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Production Biodiesel from Kapok Seed Oil Using Ultrasonic

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Production Biodiesel from Kapok Seed Oil Using Ultrasonic

A. Suryanto[1*)], Zakir Sabara, H.W[1], Hardi Ismail[2], Andi Artiningsih[1], Ulva Zainuddin[1], Almuknin Almukmin[1], Nurichsan.U[1], Niswah. F. W[1].

[1]Department of Chemical Engineering Faculty of Industrial Technology Universitas Muslim Indonesia (0411)- 447562, Indonesia
[2]Department of Industrial Engineering, Faculty of Industrial Technology Universitas Muslim Indonesia (0411)-447562, Indonesia
[*)]Email : a.suryanto@umi.ac.id

Abstract : Biodiesel is a renewable, non-toxic, environmentally friendly fuel made from vegetable oils through a transesterification reaction with methanol. During this time the manufacture of biodiesel takes a long time which can be overcome with ultrasonic heating. The use of sound waves can decrease the reaction time and the number of catalysts. The purpose of this study was to study ultrasonic utilization as a heater in transesterification reaction of kapok seed oil with the addition NaOH catalyst concetration of 0.25, 0.5, 0.75 and 1% (w/w) with 50 Hz of frequensi ultarsonic and reaction times were of 1, 2.5, 5, 10, 15 and 30 min. The reaction conversion of kapok seed oil with NaOH catalyst at 0.5% (w/w) concentration, reaction time 15 minutes was 73.56% at each 1: 9 molar ratio. The results of the analysis of several parameters on biodiesel products show that they have met the specification based on Indonesian National Standard (SNI-04-7182-2006).

Keywords: Kapok seed oil, biodiesel, transesterification, ultrasonic

1. Introduction

Biodiesel, as a renewable fuel, has superior advantages-environmentally friendly, biodegradable and lower emission compared to fossil fuels. Biodiesel, as diesel fuel made from renewable materials, consists of alkyl esters of fatty acids and it can be prepared from vegetable, animal and used cooking oil, or recycled oil [1]. Vegetable oils that can be developed as a raw material for manufacturing of biodiesel are obtained from plants-palm, castor and callophyllum inophyllum fruit. [2]. Biodiesel can be prepared via trans-esterification of fatty acids. Fatty acids reacted with an alcohol produces an ester and glycerin as by products. Even though glycerin is only as by product, its price is quite high. Trans-esterification is the stage of conversion of triglycerides (vegetable oil) into alkyl esters by reaction with the alcohol and produces, glycerol. Among alcohols as source of alkyl, methanol is commonly used for it is cheap and most reactive. Biodiesel chemically defined as methyl esters derived from natural oils or fats such as vegetable oils, animal or other vegetable oil [3].

Preparation of biodiesel has been widely developed in the conventional manner [4]. The development of the manufacturing process of biodiesel has been applying ultrasonic to accelerate the reaction, [5]. The use of ultrasonic is an alternative to manufacture of biodiesel to enhance the conversion process. With the development of the manufacturing process, including the development of alternative fuel sources of energy, and one of them is that ultrasonics can accelerate the reaction [7]. Wave radiation is absorbed by polar molecules-water, sugars and fats as well as other substances that atoms are excited and produced heat. Heating takes place simultaneously and uniformly on the excited atoms and produce heat at the same time. The use of ultrasonics provides many advantages as follows: fast startup time, faster heating, efficient energy and the lower process cost, easy to monitor, precise, selective heating and the better quality of the final product [8].

Kapok seed oil contains saturated fatty acid of 71.95% [Nicson PoltaK], higher than coconut oil. This shows that cotton seed oil is easily rancid, so it is poorly developed as a food oil. However, kapok seed oil has the potential to be developed as a raw material in the manufacture of biofuels, especially

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substituting diesel oil. This research aims to study the development of the process of making biodiesel from kapok seed oil by utilizing ultrasonics as an energy source and determine the effect of reaction time on biodiesel formation at various power using homogeneous catalysts.

2. Materials and Methods

2.1. Description of Apparatus Experimental

The production of biodiesel was conducted in a batch reactor using ultrasonic radiation as heating sources. The operation condition is the mole ratio of kapok seed oil and methanol (1:9) and and frequensi ultrasonic 50 Hz. The ultrasonic commercial used in this study is Electrolux DELTA 318 H. The design of equipment used in this study is shown in Fig. 1. The reactor is a round bottom flask made from Pyrex glass equipped by stirring bar and thermocouple sensor. The kapok seed oil used in this experiment obtain from commercial market.

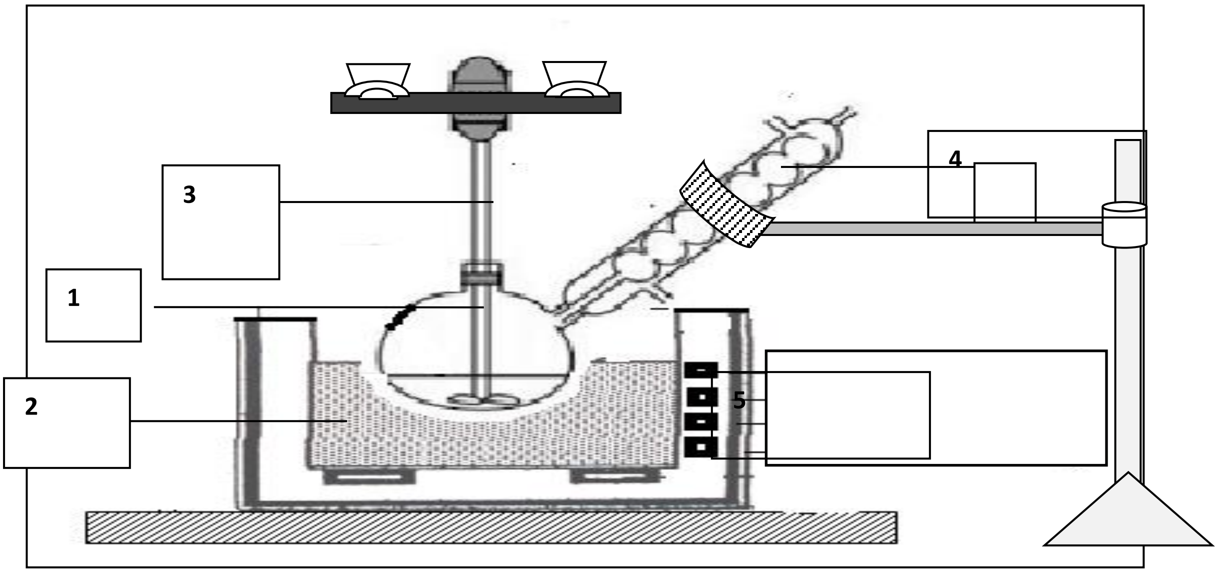

Figure.1 The experiment setup for transesterification process assisted by ultrasonic, 1. Batch reactor, 2. ultrasonic , 3. stirring bar 4. reflux condensor, 5. power control instrument, time setting.

2.2. Experimental Procedure

First of all kapok seed oil was introduced in the reactor and then mixture of methanol and NaOH added. The reaction was started by turn on the ultrasonic frequeni 50 Hz and set reaction times 2.5 min. The process is repeated for other variables reaction of reaction time 1, 2.5, 5, 10, 15, and 30 minutes. After the reacting operation, the catalyst was separated from the reaction mixture using separating funnel, be washed twice with methanol, and dried at 110 °C in atmosphere to a constant weight. The physical and chemical properties of the products, density, viscosity and acid number, were analyzed by ASTM test (American Standard Testing Method).

3. Results and Discussion

Firstly, kapok seed oil was characterized to determine their physical and chemical properties, as show in table 1. From this table in the kapok seed oil used in this study contained FFA less than one percent. The viscosity of shown in about 32.5 mm^2/s. Biodiesel produced was analized using Gas Chromatography as shown in Figure.2

Table 1. Physicochemical properties of kapok seed oil

Properties	**Unit**	**kapok seed oil**
Water content	%	0.991
Density	g/mL	0.913
Viscosity	mm^2/s 40 °C	32.5
Free fatty acid	%	3.189
Acid number	mg.KOH/g.oil	3.453

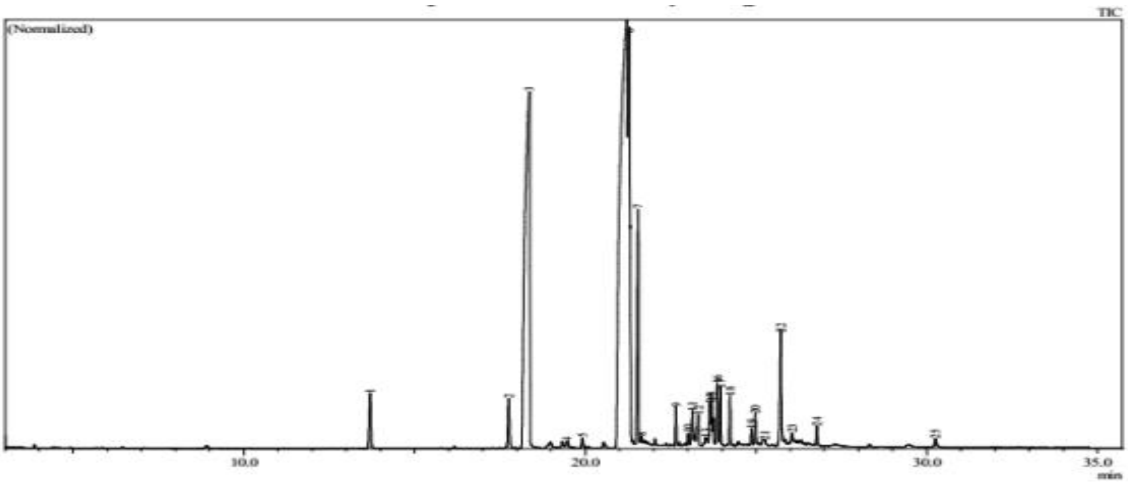

Figure. 2 GC Chromatogram of produced methyl ester from kapok seed oil\

3.1. The effect of reaction times on the yield of biodiesel

Effect of time on kapok seed oil transesterification process is shown in Figure 3. Transestrification reaction time is very important to do evaluation for determain and ensuring the reaction process can be run properly. Figure. 3 shows that at 1 minute the resulting biodiesel product was 38.2 gradually increased at 2.5 to 10 minutes reaction time of 65.5% and significantly increased at reaction time of 15 minutes ie 78%, But by increasing the reaction time 30 does not increase the yield gain even tend to be constant and this indicates the reaction process has been completed. The use of ultrasound in the transesterification reaction can decrease the reaction time.

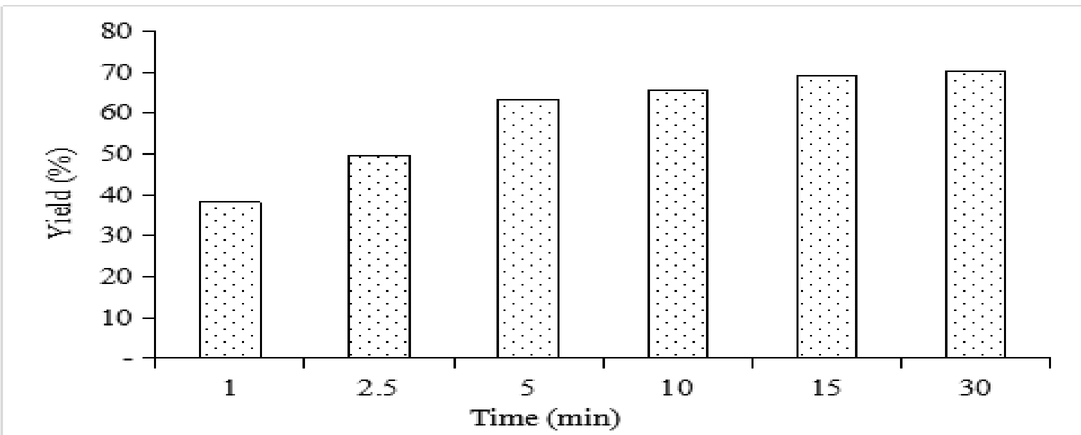

Figure 3. The effect of reaction times on biodiesel yields with 1:9 molar ratio of oil to methanol, 0.5 w.t % KOH.

The use of ultrasonic can help accelerate the process of transesterification reaction of kapok seed oil and methanol. This indicates that the effect of the resulting heat cavitation provides great energy on reagent molecules to decrease the activation energy of the reaction so that the reaction rate increases. Increased rate of reaction will result in conversion to form higher methyl esters in a relatively short time. Figure. 3, shows that the yield increases with time transesterification to 5 minutes. This indicates that the longer the reaction time the reaction more perfect. And at the time reaches 5 minutes conversion process is almost perfect. Meanwhile, if the extended processing time of more than 5 minutes, then decrease the yield, this may be caused due to overheating similarly [10]. From Figure 3. shows the oil before it is converted into methyl esters having a high viscosity of 32.5 mm^2/s so it is not possible to be mixed with diesel fuel. However, after conversion into biodiesel, the viscosity dropped to 5.58 - 2.83 mm^2/s, which means a decrease viscosity of about 90%. It shows the formation of methyl esters and almost finished.

Conventional biodiesel production using a homogeneous catalyst is generally reported to be the largest yield gain at 1% concentration with a reaction time of 1 hour. Yakob, et, all, 2008, performed a transesterification reaction using microwave irradiation with a 99% homogeneous catalyst achieved at 15 minutes reaction time. Figure 3 shows the effect of time variation on yield of biodiesel product at 0.5% NaOH catalyst (b/b) concentration with 50 kHZ ultrasonic frequency.

3.2. Effect of Catalyst Concentration

The effect of catalyst concentration in making biodiesel with ultrasonic aid was done with variation of catalyst concentration 0.25; 0.5; 0.75 and 1% (w / w) of the weight of kapok seed oil.

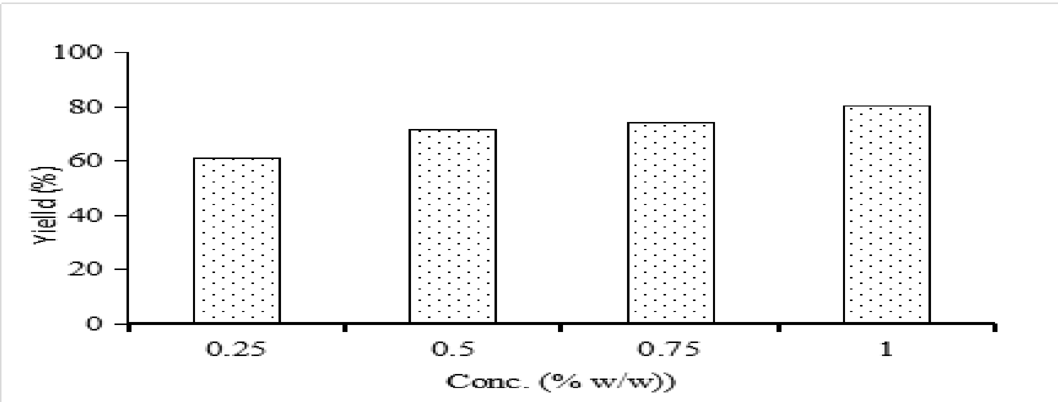

Figure 4. The effect of catalyst concetration on biodiesel yields with 1:9 molar ratio of oil to methanol reaction timen 15 min.

Frequency the sound waves used in the transesterification process of kapok seed oil with methanol are 50 Hz, the reaction time is 15 minutes as shown in Fig. 4. From Figure 4 it can be seen that the yield of yiled biodiesel products increases with the increase of catalyst concentration. The catalyst will react with methanol and form methoxide. This ion will react with cotton seed oil to produce methyl esters. The more catalysts used, the more methoxide ions are formed, the greater the odds of kapok seed oil become biodiesel. In Figure 4 the increase in yield yield occurs at concentrations of 0.25 to 0.5% (w/w), but at concentrations of 0.75-1% (w/) is relatively constant. This is because the activity of the catalyst decreases so that the catalyst can no longer activate the reacting fatty acids.

3.3. *Biodiesel properties of coconut biodiesel*

The quality of biodiesel is important for usage in a diesel engine. In this work, biodiesel from kapuk seed oil produced at the optimum condition was sent for quality testing standart metode. The product, biodiesel obtained met the standard of the parameters determined ASTM as shown in Table 2. Physical and chemical properties of biodiesel were in the range of standard number of ASTM.

Table 2. Comparisons biodiesel production with biodiesel standar

Physical properties	Unit	Sample	Standard ASTM
Relative density	gr/ml 25 ºC	0.897	-
Viscosity	mm^2/s, 40ºC	3.86	1.90-6.0
Sulfur content	%	0.098	-
Yield	%	80	-
Acid number	mg.KOH/gr	0.472	< 0.80
Water content	%	0.046	<0.05

4. Conclusion

The ultrasonic could be shortening the reaction time for biodiesel production from kapok seed oil. It was found that the greater the power used was the lower of yield of biodiesel obtained. The highest yield was 80 percent, or 85 percent conversion at frekwensi 50 Hz reaction time 15 min. In general, the quality of product obtained met the standard numbers of biodiesel, ASTM.

5. Acknowledegement

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6. References

[1] A. Suryanto, S. Suprapto, M.Mahfud, 2015, Production Biodiesel from Coconut Oil Using Microwave : Effect of Some Parameters on Transesterification Reaction by NaOH Catalyst BCREC, 10 (2), 162-168.

[2] Alex de Nazare de Oliveira, Laura Rafaela da Silva Costa, Liza Helena de Oliveira Pires, Luis Sdriano S. do Nascimento, Romula S. Angelica, Carlos E.F da Costa, Jose R. Zamian, Geraldo N. da Rocha Filho, 2013, Ultrasonic assitsed preparation of a new esterification catalyst from wasted flint kaolin, J. Fuel, 103, 626-631.

[3] Chowdhury.K, L.A Banu, S.Khan and A. Latif, Studies On the Fatty Acid Composition Of Edible Oil, 2007.

[4] Galema, A.S.,(1997), Ultrasonic Chemistry", Chemical Society Reviews, Volume 26, 233-238.

[5] Gude, Gnaneswar, V., Patil,P., Martinez-Guerra,E., "*ultrasonic Energy Potential for Biodiesel Production",* Mississippi State University, Chemistry Central, USA.

[6] Immacolata Manco, Laura Giordani, Vittorio Vaccari, Massimo Oddone, 2011, Microwave Technology for The Biodiesel Production : Analytical Assesments, J. Fuel 95, 108-112.

[7] Jiputti, J. Kitiyanan, B. Rangsunnivit, P. Bunyakiat, K. Attnatho, L. Jenvanipanjakul. P, 2006, Transesterification Of Kernel Oil and Crude kapuk seed oil by Different Solid Catalysts, Chemical Engineering Journal, 116, 61-66.

[8] Kang-Shin Chen, Yuan-Chung Lin, Kuo-Hsing Hsu, Hsin-Kai Wang, 2012, Improving biodiesel Yield from waste cooking oil by using sodium methoxide and a microwave heating system.

[9] Ming-Chien Hsiao, Chin Chiuan Lin, Yung-Hung Chang, 2011, Ultrasonic Irradiation Assisted Transesterification of Sobybean Oil to Biodiesel Catalyzed by Nanopowder Calcium Oxide, J. Fuel 90, 1963-1967.

[10] Motasemi, F.N.Ani, 2012 A Review on Ultrasonic Aassisted Production of Biodiesel, Renewable and Sustainable Energy Reviews 16, 4719-4733.

[11] Nixon Poltak. F, (2013) Making Biodiesel From Kapok Seed Oil with esterification process of transesterification, Journal Technolgy Of Chemical Industrial, 2(2)p.262-266.

[12] Ritesh Kumar, G. Ravi Kumar, N.Chandrashekar, 2011, Microwave assisted alkali-catalyzed transesterification of *Pongamia pinnata seed* oil for biodiesel production.

[13] Veera Gnaneswar Gude, Prafulla Patil, Edith Martinez Guerra, Shuguang Daeng and Nagamany Nirmalakhandan, ultrasonic Energy Potensial for Biodiesel, 1-5, 2013.

[14] Quitain, T.A., Hrioyuki D.,Katoh, S., and Moriyoshi,T.“*Utrasonic-Assisted hydrothermal degradation of silk protein to amino acids”*, Kumamoto University Japan, 2011.