel yield was increased by increasing reaction from 1 to 4 hours. Reaction time for the transesterification increases with increases the conversion rate of bio-diesel had observed with the increasing of time up to 4 h, after 4h there was decreasing in the bio-diesel yield. Therefore, optimum reaction time was 4h.

3.5. Effect of Mixing on Bio-Diesel Yield

Fig.6 shows the effect of differentmixing on yield(400-1000) rpm , it can be see figure 6. The bio-diesel yield produced increased from 65% to 95% whenrate of mixing increasing from 400 to700 rpm and then decrease below 700 rpm.

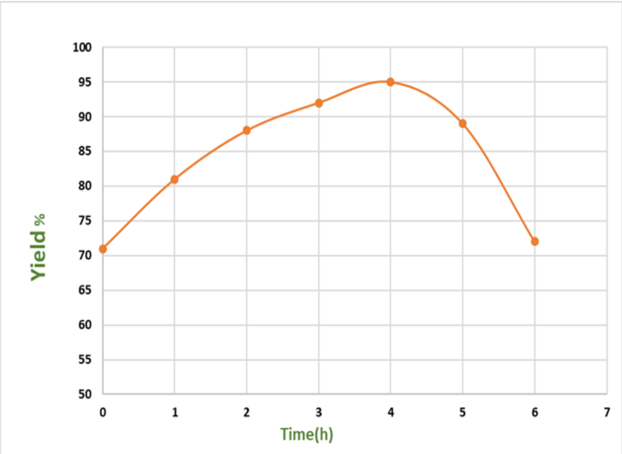

Fig. 6. Effect of reaction time on bio-diesel yield

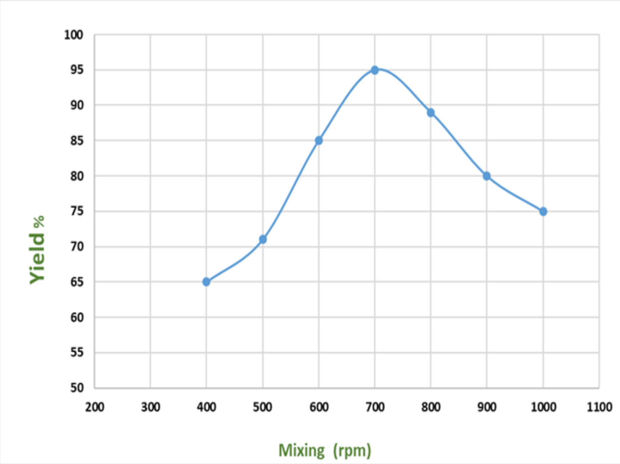

Fig. 7. Effected rate of mixing on bio-diesel yield

4- Conclusions

The aim of this project was to assess biodiesel production from cooking used oil in the presence bio catalyst (eggshell). Five factors were investigated oil/methanol ratio, catalyst, reaction time, mixing rate and temperature in order to optimize the process. The best reaction conditions obtained were methanol/oil r ratio (20% vol.), catalyst amount (15g of egg shell), time of reaction (4hr), rate of mixing (700 rpm) and temperature (60°C). It was assumed that the catalyst was used in sufficient amount with respect to oil in order to shift the reaction toward the formation of methyl ester.

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انتاج الوقود الحيوي باستخدام زيوت الطبخ النباتية المستعملة

مروان حسين و حيدر عبدالحميد

كلية الهندسة-جامعة بغداد

الخلاصة

الوقود الحيوي مهم لحل مشاكل الطاقة ونستطيع انتاجه من الزيت النباتي المستخدم باستخدام عوامل مساعده حيويه وفي هذا البحث تم استخدام قشور البيض كعامل مساعد وكذالك استخدم ثلاثة نسب من كحول الميثانول وهي (35,30,25,20,15,10,5)% واستخدم ايضا في هذا البحث عدة اوزان من العامل المساعد وهي (25,20,15,10,5) غم من قشور البيض.

ان انتاج الوقود الحيوي يتأثر بعدة عوامل مهمة وهي نسبة الكحول(35,30,25,20,15,10,5)%,كمية العامل المساعد (25,20,15,10,5) غم ,الحرارة (75,70,65,60,55,50,45) درجة سيليزية , وقت التفاعل (0-6) ساعة و معدل الخلط (400-1000)دورة/دقيقة . وفي هذا البحث تم الحصول على اعلى كمية من الوقود الحيوي وهي 95 % تحت ظروف 20% ميثانول و 15 غم من العامل المساعد الحيوي ودرجة حرارة 60 درجة سيليزية.

الكلمات الدالة: وقود حيوي, زيت طبخ مستخدم, الطاقة المتجددة