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Production of Ethyl Ester With The Influence of Electrode type, Rection Time and Electric Voltage From Used Frying Oil

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Production of Ethyl Ester With The Influence of Electrode type, Rection Time and Electric Voltage From Used Frying Oil

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Abstract. Ethyl ester or biodiesel that is an alternative energy because of its renewable nature. The production of ethyl ester involves an alcoholysis reaction between ethanol and triglycerides using a strong base catalyst. The source of triglycerides is derived from used frying oil to increase the economic value of used frying oil whose production in indonesia reaches 4 million tons/year. Used frying oil is taken from restaurants in Palembang, South Sumatra. It has free fatty acid values of 1.024% so that transesterification can be carried out directly using a strong KOH base catalyst. The research was conducted using an electrolysis reaction with NaCl as an electrolyte. Variations of made to the type of electrodes, namely aluminum and stainless steel, the reaction time was 3 hours; 3.5 hours; 4 hours; 4.5 hours; and 5 hours and the supplied current voltage which is 15 V; 25 V; 35 V to see the effect on the percent yield of ethyl ester produced. The highest percent yield of Ethyl Ester was obtained samples with a reaction time of 3.5 hours, a voltage of 35 V, and an aluminum electrode of 99.8%.

1. Introduction

Energy is a crucial part in every side of human life. most of the human used the energy in their life, especially in transportation, industry, and the others. However, the existence of fossil energy in the world has diminished along with the depletion of petroleum reserves because of its non-renewable. According to the Central Statistics Agency in 2013, oil production in Indonesia is tended to decline. This is precisely contrary to the amount of community demand for oil which has increased every year. this is precisely contrary to the public demand for the amount of oil which has increased every year. Therefore, alternative energy such as biodiesel which is more economical and environmentally friendly is needed.

The Ministry of Energy and Human Resources (Mineral Resources) explained the remaining availability of Indonesia's petroleum that can be exploited is only 3.7 billion barrels and is expected to be used up in about 10 years. If it only relies on petroleum as a supply of diesel raw materials, Indonesia will become an importer in meeting national diesel needs. Therefore, the Government established a national energy policy through the Republic of Indonesia Presidential Regulation No. 5 of 2006 concerning innovations for the procurement and supply of alternative renewable energy sources to replace petroleum-based fuels.

One of the efforts that can be carried out by a Chemical Engineer is producing ethyl ester from used frying oil [1] to the variation of the electrolysis current voltage by the addition of ethanol/methanol, where used frying oil obtained from home industry is processed by filtering to separate from the residual frying impurities. Purification of used frying oil be carried out by the adsorption process using activated carbon adsorbents [2].

From this problem that inspired researchers to use waste cooking oil as raw material derived from various types of frying oil [3], in the process of ethanol/methanol ratio with variations current voltage on electrolysis to obtain ethyl esters .

The chemical reaction of ethyl ester (biodiesel) production has a side product, that is glycerol. to produce the ethyl ester itself has the Indonesian National Standard (SNI) in order to obtain a good quality ethyl ester (biodiesel). ethyl ester (biodiesel) production has been widely carried out, in general using homogeneous catalysts namely KOH and NaOH. Because of this, researchers will develop using a NaOH catalyst. In addition to the KOH and NaOH catalysts, producing biodiesel can also use a kaolinite catalyst [4].

The research was carried out directly by filtering the waste cooking oil, which has been cleared to be reacted with KOH, the result of ethyl esther is continued by analyzing the cetane number, density, and kinematic viscosity.

2. Experimental

The raw material used 150 ml of used cooking oil, which had previously been heated to 40°C and filtered. Then the raw material analysis process is carried out. First weigh 5 grams of used cooking oil add 50 ml NaOH then stir and heat 40°C. Then the mixture is titrated until the mixture turns pink. Next calculate the Free Fatty Acids (%FFA).

Next do electrolysis process by using stainless steel and alumunium as the cathode and anode. The flow of electricity veries 15 V, 25 V and 35 V with 3 hours, 3,5 hours, 4 hours, 4,5 hours and 5 hours at speed of 400 rpm. After elctrolysis process, ethyl ester will be obtained which is ready to be analyzed for density, viscocity and flash point.

3. Results and Discussions

Based on research conducted and analysis of samples in the form of density, flash point and viscosity values resulting from the electrolysis of waste cooking oil into biodiesel from voltage variations, reaction times, and types of electrodes used, the following research table is obtained.

Table 1. Result of the research (Aluminium Electrode)

Time Reaction (hour)	Electrical Voltage (V)	Yield Biodiesel (%)	Density (g/cm^3)	kinematic Viscosity (cSt)	Flash Point (°C)
SNI		-	850–890	2,3–6,0	Min 100
	15	87,60	912	9,6096	217
3	25	83,00	909	8,6086	210
	35	94,75	910	9,7097	204
	15	97,93	911	10,1101	203
3,5	25	77,05	910	8,6086	208
	35	99,80	912	8,9089	210
	15	94,87	911	9,7097	201
4	25	93,70	912	9,1091	205

	35	97,28	911	9,7097	206
	15	94,61	909	8,7087	208
4,5	25	80,06	924	17,5175	209
	35	96,10	911	9,8098	207
	15	94,60	909	8,6086	209
5	25	85,24	913	10,1101	204
	35	91,00	910	8,9089	206

Table 2. Result of the research (*Stainless Steel* Electrode)

Time Reaction (hour)	Electrical Voltage (V)	Yield Biodiesel (%)	Density (g/cm3)	kinematic Viscosity (cSt)	Flash Point (°C)
SNI		-	850–890	2,3–6,0	Min 100
	15	93,64	911	9,7097	208
3	25	91,30	913	10,6106	210
	35	88,73	911	9,3093	204
	15	87,10	907	7,4074	203
3,5	25	91,77	905	7,2072	198
	35	92,80	911	9,6096	204
	15	94,95	912	9,4094	200
4	25	95,51	906	7,8078	199
	35	92,20	909	8,9089	188
	15	94,15	910	9,6096	201
4,5	25	92,60	901	7,6076	191
	35	86,97	905	8,1081	190
	15	96,62	905	7,4074	188
5	25	88,45	908	8,4084	156
	35	88,75	912	9,9099	148

3.1 Testing of Free Fatty Acid (FFA) Content on Waste Cooking Oil

Based on the result of testing the Free Fatty Acid (FFA) content on waste cooking oil from one restaurant in Palembang, the FFA value is 1.024%. This value indicates that the waste cooking oil can be directly carried out with a transesterfication reaction with a strong base catalyst in the form of KOH. The esterification process needs to be carried out if the fatty acid content in waste cooking oil is ≥ 2% [5]. The esterification process is carried out by using a strong acid catalyst to prevent the formation of soap products during the reaction.

Table 3. Characteristics of Waste Cooking Oil

Parameter	Analysis Results	Cooking Oil Standards	Biodiesel Standards
FFA (%) value	1,024	Max 0,3	Max 0,8
Cinematic viscosity on 40^{o}C (cSt)	39,6296	-	2,3 -6,0
Density (g/cm^3)	0,944	-	850-890

3.2 Biodiesel Formation Through Electrolysis Process

The electrolysis process is carried out to convert waste cooking oil and ethanol as reactants to ethyl ester (biodiesel) with variations in reaction time, electrical voltage, and types of electrodes. Electrolysis cells are carried out to convert electrical energy into chemical energy to speed up the transesterification process. Ethanol is used as raw material because ethanol production can come from renewable materials. The addition of NaCl is carried out in the reaction to make an electrolyte solution so that the ion transfer between the anode and cathode can take place effectively. Aluminum and stainless steel are used as electrodes because they are more difficult to oxidize.

The distance between the anode and the catode is set at 3 cm because the distance between the electrodes also affects the electrolysis process. KOH compounds are used as catalysts in this process. Solid KOH is homogenized phase with raw materials so that the reaction is easier to happen by dissolving it in ethanol. This is done to accelerate biodiesel products from the process carried out. The transesterification process without the help of a catalyst requires a long time and high temperature and pressure. In the transesterification reaction, 1 mole of triglycerides will react with 3 moles of ethanol with the help of the KOH catalyst to produce 3 moles of biodiesel and 1 mole of glycerol as in equation 4.1

$$(C_{17}H_{35}COO)_3 + 3C_2H_5OH \underset{KOH}{\leftrightarrow} 3C_{17}H_{35}COOC_2H_5 + C_3H_5(OH)_3 \quad (1)$$

Reaction at the anode (aluminum electrode):

$$Al \rightarrow Al^{3+} + 3e^- \quad (2)$$

Reaction at the catode (aluminum electrode):

$$2H_2O + 2e^- \rightarrow H_2 + 2OH^- \quad (3)$$

Reaction at the anode (stainless steel electrode):

$$Fe \rightarrow Fe^{2+} + 2e^- \quad (4)$$

Reaction at the catode (stainless steel electrode):

$$2H_2O + 2e^- \rightarrow H_2 + 2OH^- \quad (5)$$

3.3 Effect of Independent Variables on Biodiesel Produced

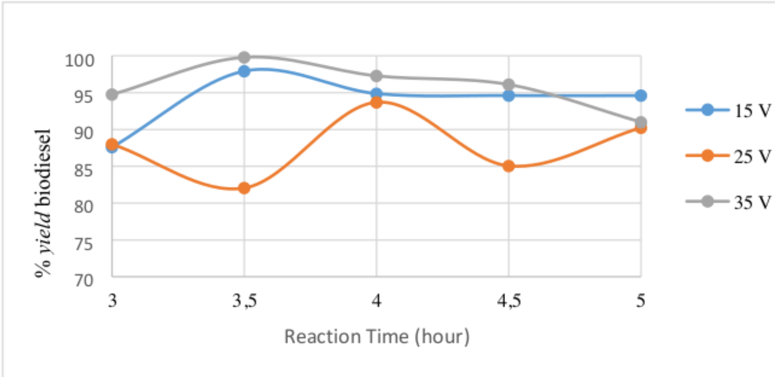

Figure 1. Effect of Reaction Time and Voltage to the Yield of Biodiesel Alumunium Electrode

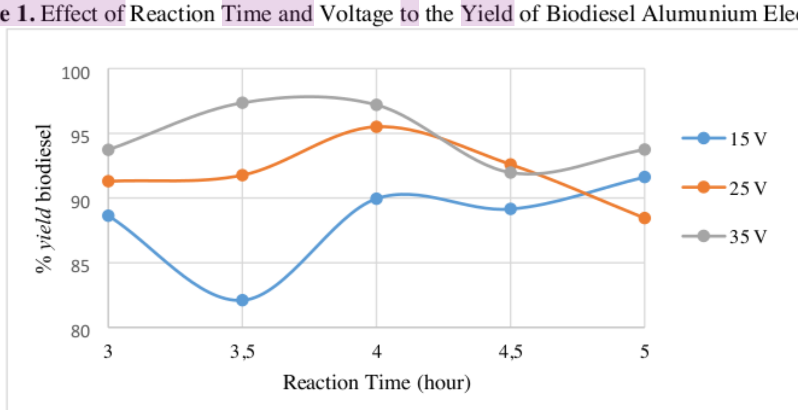

Figure 2. Effect of Reaction Time and Voltage to the Yield of Biodiesel Stainless Steel Electrode

From the above of two graphs indicate that on aluminum electrodes and the highest rated stainless steel biodiesel yield is at the 3,5 hour reaction time with an electrical voltage of 35 V. This is due to the time has reached the optimum time of reaction and the resulting hydroxyl ion (OH^-) increases in the current voltage supplied to reaction. The results showed the highest percent of biodiesel yield gained at 99,8% on aluminum electrodes with 3,5 hour reaction time and 35 V power voltage.

4. Conclusion

From research that has been conducted can be concluded that percentage of biodiesel yields tends to increase with increasing reaction time. The highest percent yield of biodiesel was obtained at a reaction time of 3.5 hours with 99.8% aluminum electrodes.

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