The effect of microwave power on the production of biodiesel from nyamplung

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Abstract. Today, energy needs in Indonesia still rely on fossil energy sources that its availability in the world is increasingly depleted. Therefore, the research for alternative energy of petroleum must be developed, one of them is biodiesel. The use of microwave as energy source of biodiesel production can speed up the reaction time. So the microwave is considered more efficient. Seeds of nyamplung has an oil content of 71.4% (w/w) by weight. With the oil content of the nyamplung seeds has great potential when used as a raw material for biodiesel production. The aim of this research to study the effect of microwave power on the production of biodiesel from nyamplung oil. Microwave power affects density, viscosity and yield of the product. The used of alkali catalyst, with higher the power, the lower the density and viscosity of the resulting product, but the resulting yield is 300 W. The power of more than 300 W is the opposite, resulting in the production of biodiesel using the optimum base catalyst at 300 W power.

1. Introduction

Along with economic growth, population, regional development and development from year to year, the need for energy needs of all sectors of the national energy users are also getting bigger. Books based Energy Security Indonesia (2014) states that fuel consumption increased rapidly from about 167.2 thousand kl/day (kl/d) in 2009 to 197.4 thousand kl/d, an increase of 18.1%, an increase in 5 years fuel consumption of 30.2 thousand kl/d. Increased consumption of fuel, especially gasoline and diesel due to the number of vehicles has increased every year.

In general reserves and the age of the national renewable energy resources are as follows:

| Name       | Availability  | Production     | Remain (Year) |
|------------|---------------|----------------|---------------|
| Crude Oil  | 4.7 billion barel | 1,126 million barel/day | 15            |
| Natural Gas| 9.3 TSCF      | 2.6 TSCF/tahun  | 35            |
| Coal       | 4,968 billion ton | 81.4 million ton/tahun | 61            |

Source: Statistical Review of World Energy, 2005

Seeing the decreasing availability of petroleum and the increasing level of oil consumption coupled with the amount of imported fuel by Indonesia greater than exports, so it needs an alternative source of renewable energy so that the achievement of national energy security [1].
The potential of new and renewable energy is very significant. Indonesia has the potential of energy resources vary considerably. There are 75,091 MW geothermal, 29,164, mini / micro hydro 769.69 MW, biogass 2.3 million BOE, municipal waste 3,000 MW, solar power 480 kwh / m2 / day, wind 3-6 m / s and fuel vegetable 161.5 million BOE, (Director General of New and Renewable Energy and Energy Conservation EMR). But in use, need to pay attention to the concept of sustainable development is a development concept on the basis of value-adding resources. Therefore, it is necessary to develop Biofuel which is a government policy through presidential Instruction No. 1 of 2006 accompanied by Energy Minister Regulation No. 25 of 2013 on the use of biofuel. In the candy there is an obligation to use biofuels to fuel distributed to meet the needs of domestic energy such as biodiesel. The advantage of biodiesel is one of the alternative fuels that are environmentally friendly because biodiesel can reduce exhaust emissions of carbon monoxide and carbon dioxide and free sulfur content compared with that of other petroleum diesel [2].

Raw materials biodiesel are vegetable oils one of them is derived from seeds nyamplung plant. Nyamplung plant is a wild plant that grows in Indonesia, growing around the coast. This plant is usually only used for timber construction needs, furniture and others. Some of the advantages of biodiesel produced from nyamplung are nyamplung oil content is high compared to other types of plants (jatropha 40-60%, Sawit 46-54%, and Nyamplung 40-73%), some parameters have met Indonesian biodiesel quality standards, seed oil Nyamplung has a fuel two times longer than kerosene [3]. Nyamplung seed oil is a potential renewable energy resource as a basic material of biodiesel without having to compete with food needs [4]. Previous research results indicate that heating using microwave radiation in organic chemical synthesis takes a relatively short time compared to conventional heating [5].

Objective of research is to study the effect of microwave power on the production of biodiesel from nyamplung oil. The transesterification reaction in this study was conducted in batch. Batch transesterification process is better than continuous process. The batch process is easy in controlling the reaction and does not require many equipments. In addition, the heating process of transesterification uses microwave radiation (microwave) which has different characteristics with conventional heating.

2. Material and methods

2.1 Materials and chemicals
Nyamplung oil which will be used as feedstock in the manufacture of biodiesel is obtained from PT. Samino biofuel. Methanol is used as a binder compounds of non-lipid in the extraction process and as reagents for transesterification reactions with levels 98%, The catalyst KOH is a catalyst used during the transesterification process using microwave.

2.2 Transesterification Method
In employing solvent-free microwave extraction, we used a domestic microwave oven (EMM-2308X, Electrolux, maximum delivered power of 800 W) with wave frequency of 2450 MHz. The dimensions of the PTFE-coated cavity of the microwave oven were 48.5 cm × 37.0 cm × 29.25 cm.
Transesterification is a major step in the process of making biodiesel as it aims to convert triglycerides contained in vegetable oils into Fatty Acid Methyl Ester (FAME) or biodiesel with glycerol byproducts.

First a mixture of methanol - a catalyst in according to variables are prepared, add acid catalyst with concentration according to variable, Running microwave radiation process in microwave oven with power and time of radiation according to variable are added with stirring using magnetic stirrer, Wash the solution using hot aquades (temperature 60 °C) inside the separator funnel, stop the heating and cooling the mixture separating the precipitate entering the reaction product into a separating funnel add the n-hexane to form three layers. Layer on FAME, the middle layer and bottom layer residual methanol in the form of glycerol, take the top screen and wash 3x with distilled water, biodiesel has been separated washed into the oven at 110 °C.

3. Results and discussion

3.1 Effect of microwave power on yield

Biodiesel yield is a comparison between the mass of biodiesel (FAME) produced (transesterification product) with the mass of nyamplung seed oil prior to esterification. The data (biodiesel mass) obtained from the experiment is not purely biodiesel due to impurities during the process.
Selection of 1% (w/w) base catalyst concentration as the best basic catalyst concentration (optimal) of the three catalyst concentration variables tested, since it yielded the largest yield in each radiation time. From the results of this trial which is represented on both images, the data pattern formed on the power and yield relationship, from 150 W to 300 W power occurs yield increases, whereas from 300 W to 600 W yields tend to decrease. At a power above 300 W, the reactant becomes hotter and methanol evaporates more frequently to meet the reflux condenser so that the contact between methanol and oil at a power above 300 W is less frequent compared to lower power. If using an alkaline catalyst, the use of power above 300 W, will cause a saponification reaction. As in some existing studies, on an alkaline catalyst, too high a temperature will decrease the yield of biodiesel due to a side reaction (saponification).

3.2 Effect of Microwave Power on Product Density
Density is the ratio of the mass amount of a substance to its volume at a certain temperature. The lower the temperature, the biodiesel will be higher and vice versa. The presence of glycerol in biodiesel affects the density of biodiesel because glycerol has a fairly high density (1.26 g/cm³). So if glycerol does not separate well from biodiesel, then the biodiesel density will increase. The seed oil of nyamplung was measured using 5 ml pycnometer. Density limit permitted by SNI 04-7182-2006 (0.850-0.890 g /ml at 40 °C).

Figure 2. Effect of amount of catalyst to the biodiesel yield at 30 minutes.
Figure 3. Effect of microwave power on product density with optimum catalyst Concentration 1% (w/w) oil with NaOH catalyst

Selection of 1% (w/w) base catalyst concentration as the optimum catalyst concentration of the three catalyst concentration variables tested. From these two figures, the data pattern formed on the power and density relationship, at 300 W power drops density of 150 W, whereas from 300 W to 600 W the biodiesel density increases. At 450 W and 600 W, the reactant faster to become hot and methanol more often evaporates to meet the reflux condenser so that the contact between methanol and oil on both power is less frequent than the lower power (150 W and 300 W). Since the contact between oil and methanol is rare, the conversion of triglycerides in oil to biodiesel is also low, resulting in increased density in transesterification products. In addition, the use of power above 300 W (high temperature), if using an alkaline catalyst, will cause saponification reaction. The presence of saponification reactions leads to an increase in product density. Ramadhas states that in the transesterification process of making biodiesel, will be produced methyl ester and glycerol. In the event of a saponification reaction in the transesterification process, the resulting biodiesel is more difficult to separate with glycerol. Glycerol, which is incorporated in biodiesel, causes the density in biodiesel to become larger, making it look more turbid [6].

3.3 Effect of Microwave Power on Product Viscosity
Nyamplung seed oil has a high kinematic viscosity, which is 53.4 cSt. (The Ministry of Forestry of the Republic of Indonesia (The Forestry Research and Development Agency.) 2008). Given the transesterification of nyamplung seed oil into biodiesel, there will be a decrease in its kinematic viscosity. Where SNI 7182-2012 complies, the viscosity standard in biodiesel is 2.3-6.0 cSt. From the tests conducted on standard biodiesel (80% biodiesel and 20% diesel) the viscosity was 3.70 cSt. Where the value of this viscosity will be used as a reference in the analysis of this study.
Selection of 1% (w/w) base catalyst concentration as the best basic catalyst concentration (optimal) of the three catalyst concentration variables tested. From these two figures, the data pattern formed on power and density relationships, from 150 W to 300 W power, decreases viscosity, while from 300 W to 600 W the viscosity of biodiesel tends to increase. As in some existing studies, on an alkaline catalyst, excessively high temperatures will increase the viscosity of biodiesel due to side reactions (saponification). Ramadhas[6] stated that in the transesterification process of making biodiesel, will be produced methyl ester and glycerol. In the event of a saponification reaction in the transesterification process, the resulting biodiesel is more difficult to separate with glycerol. The glycerol in the biodiesel results in greater product viscosity, making it more turbid [6].

4. Conclusion
Microwave power affects the density, viscosity and yield of biodiesel production. For an alkaline catalyst, the higher the power the lower the density and viscosity of the product, but the higher the power the higher yield of the product. The power of more than 300 W is drop, resulting in the production of biodiesel using the optimum base catalyst At 300 W power. The highest yield on 300 watts of power is 96 % with a reaction time of 60 minute.

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