Evaluation of A Constructed Unit for Biodiesel Production From Expired Reused Vegetable Oils

Sehsah, E.M.[1], & Omara, A.I.[2]

[1]Dept. of Agric. Eng., Faculty of Agric., Kafr El-Sheikh University, 33516, Egypt.

[2]Dept. of Agric. Eng., Faculty of Agric., Alexandria University, Egypt.

Received: 1 June, 2017 *Revised: 6 July, 2017* *Accepted: 13 July, 2017*

ABSTRACT

Biodiesel (Fatty Acid Methyl Esters) has become one of the most promising alternative source of energy in the world. The aim of this study was to design and construct a laboratory production unit to produce 500 liters per day of biodiesel from waste vegetable oil (WVO) and to investigate the effect of two different catalysts on some properties of biodiesel production.

The biodiesel production unit was constructed at the Department of Agricultural-Engineering, Faculty of Agriculture, Kafr El-Sheikh University, Egypt. The biodiesel production unit consisted of the two centrifugal pumps, an electrical heater and a thermostat type RTM were fixed inside the main tank and isolated by aluminum tap. The unit was provided the three electrical valves to be used for controlling vegetable oil's flow-rate and biodiesel production. The vegetable oil waste was collected from several restaurants, the food technology department, kafr elsheikh University and from the food industry in Kafr elsheikh and Alexandria governorates. Two catalysts; (Methanol with sodium hydroxide and ethanol with sodium hydroxide) were added into the unit during the process of biodiesel production. The collected WVO was screened to remove all Food residuals first. The oil was then heated for 30 min to remove the water content. The manufactured biodiesel unit is to produce 500 liter/day of biodiesel from the WVO under local conditions. The measured energy requirements to produce 60 liters biodiesel from WVO were 1.31 kWh, 1.14 kWh and 0.97 kWh for WVO at feeding rate of 12.76 liter per min, 7.05 liter per min and 4.84 liter per min, respectively. Standard procedures were followed to determine the product properties. The flash point of biodiesel were 60°C, 64°C, 64°C, 68°C for B100 (ethanol catalyst), B100 (methanol catalyst), B20 (ethanol catalyst), B20 (methanol catalyst) respectively. The HHV for biodiesel were 41.98 MJ/kg, 41.74 MJ/kg, 42.06 MJ/kg and 41.83 MJ/kg for B100 (ethanol catalyst), B100 (methanol catalyst), B20 (ethanol catalyst), B20 (methanol catalyst) respectively.

Keywords: biodiesel, waste vegetable oil, biodiesel production unit

INTRODUCTION

Biodiesel is the name given to fuel for Diesel engines developed by chemical conversion of vegetable oils or animal fats. Vegetable oils can work well as Diesel fuel by itself. This was demonstrated by Rudolf Diesel in his engine at the 1900 world's fair, using peanut oil as fuel. However, vegetable oils are characteristically viscous and difficult to be burned efficiently at ambient temperatures in modern vehicles. Waste vegetable oil (WVO) can be acquired from grease recyclers or directly from grease containers at the restaurants. Sehsah *et. al.* (2015) reported that, ethanol production from biomass is one way to reduce both environmental pollution and the consumption of crude oil. Biodiesel no aromatics, has a higher cetane number, and contains 10-11% oxygen by weight Lin, *et al.* (2011). These properties can reduce the emissions of carbon monoxide (CO), hydrocarbons (HC), and particulate matter (PM) significantly in the exhaust gas as reported by Graboski, *et al.* (1998). According to Utlu and Kokac (2008), there was an average decrease of 14% of CO_2, 17.1% of CO and 22.5% of smoke density when using biodiesel. Puppan (2005) have deliberated the advantages of biofuels over fossil fuels to be: (1) availability of renewable sources, (2) representing CO_2 cycle in combustion, (3) environmentally friendly, and (4) biodegradable and sustainable.

Biodiesel, which now is considered as a possible alternative of fossil fuels is commonly composed of fatty acid methyl esters that can be prepared from the triglycerides in vegetable oils by transesterification with methanol Gerpen (2005). The resulting biodiesel is rather similar to conventional diesel fuel in its main characteristics Meher, *et al.* (2006).

Vegetable oils are possible feed stocks for biodiesel production since they are renewable in nature, and can be produced at a large scale. However, it may cause some economic problems such as the competition with the edible oil production, which may increase the cost of both edible oils and biodiesel Janaun and Ellis (2010). In order to overcome these disadvantages, researchers have been interested in other feed stocks such as waste cooking oils Pedro, *et al.* (2006) and grease and animal fats which are not appropriate for human consumption Leung *et al.* (2010). Currently, chemical methanolysis using alkali-catalyst is the most popular commercial method that gives high yield in short time of reaction. In some previous studies, a great percentage of biodiesel production cost was accounted for the feed stock value. On the other hand, cheap low-grade feed stock often contains large amount of free fatty acids (FFA).

The raw materials of biodiesel production are Vegetable oils, as well as animal fats, and short chain alcohols. Worldwide, the most used oils for biodiesel production are: palm (Asian and Central American countries), rapeseed (the European Union), soybean (United States of America and Argentina), and sunflower. Other oils are also used, such as linseed, peanut, safflower, animal fats, and used vegetable oils. Methanol is the most regularly used alcohol although ethanol can also be used. Since cost is the main concern in biodiesel production (mainly due to oil prices), the use of non-edible vegetable oils has been studied as a suitable solution for such a problem for several years with promising results. In addition, and due to its relative low cost, other non-edible oils such as cotton, jojoba, castor oil, and Jatropha have another undeniable advantage for biodiesel production which lies in the fact that no foodstuffs are consumed to produce fuel Romano *et al.* (2006).

Animal fats are also a promising option, especially if livestock are available as potential resources. However, it is necessary to carry out preliminary treatments since they are solid. Furthermore, highly acidic grease from cattle, poultry, pork, and fish can also be used. In biodiesel production alcohols with short chains, including ethanol, methanol, butanol, and amylic alcohol can be used, because of their low cost and reasonable properties, Methanol (CH_3OH) and ethanol (C_2H_5OH) are the most widely used alcohols. Despite of its high toxicity, methanol is often preferred over ethanol because its use in biodiesel production requires simpler technology; and excess alcohol may be recovered at a low cost and higher reaction speeds. Several countries such as Spain and Brazil are carrying out such research. The content of free fatty acids, water and non-saponificable substances are key parameters to achieve high conversion efficiency in the trans-esterification reaction. The use of basic catalysts in triglycerides with high content of free fatty acids is not advisable, since part of the latter reacts with the catalyst to form soaps, Turck (2002). Part of the catalyst is wasted, and is no longer available for trans-esterification. The efficiency of the reaction diminishes with the increase of the acidity of the oil; basic trans-esterification is viable if the content of FFAs is less than 2%. The alcohol used for biodiesel production must be mixed with a catalyst before adding the oil. Potassium (K) and sodium (Na) hydroxides are among the most widely used basic catalysts. For production at an industrial scale, K or Na methoxides or methylates must be commercially available. In the past decade, due to the stable growth of biodiesel production, glycerin production increased. Seeking more economical benefits from glycerin, several researchers pursued new applications, particularly in connection with surfactants and polymers Claude, (1999). For further development in new commercial applications uses of glycerin are in principle similar to those of other poliols (sorbitol, glycol, pentaerythritol, etc.). The objectives of this work include:

1- Construct a laboratory prototype unit for biodiesel production using local materials.
2- Evaluate the performance of the laboratory unit to produce biodiesel from waste vegetable oil using two different catalysts methanol and ethanol.
3- Estimate key properties that affect the performance of biodiesel such as Viscosity, Density, free fatty acid and High Heat Calorific Value.

MATERIALS AND METHODS

The biodiesel production unit

The laboratory unit consists of:

1- Two 60 liter tank; one is used to collect the WVO and the other to be used as the main processing tank for biodiesel production.
2- Two 30 liter plastic tanks, one is prepared

to collect the biodiesel production and the other is used to prepare the two catalyst from Methanol with sodium hydroxide and ethanol with sodium hydroxide.

3- Two centrifugal pumps (model Turbo QB60 with 0.37 kW).

4- Three electrical valves (model Invensys made in Italy 220 VAC) to be used to control the flow-rates of waste vegetable oil and biodiesel production.

5- An electrical heater and a thermostat (type RTM from Thermewot CO. Italy with 1300 W) fixed into the main tank and isolated by aluminum tap.

6- Three-line electric switches were used as control units in the manufactured biodiesel unit.

7- An aluminum frame used to fix all unit parts.

8- A four meter long plastic pipe with a 1.27 cm diameter used to transfer the biodiesel production out.

9- Three manual valves to be used to adjust the flow rates of WVO and Alcohol with Sodium Hydroxide. pH meter KEDID was used to measure the pH value during the process to obtain the proper situation of biodiesel. A PSGI wattmeter was used to measure the consumed power required for operating the biodiesel unit.

Procedures

The WVO was obtained from the food technology department in Kafr elsheikh University, local restaurants and food industry in Kafr elsheikh Government, Egypt. The analysis of costs to produce the biodiesel from WVO in this current research was not discussed under Egyptian marketing condition. All WVO collected from different sources is stored in a receiving tank. The WVO was screened to remove all food residuals and then was pre- heated for 30 min to remove the water content in the oil. The WVO is pumped from the receiving tank to the main processing tank.

The flow rate of the WVO from the receiving tank to feed the main tank is adjusted by a manual and electrical valve as illustrated in figure 1. Three different feeding rates at full, half and 1/4 valve set to give 12.76, 7.05 and 4.84 liter/ min.

The time used to feed the 60 liter of WVO into the main tank was 8 min. The second pump between the Alcohol and Hydroxide sodium tank was operated to add 1500 ml of the Alcohol and sodium Hydroxide into the 60 liter of WVO in the main tank. The mixture was for 5 min after closing the inlet valve in the main tank. The heater was operated for 30 min at 60°C temperature of the mixture (WVO and Alcohol with sodium hydroxide). The pH meter (model KEDID Ph/ORP-6658H) was used to measure the pH value and controlled in the range 8 to 9 values by adding 8 droplets of phenol. Fatty acid methyl ester was prepared by base-catalyzed transesterification of WVO with methanol in the presence of NaOH as a catalyst. Before transesterification, WVO was filtered and heated to 65 - 70ºC for 30 min. Methanol (5:1 molar ratio methanol/ WVO) was mixed with sodium hydroxide (0.01% w/w), until all of the NaOH was dissolved in methanol.

The fatty acid ethyl ester prepared similar to the step of fatty acid methyl ester preparation. The concentration of ethanol 10 % was mixed with NaOH to prepare the base-catalyzed transesterification of WVO.

Measurements of Operational Parameters:

Energy Consumption

The power requirement to operate the biodiesel unit parts were measured and recorded for the three flow rates. Knowing the operating time for each part in the unit, the total energy for the biodiesel production can be estimated. Energy requirement for producing 60 letter of biodiesel from WVO were calculated after measuring the power consumed for the pumps, electric valves and the heater during the operation time of biodiesel production. The total energy consumed for two pumps, two electric valves and the heater were calculated by using the following equation:

$$E_t = E_p + E_v + E_h$$

Where:

- E_t total energy consumed or energy requirement, kW.h
- E_p pump energy = power measurement of each pump * operating time, kW.h
- E_v electric valves energy = power measurement of each valve * operating time, kW.h
- E_h heater energy= power measurement of the heater * operating time, kW.h

The values of the above requirement energy to produce the 500 liter per day (8 operation hr.) of biodiesel are given in table (1) for the three different flow-rates. The glycerin was collected and weighted after every treatment of biodiesel production.

Microbial Contamination

Water contamination should be controlled since the microorganisms usually grow at the fuel water interface. The microbial contamination test of biodiesel was carried out in Laboratory of microbiology, faculty of agriculture.

Determination of Free Fatty Acid (FFA):

The AV and FFA were calculated using the following equations:

AV = 56.1 * A * N / Woil and

FFA= AV/2, %

Where: AV is acid value in oil sample, 56.1 is the molecular weight of the solution employed for titration (g/mol), A= volume of standard alkali used (KOH), ml, N = normality of standard alkali used (KOH), and Woil = weight of biodiesel used. A neutral solvent (a mixture of petroleum ether and ethanol) was prepared and 50 ml of it was taken and poured into the beakers containing the 2 gm from every biodiesel blend B100 and B20 samples. The mixture was stirred vigorously for 30 minutes. The 0.56 gm of potassium hydroxide (KOH) pellet was measured and placed in a separate beaker and 0.1 M KOH was prepared.

ASTM's petroleum standards are instrumental in the evaluation and assessment of the physical, mechanical, thermal, and chemical properties of crude oils, hydrocarbons, and other naturally occurring energy resources used for various industrial applications. The following standard tests numbers ASTMD 93 for flash point, ASTMD 445 for viscosity, ASTMD4868 for the High Heat Calorific Value (HHV) and ASTMD distillation for the glycerin were measured for 100% biodiesel (B100) and for a blend of 20% of biodiesel and 80% fossil diesel (B20%) these tests were evaluated at the laboratory of Faculty of Science, Alexandria University to evaluate the biodiesel fuel properties.

Kinematic Viscosity Determination (ASTM D 445)

The ASTM D 445 standard was used to measure the viscosity of both biodiesel B100 and B20. A viscometer is inserted into a water bath with a set temperature and left for 30 minutes. Samples from every biodiesel (B100 and B20) produced by ethanol and methanol catalyst were added to the viscometer and allowed to remain in the bath as long as it reaches the test thermometer. The procedure was repeated a number of times and the average values were considered and are then multiplied by the viscometer calibration constant to give the kinematic viscosity.

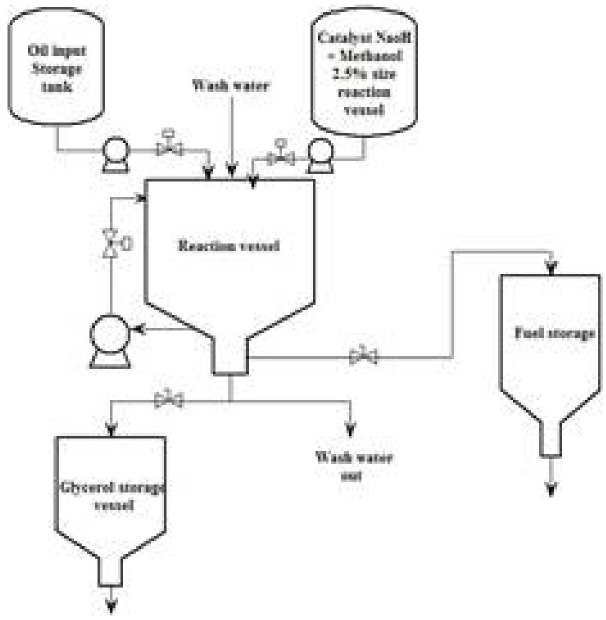
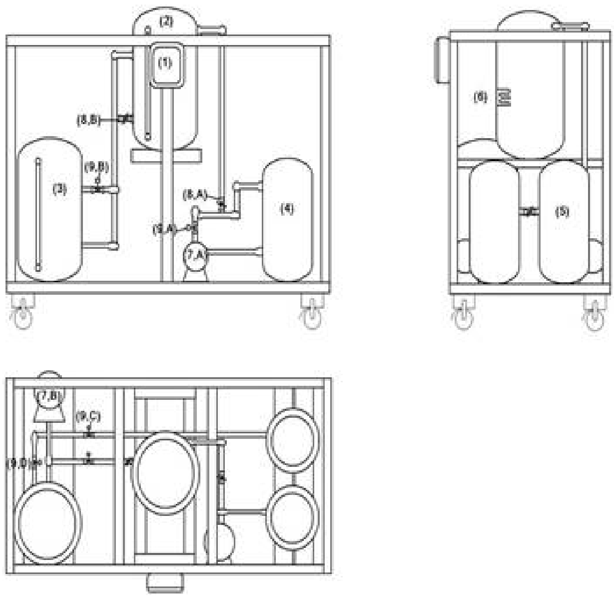


Fig. 1: Diagram of process flow for Biodiesel production from WVO



1- Control unit 2- Main processing tank 3- VOW tank
4- Catalyst tank 5- Biodiesel tank 6- Heater
7- Pump 8- Electrical valve
9- Mechanical valves

Fig. 2: The diagram of constructed biodiesel production unit

Fig. 3: The assembled constructed biodiesel production unit

Determination of Flash Point: ASTM D 93

The flash point standard test ASTM D 93 was prepared to evaluate the biodiesel (B100 and B20) for both ethanol and methanol catalysts. A sample of the biodiesel is heated in a close vessel and ignited. The biodiesel is placed in a cup in such a quantity as to just touch the prescribed mark on the interior of the cup. As the biodiesel B100 and B20 approaches its flashing, the injector burner is lighted and injected into the oil container after every 12 second intervals until a distinct flash is observed within the container.

Total Glycerin

The standard test ASTMD distillation for the glycerin was prepared to measure the glycerin percentage in the sample. The finished fuel blends, the ability to directly measure glycerin is compromised by interference with naturally occurring petroleum biodiesel fuel components.

High Heat Calorific Value (HHV)

The standard test ASTMD 4868 for the High Heat Calorific Value (HHV) was prepared to find the HHV for blend biodiesel (B20 and B100) for both ethanol and methanol catalysts.

RESULTS AND DISCUSSIONS

Energy requirement

The data in Table (1) summarizes the measured energy requirements to produce 60 liter biodiesel from WVO and operation time for every powered component in the unit. It is noticed that the heater consumed the highest value of energy requirement compared to the pumps and other main parts in the system. The measured energy requirements to produce 60 liters biodiesel from WVO were 1.31 kWh, 1.14 kWh and 0.97 kWh for WVO feeding rates 12.76 liters/min, 7.05 liters/min and 4.84 liters/min respectively. The increasing of feed rate tends to increase the energy consumption to produce the biodiesel from WVO. Figure (4) presents the Energy requirements to produce 500 liter biodiesel from WVO. The determination Energy requirements to produce 500 liter biodiesel were 10.98 kWh, 9.49 kWh and 8.11 kWh for WVO feeding rate 12.76 liters/min, 7.05 liters/min and 4.84 liters/min respectively. The specific consumed Energy to produce 500 liter biodiesel were 0.022 kW h/liters 0.019 kW h/liters and 0.016 kW h/liters for WVO feeding rate 12.76 liters/min, 7.05 liters/min and 4.84 liters/min respectively.

Figure (5) illustrate the effect of feeding rate on the energy requirement for biodiesel production from WVO. It is noticed that increasing of feeding rate of waste oil in manufactured unit tends to increase the energy requirement. As well as, the regression equation between the feeding rate and energy requirement was found a power equation with R2 of 0.97 as shown in Figure (5).

Table 1: The measuring values of energy consumed for the two pumps, valves and the heater in biodiesel unit production.

Biodiesl unit parts	Power, W	Operating time, min			Energy requirement for 60 L, kWh		
		flow 1	flow 2	flow 3	flow 1	flow 2	flow 3
Pump 1	212	12.4	8.5	4.7	0.044	0.030	0.017
Pump 2	135	0.5	0.5	0.5	0.001	0.001	0.001
Valves	22	14	9.5	5.5	0.005	0.003	0.002
Agitation pump	229	5	5	5	0.019	0.019	0.019
Heater	680	30	30	30	0.340	0.340	0.340
Total	1278	61.9	53.5	45.7	1.318	1.140	0.973

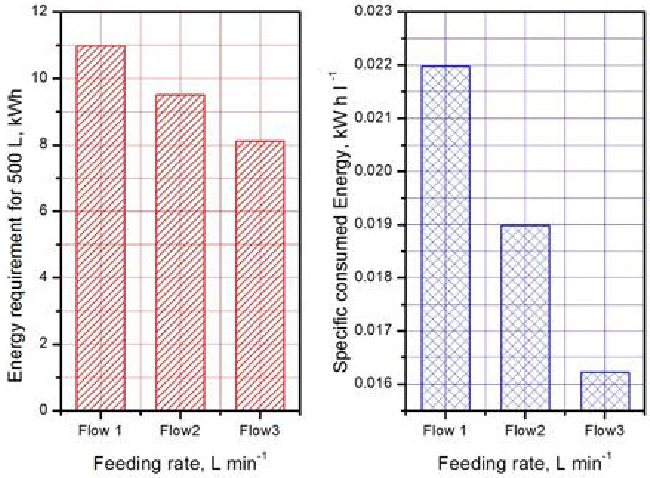


Fig. 4: Daily energy requirement and specific consumed energy for biodiesel production from WVO

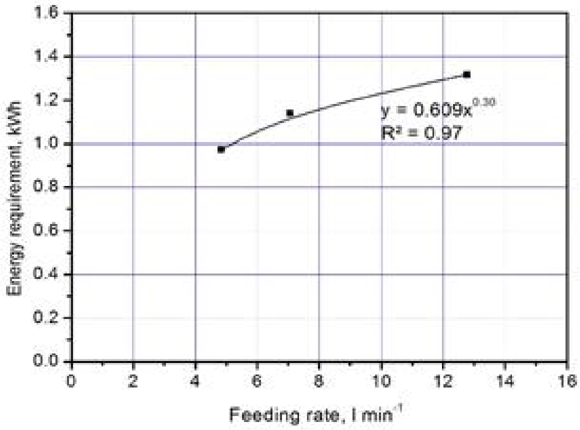


Fig. 5: The effect of feeding rate on the energy requirement for biodiesel production from WVO

Biodiesel fuel properties

The data in Table (2) show the properties of biodiesel and their blends (B100 and B20). The density of biodiesel production from the manufactured unit were 0.873 gcm^{-3}, 0.862 gcm^{-3}, 0.857 gcm^{-3} and 0.843 gcm^{-3} for biodiesel 100 (ethanol catalyst), biodiesel B100 (methanol catalyst), biodiesel 20 (ethanol catalyst), biodiesel B20 (methanol catalyst) respectively. The methanol catalyst gave the low density values compared to the ethanol catalyst for both biodiesel B100 and biodiesel B20. As well as, the ethanol catalyst gave the low values of the flash point compared to the methanol catalyst for biodiesel B100 and biodiesel 20 blends. The flash point of biodiesel were 60°C, 64°C, 64°C, 68°C for biodiesel B100 (ethanol catalyst), biodiesel 100 (methanol catalyst), biodiesel B20 (ethanol catalyst), biodiesel B20 (methanol catalyst) respectively.

Also, the methanol catalyst gave the low values of Heat calorific value (HHV) compared to the ethanol catalyst for both biodiesel B100 and biodiesel B20. The HHV for biodiesel were 41.98 MJ/kg, 41.74 MJ/kg, 42.06 MJ/kg and 41.83 MJ/kg for biodiesel B100 (ethanol catalyst), biodiesel B100 (methanol catalyst), biodiesel B20 (ethanol catalyst), biodiesel B20 (methanol catalyst) respectively. As well as, the free fatty acid decreased in biodiesel B20 (ethanol catalyst), biodiesel 20 (methanol catalyst) compared to the biodiesel B100 (ethanol catalyst), biodiesel B100 (methanol catalyst) as shown in Table (2).

The viscosity of biodiesel production from the manufactured unit were 4.7 cSt, 4.5 cSt,, 4.5 cSt, and 4.8 cSt, for biodiesel B100 (ethanol catalyst), biodiesel B100 (methanol catalyst), biodiesel B20 (ethanol catalyst), biodiesel B20 (methanol catalyst) respectively. The ethanol catalyst may be gave the high values of fuel properties but on the other hand it expansive compared to the methanol catalyst. We recommended using the methanol as catalyst that produced the low cost of biodiesel production under local conditions. The properties of biodiesel fuel production by using the methanol catalyst may be accepted to apply as an alternative fuel in farm machinery. On the other hand the con-

Table 2: The properties of diesel, biodiesel and their blends

Fuel	Viscosity at 40°C, cSt,	Density, g cm^{-3}	FFA	Flash point, °C	HHV (MJ/kg)
Diesel	2.76	0.826	ND	53	44.8
Biodiesel(ethanol catalyst) B100	4.7	0.873	2.27	60	41.98
Biodiesel(Methanol catalyst) B100	4.5	0.862	2.13	64	41.74
Biodiesel(ethanol catalyst) B20%	4.5	0.857	1.81	64	42.06
Biodiesel (Methanol catalyst) B20%	4.8	0.843	1.67	68	41.87

structed unit can be used to produce the biodiesel and in the same time it would help in reducing the waste of cooking vegetable oil.

3- Glycerin Analysis

Glycerin is a byproduct of the production of biodiesel. The percentage of glycerin concentration analysis in byproduct quantity from WVO was 19.5%. The total byproduct solid material from the WVO was 24.6 kg and 23.9 kg from every 60 liter WVO raw material for ethanol and methanol catalyst respectively. The result of the current research shows that the evaluation and the tested of the constructed biodiesel unit that may able to produce the biodiesel from the WVO under local conditions. The test samples of biological contamination indicated that there are few of some bacteria in the samples and it could be negligible after 3 months of storage at 24°C.

SUMMARY AND CONCLUSIONS

The manufactured unit of biodiesel with capacity 60 liter tank could be able to produce 500 liter of biodiesel under local conditions daily. On this study, the methanol catalyst gave the low density values compared to the ethanol catalyst for both biodiesel B100 and biodiesel B20 blend. As well as, the ethanol catalyst gave the low values of the flash point compared to the methanol catalyst for biodiesel B100 and biodiesel B20 blends. The free fatty acid decreased in biodiesel B20 (ethanol catalyst), biodiesel B20 (methanol catalyst) compared to the biodiesel B100 (ethanol catalyst), biodiesel B100 (methanol catalyst). The methanol catalyst gave the low values of HHV compared to the ethanol catalyst for both biodiesel B100 and biodiesel B20 blend. It is important to be mentioned that, "in order for biodiesel to be a fully renewable fuel, it should be obtained from waste vegetable oils or animal fats, together with an alcohol that is produced from biomass, such as bioethanol, instead of being a petrochemical product". The result indicated that, the increasing of feed rate tends to increase the energy consumption to produce the biodiesel from WVO.

ACKNOWLEDGMENT

The Authors would like to thank all staff members in laboratory of Microbiology, Faculty of Agriculture, Kafr Elsheikh University and the staff member in Agric. Eng. Dept., Fac. of Agriculture, Alexandria University.

REFERENCES

Claude S., **1999**. Research of new outlets for glycerol recent developments in France. J. Fett/ Lippid **3**:101–104

Fukuda H, Kondo A, & Noda H., **2001**. Biodiesel fuel production by transesterification of oils. Journal of Bioscience and Bioengineering, **92**: 405–416

Gerpen J.V., **2005**. Biodiesel processing and production, Fuel Processing Technology, **86**: 1097–107.

https://www.astm.org/Standards/petroleum-standards.html#D02.06.

Janaun, J. & N. Ellis, **2010**. Perspectives on biodiesel as a sustainable fuel. Renewable and Sustainable Energy Reviews, **14**:1312–1320.

Leung D.Y.C., Wu X., & Leung M.K.H., **2010**. A review on biodiesel production using catalyzed transesterification. Applied Energy, **87**: 1083–1095.

Lin, Y., Luo J., Hwangb S. J., Liau P., Lu W. & Lee H., **2011**. The influence of free fatty acid intermediate on biodiesel production from soybean oil by whole cell biocatalyst. Journal of Biomass and Bionergy, **35**: 2217 – 2223.

Math, M.C., Kumar S.P., Soma V. & Chetty, M.C. **2010**. Technologies for biodiesel production from used cooking oil A review. Journal of Energy for Sustainable Development, **14**:339–345.

Meher L.C., Sagar D.V. & Naik S.N., **2006**. Technical aspects of biodiesel production by transesterification—a review. Renewable and Sustainable Energy Reviews, **10**: 248–268.

Pedro F., Correia J.N., Idalina R., João M., Berkemeier R., & Bordado J.M., **2006**. Production of biodiesel from waste frying oils. Waste Management, **26**: 487–94.

Puppan D., **2002**. Environmental evaluation of biofuels. Periodica Polytechnica Series Social and Management Sciences, **10**: 95–116.

Romano S.D, G. E, Suárez, & Laborde M.A., **2006** Biodiesel. In: Combustibles Alternativos, 2nd edn. Ediciones Cooperativas, Buenos Aires

Sehsah E.E, Belal E.B., Abu sheisha R.R., & Ellawady A., **2015**. Production of Bio-ethanol from potetoes wastes as an alternative fuel. University of Belgrade, Faculty of Agriculture, Institute of Agricultural Engineering, Scientific Journal, Agricultural Engineering. **3**: 99-108

Turck R., **2002**. Method for producing fatty acid ester of monovalent alkyl alcohols and use thereof. USP 0156305

Utlu Z. & Kokac MS. **2008**. The effect of biodiesel fuel obtained from waste cooking oil on direct injection diesel engine performance and exhaust emissions. Renew Energy, **33**: 1936-1941.

تقييم وحدة مصنعة لانتاج الوقود الحيوى من الزيوت النباتية معادة الاستعمال ومنتهية الصلاحية

السيد محمود البيلى صحصاح(١)، عبدالعزيز ابراهيم عمارة(٢)

(١) قسم الهندسة الزراعية، كلية الزراعة، جامعة كفر الشيخ.

(٢) قسم الهندسة الزراعية والنظم الحيوية، كلية الزراعة، جامعة الإسكندرية.

تهدف هذه الدراسة إلى بحث إمكانية تصنيع وحدة معملية محلية لإنتاج الوقود الحيوى بخامات محلية ولذا إمكانية الاستفادة من مخلفات الزيوت النباتية الى تسبب أضرار بيئية فى أنتاج الوقود الحيوى و رفع قيمتها الاقتصادية. تم تصنيع الوحدة بمعمل قسم الهندسة الزراعية كلية الزراعة جامعة كفرالشيخ والتى تتكون من أطار من الألومنيوم مثبت به خزان رئيسى بسعة ٦٠ لتراً متصل بطلمبة كهربائية موديل Turbo QB60 قدرة ٣٧٠ ووات لإمداد الخزان بالزيوت و يحتوى الخزان أيضا على سخان كهربائى قدرة ١٣٠٠ ووات موديل Thermowot Co وعدد ٢ صمام كهربائى للتحكم فى عملية اضافة الكحول و الصودا الكاوية و كذا عمل دورة للتقليب كما تحتوى الوحدة على خزان بسعة ٣٠ لترا لكحول الميثيل أو الإيثيلي و كذا الصودا الكاوية حيث يتم اضافتها بواسطة طلمبة أخرى مركبة فى قاع الخزان و بها صمام كهربائى و خزان آخر بسعة ٦٠ لترا لتجميع الزيوت الناتجة من مخلفات المطاعم و الذى يحتوى على مصفاة أو شبكة من السلك لتنقية الزيوت من المخلفات الصلبة و الشوائب علما بأنه تم تجميع المخلفات من قسم الصناعات الغذائية بكلية الزراعة جامعة كفرالشيخ و بعض المطاعم من محافظة كفرالشيخ و الأسكندرية. أيضا يوجد بالوحدة خزان لتجميع الوقود الحيوى الناتج و الجليسرول مع تجميعة فى خزان منفصل عن الوحدة أسفل الخزان الرئيسى و الذى يتم فيه انتاج الوقود الحيوى. كما تحتوى الوحدة على عدد ٣ صمامات ميكانيكية للتحكم فى معدلات التصرف بالإضافة إلى وجود عدد ٣ صمامات كهربائية متصلة عند مخرج الطلمبتين و الثالث عند مدخل الزيت فى الخزان الرئيسى لعمل دورة التقليب ، ايضا تحتوى الوحدة على لوحة تحكم كهربائية للتشغيل و التحكم فى اضافة الزيوت و الكحول و الصودا الكاوية و فترة عمليات الأضافة و التقليب و التفريغ و تم اختبار نواتج الوقود الحيوى و الجليسرول بمعامل قسم الهندسة الزراعية و جامعة الأسكندرية. أستعمل مقياس القدرة الكهربية موديلWattmeter PSGI و جهاز KEDID Ph لقياس رقم الحموضة. و قد أوضحت النتائج أنه يمكن تصنيع وحدة محلية لإنتاج الوقود الحيوى تحت الظروف المصرية و بخامات محلية. كما بينت النتائج أيضا أن زيادة معدل التغذية بالزيوت للوحدة المصنعة لإنتاج الوقود الحيوى تؤدى الى زيادة معدل الطاقة المطلوبة لإنتاج الوقود الحيوى و كانت علاقة الارتباط بينها علاقة ممثلة بمعادلة قوى و لها معامل ارتباط R^2 = ٠,٩٧ كذلك أوضحت النتائج أن استهلاك الطاقة لإنتاج ٦٠ لترا من الوقود الحيوى بلغ ١,٣١ ك.وات ساعة و ١,١٤ ك.وات ساعة و ٠,٩٧ ك .وات ساعة عند معدلات تغذية للوحدة بلغت ١٢,٧٦ لتر/د و ٧,٠٥ لتر/ د و ٤,٨٤ لتر / د على الترتيب. بينما بلغت معدلات استهلاك الطاقة اللازمة لإنتاج لتر واحد من الوقود باستعمال الوحدة المصنعة ٠,٠٢٢ ك.وات ساعة/لتر و ٠,٠١٩ ك.وات ساعة/لتر و٠,٠١٦ ك .وات ساعة/لتر ساعة عند معدلات تغذية للوحة بلغت ١٢,٧٦ لتر/د و ٧,٠٥ لتر/ د و ٤,٨٤ لتر / د على الترتيب. كما وجد أن استعمال الكحول الإيثيلي فى أنتاج الوقود الحيوى(البوديزل) يعطى أقل كثافة للوقود الناتج عند خلطة بنسبة ٢٠ ٪ و الوقود الحيوى بنسبة ١٠٠ ٪ مقارنة بالميثانول فى أنتاج الوقود الحيوى. كما أعطى الكحول الأثيل أقل درجة وميض (flash point) مقارنة بالميثانول عند نسبة الخلط بنسبة ٢٠ ٪ و عدم خلطة حيث كانت ٦٠°م، ٦٤°م، ٦٤°م، ٦٨°م لكل من الوقود الحيوى (الميثانول ٢٠٪) و الوقود الحيوى (الميثانول ١٠٠٪) الوقود الحيوى (الأيثانول ٢٠٪) الوقود الحيوى (الأيثانول ١٠٠٪) على الترتيب. كما تبين أيضا أن أعلى قيمة حرارية للوقود المنتج من الوحدة عند خلطة بنسبة ٢٠ ٪ مع السولار و عند استعمال الأيثانول فى أنتاجة حيث بلغت قيمتها ٤٢,٠٦ ميجاجول/كجم. كما اتضح من التحليل الكيميائى للمنتج الإضافى الجليسرين أن نسبته بلغت ١٩,٥ ٪ لكل كجم من الكمية الناتجة من المكون الصلب عند أنتاج الوقود الحيوى باستعمال الوحدة المصنعة معمليا.