Effect of Different Type Catalyst on Biodiesel Production from Jatropha Curcas Oil via Transesterification using Ultrasonic Assisted

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Abstract: Biodiesel as an alternative energy can be produced through transesterification reaction from different vegetable oils such as palm oil, coconut oil, jatropha oil and other sources. Jatropha oil has 4.61% free fatty acids (FFA<5%) so the biodiesel production can be done directly by the transesterification reaction. The purpose of this study is to determine the effect of transesterification time and the type of catalyst on the yield of biodiesel obtained. The catalysts used are sodium hydroxide (NaOH), potassium hydroxide (KOH), and sodium methoxide (CH_3ONa) with a concentration of 1% mass of oil dissolved into methanol using of 1:6 molar ratio. Transesterification reaction assisted by ultrasound 35 kHz with different time of reaction (10, 15, 20, 25, and 30 minutes). The highest biodiesel yield was obtained at 30 minutes with 89,531% using KOH as catalyst. The results of physical properties such as viscosity of 5.71 cSt, density of 860.17%, and moisture content of 0.0136% have met SNI 7182-2015 standard.

1 INTRODUCTION

The depletion of fossil fuels in the near future makes the world community look for alternative energy sources (Mohandass. *et al,* 2016). Indonesia is one of the world's petroleum-producing countries, but to date is still importing fuel oil to meet fuel needs in the transport and energy sectors. Thus, the government is trying to reduce the amount of imported fuel oil by increasing the use of biodiesel to be mixed in fossil oils as diesel fuel. One of them is biodiesel used as a substitute of petroleum fuel (Kementerian ESDM, 2013). The Government of Republic Indonesia issued a Minister of Energy and Mineral Resources Regulation No. 25 of 2013 on supply, utilization and trading biofuel, which requires increased use of biodiesel in the transportation, industrial, commercial and power sectors. It is targeted that in 2013 it saved 1.3 million kilo liter of diesel fuel and 4.4 million kilo liter in 2014, in the next year there will be a decrease in diesel fuel imports by 5.6 million kilo liter (Kementerian ESDM*,* 2013). Biodiesel, is a fuel that is potentially used as a substitute for petroleum fuel. This is because of being from renewable, non toxic and biodegradable like vegetable oil . (Ji. *et al,* 2006; Deng *et al*, 2010). In addition, biodiesel / biofuel is also environmentally friendly fuels, it does not contain sulfur to reduce the environmental damage caused by acid rain (Azis, 2010). Biodiesel can be produced by the transesterification process or alcoholysis of vegetable oil or animal fats. The cost of biodiesel production is mainly influenced by the system used and the cost of raw materials. Currently, waste oil or fats are used in biodiesel production because 70 to 90 % of production costs are due to raw materials. Alternatively, overall production costs can also be reduced by optimizing the efficiency and the catalyst used (Talha and Sulaiman, 2016). The aim this process to reduce the viscosity of vegetable oil or animal fats can be applied in regular combustion engine (Prabaningrum *et al,* 2014). The alcoholysis process is the reaction between short-chain alcohol with triglyceride from vegetable oil to produce fatty acid alkyl ester (biodiesel) and glycerol as by-product (Hoque and Gee, 2013). The presence of catalysts in this process is very necessary to enhance the reaction rate and ultimately the biodiesel yield. The alcoholysis reaction is reversible and excess alcohol shifts are equilibrium to the product side (Rahmah *et al,* 2013). Many different type of alcohol can be used in this reaction, including methanol, ethanol, propanol and butanol. The general equation of

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transesterification reaction can be shown in Figure 1 below :

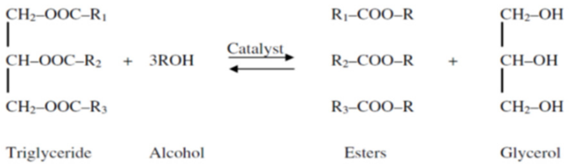
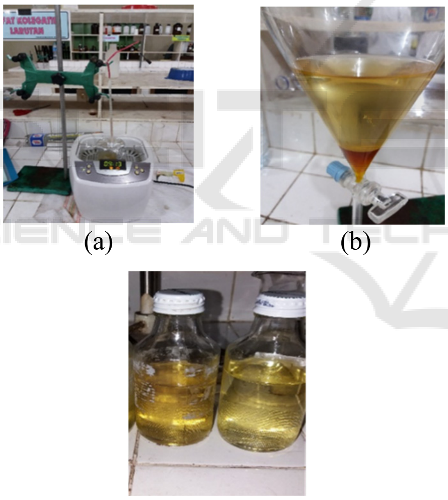


Figure 1: General equation of transesterification reaction.

Figure 1 above shown the comparison of molar ratio between triglyceride and alcohol to produce of ester (biodiesel) and also glycerol as by product.

2 METHOD

The ultrasonic apparatus as source of energy was performed to production of biodiesel in a batch reactor (Rahmah *et al,* 2013; Rahmaniah *et al,* 2013; Suryanto *et al*, 2015). The design of equipment used in this work shown in Figure 2a below :



(a) (b) (c)

Figure 2: (a). Ultrasonic equipment; (b). two phase layer product; (c). product of biodiesel.

Figure 2a shown the jatropha curcas oil as raw materials were transesterified using ultrasonic reactor assisted. In this work, KOH, NaOH and CH_3ONa was dissolved each with methanol. Jatropha curcas oil as feedstocks was taken at following reaction time 10, 15, 20, 25 and 30 minutes. Once the reaction is complete, the samples is immediately quenched in water to stop the reaction until two phases are formed. The next process, sample is washed using distilled water 3-4 times until the water layer became clear (figure 2b). The last, is the heating process to remove a lot of water in the ester as product. Finally, biodiesel can be stored (figure 2c). To calculate the percentage of yield can use the following formula:

$$Yield = \frac{Weight\ of\ Biodiesel}{Weight\ of\ Raw\ Materials} \times 100\ \% \qquad (1)$$

3 RESULT AND DISCUSSION

The most commonly used alkaline or base catalyzed transesterification are NaOH, KOH and CH3ONa. Alkaline catalyzed transesterification is more rapid than acid catalyzed and is used in the commercial production of biodiesel. Event at ambient temperature, the alkaline catalyzed reaction proceeds faster usually reaching more than 80 % a few minutes using ultrasonic assisted (Rahmaniah *et al,* 2013). This is the yield comparison of the three types of catalyst used in this work. When using NaOH as catalyst, the yield can be shown in Figure 3 as follows:

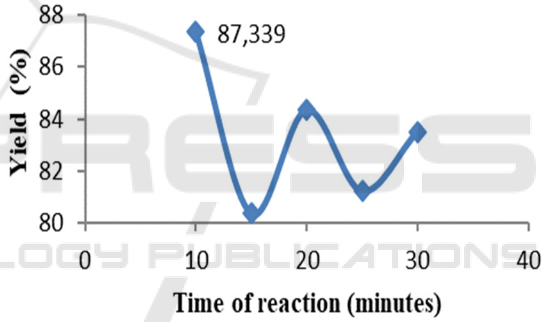


Figure 3: The yield of biodiesel using the NaOH as catalyst.

Figure 3 shown the high biodiesel yield using NaOH as catalyst, namely 87.339 % at 1 : 6 molar ratio of jatropha curcas oil to methanol and 1 % concentration of NaOH to raw materials. In this experiment, only three types of catalyst were used they were sodium hydroxide (NaOH), potassium hydroxide (KOH), and sodium methoxide (CH_3ONa).

For the biodiesel production using KOH as catalyst, the yield can be shown in Figure 4 as follows:

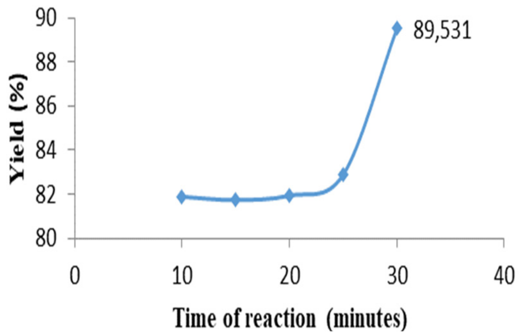


Figure 4: The yield of biodiesel using the KOH as catalyst.

Figure 4 shown the high biodiesel yield using KOH as catalyst, namely 89.531 % at 1 : 6 molar ratio of jatropha curcas oil to methanol and 1 % concentration of KOH to raw materials. The results showed that KOH gave the better yield, compared with NaOH.

For the biodiesel production using CH_3ONa as the third catalyst in this work, the yield can be shown in Figure 5 as follows:

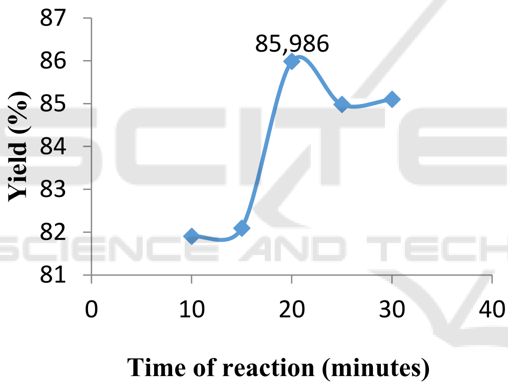


Figure 5: The yield of biodiesel using the CH_3ONa as catalyst.

Figure 5 shown the high biodiesel yield using CH_3ONa as catalyst, namely 85.986 % at 1 : 6 molar ratio of jatropha curcas oil to methanol and 1 % concentration of CH_3ONa to raw materials.

There are no significant different between these three catalyst in term of biodiesel yield. There are also no clearly reason to explain why KOH is better than other catalyst. But, there are many researchers found that types of catalyst performance are strongly dependent on raw materials used. Besides, catalysts performances were also affected by the reaction conditions.

4 CONCLUSIONS

From the results of this study, it was found that of the three types of catalyst used, KOH produced the highest yield of 89.53 %, while the use of ultrasonic assisted in the transesterification reaction give the impact of reaction time reduction compared of conventional process which can take between 2-4 hours. Results of the physical biodiesel properties namely of the 5.71 cSt viscosity, density of 860.17 % and moisture content of 0.0136 % has met SNI 7182-2015 standard.

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