SEPARATION PROCESS BIODIESEL FROM WASTE COOKING OIL USING ULTRAFILTRATION MEMBRANES

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Abstract. The use of cooking oil repeatedly in the processing of food can lead to health disorders, including liver and kidney damage. Waste cooking oil or used cooking oil if disposed of can lead to environmental pollution. One solution to overcome the problem is to recycle waste cooking oil into biodiesel, which can be used as an alternative fuel. Biodiesel from vegetable raw materials is very advantageous because it can be renewed. In this research, waste cooking oil is reacted with an alcohol using an alkaline catalyst. The separation process of products is done by using ultrafiltration membranes. Membrane separation with ultrafiltration products can accelerate the separation time of the biodiesel byproducts. Membrane was made by annealing method with a composition sellulose acetate 25%, 30% formamide and 45% acetone. The separation of the product using ultrafiltration membranes obtained maximum product ± 1848 mL, with the composition of the raw materials is waste cooking oil is 2000 mL, 400 mL of methanol and 14 g NaOH. Results of analysis of the resulting biodiesel product is the density of 0.874 g / m, the viscosity of 3.5 cs, a refractive index of 1.477 and a pH of 7. The analysis shows that the separation of the product by the ultrafiltration membrane approach the standard UNI 10635.

Keywords: Biodiesel; Membranes; Waste Cooking Oil; Ultrafiltration

I. INTRODUCTION

The research of a fuels that benefit to be continued and developed, one of which in the form of diesel fuel made from vegetable oil called biodiesel. As an alternative fuel, biodiesel has advantages because it is made of oil that comes from plants, so it can be renew and environmental friendly.

Reference [1] has determined that the type of vegetable oil used is cooking oil (cooking), based on the results of the feasibility of raw materials. Reference [2] shows processing of biodiesel from cooking oil is an effective way to lower the selling price of biodiesel because of the raw material is cheap. According to [3] the main reason for seeking alternative sources of fuel for diesel engines due to high prices of oil products.

Reference [4] shows biodiesel synthesize from cooking oil with the former of trans-esterification process. Reference [5] has been synthesizing biodiesel catalyst process with 2 stages, namely the process of esterification catalyst ferry sulphate and potassium hydroxide base catalyst. Synthesis process with a second stage requires the consumption of methanol twice folding, biodiesel yield also decreased by 20% -30% and requires a reaction time [6]. Reference [7] has developed a technique used cooking oil biodiesel processing using enzymatic processes. The downside of this technique requires high production costs and long reaction times.

Reference [8] shows to produce high-quality biodiesel, required an appropriate pretreatment prior to the transesterification In addition, the separation process of the biodiesel byproduct takes a long time. Membranes separation can be replaced the old separation procedures on the product side. Ultafiltration separation membranes have several advantages, namely separation or purification can be process without changing the substance phase to be separate.

Separation can be done at room temperature, allowing substances that are sensitive to temperature without damaging the chemical properties [9]. In this research, the process of making biodiesel using the method of transesterification using methanol and sodium hydroxide as a catalyst. Biodiesel separation process performed using ultrafiltration membranes to obtain biodiesel that meets the standards and does not require a long time in the separation process.

II. MATERIALS AND METHODS

A. Membrane preparation.

Membranes made by using a formula Manjikian, US Pat.3483282,9.12.1969 namely cellulose a 25%, 45% acetone and 30% formamide. The procedure of making the sheets is done by making the solution hubcap of the formula mixture. Homogeneous mixture made up approximately 24 hours, and the clear yellowish-colored and thick. Next the film formation process is done, where a piece of glass by setting up a size 30 cm x 20 cm, wash clean and then dry it, plug the duct tape on the edge of the top and bottom are adjusted to the size of the membrane to be made.

A layer of film will be formed on a glass substrate, by putting the solution above dop glass and pressed with a glass pipe measuring 1 cm with a length of 25 cm, which functions to suppress the solution to the above film forming dop glass. Next lift the autoclave and leave for 5-10 seconds open aerial. Process annealing is done by putting the pieces of the glass contains the solution of the dop to the container that contains water ice, which serves to process annealing in the making membrane. Soak for 5-7 minutes then remove the glass and sheet glass from the surface membrane. Membrane sheet can be used according to the desired size.

B. Ultrafiltration Membrane Preparation

Membrane sheet that has been produced in accordance with the cross section cut the membrane. Membrane tank, tank lid and base membrane made using fiber materials. Membrane selection material using fiber, as a sample to be separated have corrosive properties. Membrane tank diameter is 12 cm and its height is 24 cm, with 0.2 cm thick membrane holder and seat height 5 cm.

C. *Making biodiesel with product separation using membrane ultrafiltration*

The first, used cooking oil to be used filtered. Then measuring the samples of each 2000 mL of 3 pieces. Add methanol to each sample of 400 mL. Add NaOH into each sample with a variation of 12, 13 and 14 g. Set the temperature at 50, 55 and 60°C for each sample. Biodiesel produced separated by UF membrane. The separation process is done with a temperature of 50, 55 and 60 ^{0}C and the operating pressure at 0.2, 0.4 and 0.6 kg / cm^2 on each sample for each experiment. A further process each sample views generated total permeate rate (biodiesel), and analyzed the physical and chemical properties of the product of biodiesel produced.

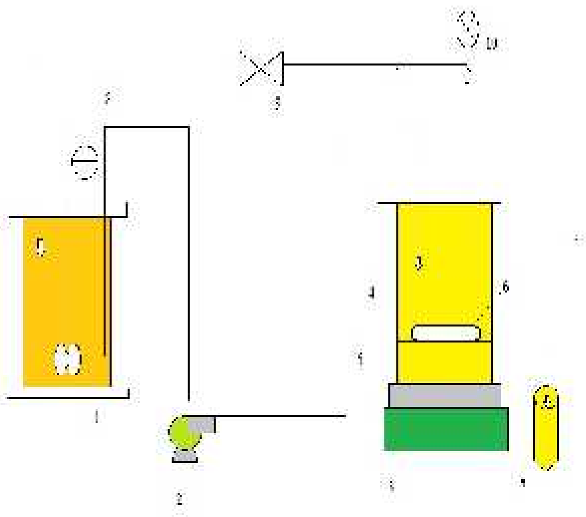

Fig. 1. **Schematic diagram of the process equipment product separation biodiesel using ultra filtration membranes**

III. RESULTS

A. Membrane produce

Characteristics of membrane composition result ASTAT 25% cellulose, formamide 30% and 45% acetone which has a thickness (mm) 0.2 and a molecular cutoff of 3000 ^{0}A. Specifications membrane tanks that produced and used in the process of separation of the product shown in Table 1.

TABLE I
THE RESULTING MEMBRANE SPESIFICATION

Unit	**Spesifikasi**		
	Material	**Size**	**Pressure**
Membrane Tank	Fiber	Diametre 12 cm High : 24 cm Vol.max : 4 L Vol. Min : 1 L	Press.max : 0,8 kg/cm^2 Press. min : o,1 kg/cm^2
Tank lid	Fiber	Diameter : 12 cm Thick : 2,4 cm	-
Holder Tank	Fiber	Diameter : 12 cm Thick : 0,2 cm High : 5 cm	-

B.The influence of temperature and pressure on permeate rate

The rate of permeate generated from the three samples with the treatment of temperature and pressure at different intervals of 5 minutes is shown in Table 2.

TABLE 2.
The effect of temperature and pressure on the rate of permeate with an interval of 5 minutes

		Volume Permeate (V_p)		
Sample	Pressure	T (50^{o}C)	T (55^{o}C)	T (60^{o}C)
	0,6	18	20	40
1	0,4	16,5	19,5	36
	0,2	15	17,5	30
	0,6	10	18	42
2	0,4	22	29	28
	0,2	20	16	22
	0,6	37	35	132
3	0,4	36	32,5	129
	0,2	34,1	29	120

Based on Table 2, it can be seen that the rate of permeate production process of biodiesel produced at intervals of 5 minutes and at a high temperature (60^{0}C) and the greatest pressure (0.6 kg / cm^2) obtained maximum permeate each sample, namely 40, 42 and 132 mL. The highest rate of formation of biodiesel contained in the sample 3, which is 132 mL This is in line with the Reference as in [8] which states that the higher pressure and temperature it will produce a high volume of permeate. The total volume of each sample at the time of 70 minutes will produce biodiesel at 560, 588 and 1848 ml. Biodiesel production is also affected by the concentration of methanol and catalyst concentration.

The catalyst serves to lower the activation energy so that the reaction speed to be higher in certain conditions. The more catalysts then energy activation of a reaction will be smaller, the faster the product consequently formed. Therefore, the reaction is carried out in accordance with certain time conducted in this experiment with the greatest concentration of catalyst (14 g) yield biodiesel obtained more and more [10]. The best results obtained in the biodiesel yield achieved when the catalyst concentration of 3.38% -b, the sample 3. Table 3 presents the maximum biodiesel production generated in this study.

Table 3.
Biodiesel production is generated at the time 70 minutes

Temperature (^{0}C)	Results Biodiesel(mL)			% Yield		
	1	2	3	1	2	3
50	280	224	1022	14	11,2	51,1
55	392	280	1400	19,6	14	70
60	560	308	1848	28	15,4	92,4

C. Results of analysis of physical and chemical properties of the product of biodiesel produced by the UF membrane.

Tests on the physical and chemical properties of biodiesel include density, viscosity, refractive index and pH. Analysis of the product to determine its quality biodiesel which is then compared to the standard UNI 10635, in biodiesel obtained from treatment trials with the highest biodiesel yield. The results of the analysis shown in Table 4.

TABLE 4
Biodiesel Quality Analysis Results in Optimum Condition

Parameter	Unit	Result	UNI 10635
Colour	-	Kuning Jernih	-
pH	-	7	7
Densitas	g/mL	0,874	0,86-0,90
Index bias	-	1,447	1,447 – 1,449
viscositas	cSt	3,5	3,5 – 5,0

Based on data in Table 4, the quality of biodiesel produced in optimum condition already qualified UNI 10635. When compared to standard Pertamina, biodiesel generated is also already qualified, wherein the color clear yellow biodiesel. For the density and viscosity is also already meet the standards Pertamina is 0.87 to 0.89 to 1.6 to 5.8 for the density and viscosity. This result is much better than [10], where the color of biodiesel produced brownish and murky. The use of a membrane in the separation process results indicate that the quality of biodiesel produced very well.

The possibility of a saponification reaction that forms the soap due to reaction with the catalyst used cooking oil and residual water contained has been minimal. It is detected from the clarity of biodiesel produced. Membrane function in separating the product from the byproduct in addition to speeding up the process is also capable of removing a byproduct of biodiesel products. This is shown by the clear biodiesel and viscosity value that meets the standards UNI 10635 standard and Pertamina. Low viscosity value may also be influenced by the amount of the catalyst added during the formation of biodiesel were optimal.

IV. CONCLUSIONS

From the discussion, it can be concluded as follows:

1. The used cooking oil has the potential to be processed into biodiesel that can be used as an alternative fuel diesel engines.
2. The optimum conditions of the process of making biodiesel is achieved when the treatment of the raw materials used cooking oil 400 ml and 14 g NaOH catalyst.
3. The optimum condition with membrane separation is achieved at a temperature of 60^{0}C, pressure of 0.6 kg / cm^2.
4. The maximum product obtained under optimal conditions was 1848 mL.
5. The results of the analysis of biodiesel products include its density, color, pH, viscosity standards Pertamina and UNI 10635.

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