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Microwave Assisted to Biodiesel Production From Palm Oil In Time And Material Feeding Frequency

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Abstract: Biodiesel (methyl esters) production from vegetable oil has commonly used. This study has the objective to produce biodiesel from palm oilassisted microwaves system in reaction time and material feeding frequency variations. Heating using a microwave is a quick and simple because it just takes several minutes or seconds that the biodiesel process production takes place. In comparation with the conventional process that takes 75 minutes to get complete reaction, the microwave assisted process only takes 4 minutes. Irradiation time should be controlled to avoid overheating which could destroy some organic molecules and radiation power setting should not be too high because it can destroy organic molecules too. Microwaves used was 12.2 cm wave length with a frequency of 2.45 GHz. Transesterification performed using KOH catalyst as much as 1% of the raw material oil. Methanol and oil ratio is 6. Variations performed on the feeding frequency material (1.2, 4 and 8 times) and reaction time (2, 4, 6, 8 and 10 minutes).Microwave irradiation assisted for biodiesel production has more efficient in time and energy. It produces large enough yield that the best results feeding frequency of materials is 2 times in 10 minute that give 97.06% yield and 94,01% reaction conversion. Increasing reaction time will increase yield and conversion. Increasing feeding frequency of material will reduce the risk of overheating which can damage organic compounds but decrease yield and conversion.
Keywords : biodiesel, palm oil, microwave, time, material feeding frequency.

1. Introduction

Diesel fossil fuel reserves dwindling and at a time will run out. Biodiesel is a potential fuel to replace diesel fuel, because it can be produce from renewable sources, vegetable oils or animal oils. The advantage of using this alternative fuel is better emissions, biodegradability, and do not contribute to increased levels of CO_2 in the atmosphere[1]. Biodiesel is one type of biofuels (liquid fuels from oil processing plants and animals) in addition to bioethanol. Biodiesel is an alkyl ester compound that is produced through the process of alcoholysis (transesterification) between triglycerides with methanol or ethanol with the aid of a base catalyst into alkyl esters and glycerol, or esterification of fatty acids (free) with methanol or ethanol with the aid of a base catalyst into alkyl esters and water.[2]

Transesterification is a reversible reaction, wherein triglyceride changed completely into diglycerides, monoglycerides, and finally into glycerin. Stoichiometrically, 3 moles of alcohol required for one mole of triglyceride, but in practice required a greater proportion of it to shift the equilibrium resulting ester more.

When the transesterification process has been widely used and are important, there are several considerations inefficiencies in the current transesterification process. In the conventional heating for the transesterification process (batch process, continuous, and supercritical methanol), heat energy is transferred by convection, conduction, and radiation from the surface to the raw material. Thus, the conventional heating consumes more energy and takes a long time for preheating and reaction, optimally an hour to produce biodiesel yield of 95%[3].

The use of microwaves as a fast and simple way to manufacture Biodiesel, the area of microwave radiation lies between infrared radiation and radio waves. Microwaves have wavelengths of 1 mm - 1 m with a frequency of between 0.3 to 300 GHz. In general, in order to avoid interference, microwave equipment is usually arranged with a wavelength of 12.2 cm with a frequency of 2.45 GHz[4]. Heating with microwave heating is more advantageous when compared to conventional methods, where the heating is very slow and inefficient due to the transfer of energy to the material depends on the flow of convection and thermal conductivity of the reaction mixture.In the present study carried out the manufacture of biodiesel by using microwaves as a batch.

The scope of this research is to find the efficient biodiesel production process assisted microwave in which many variables as percent of power used, temperature, feeding material frequency, the mole ratio, reaction time, and catalyst. The time and feeding material frequency variations in the heating of the biodiesel conversion had taken for our research.

This study has the objective to produce biodiesel from palm oil assisted microwaves system in reaction time and material feeding frequency variations to increase transesterification yield and conversion.

2. Materials and Methods

Data collecting from the laboratory experimental and the result analysis using TLC (Thin Layer Chromatography) and GC-MS (Gas Chromatography Mass Spectrometry) to identify the components on biodiesel,

The materials used are vegetable oil, acetic acid, ethyl acetate, penolptalein indicator, Iodine, potassium hydroxide technical, technical methanol, n-hexane. This study was conducted using a microwave brands Neovance with 900 Watt power. Power is set at 20%. The vegetable oil is palm oil Bimoli brandedfor 50 grams. Transesterification performed using KOH catalyst for 1% from the raw material oil. Methanol and oil ratio is 6. Variations performed on the feeding frequency of material (1.2, 4 and 8 times) and reaction time (2, 4, 6, 8 and 10 minutes).

Vegetable oil, methanol and catalyst are incorporated into the glass beaker and stirred evenly using a magnetic stirrer. The solution was put in a microwave which has in its set. Transesterification performed in the microwave for 2 minutes and feeding frequency of materials 1, 2, 4 and 8 times revenue. Frequency setting material feedconducted by inserting and removing the material as much as 1, 2, 4 and 8 times within 2 minutes such. The final result of transesterification removed and separated from the glycerol by gravity in the separating funnel. Crude biodiesel was washed with water until the washing water remains clear. This procedure is repeated for a reaction time of 4, 6, 8 and 10 minutes.

3. Results and Discussion

Vegetable oil as raw materials had lower levels of free fatty acids (FFA) 0.021218% so it can be directly carried out the transesterification process (esterification step is not required). The results of transesterification using a microwave irradiation can be seen in Figure 1.

According to Figure 1, for 2 minutes reaction, the feeding material frequency are 1, 2, 4, 6, and 8 times give the reaction yield 91.38%; 90.73%; 89.48%; 86.90%; 88.96%. It can be seen that at the same time (eg 2 minutes) the yield decrease with increasing frequency of feeding materials reactions due to the methanol as reactant, evaporate during the process so that the yield decreased. While the once frequency of feeding material revenue at 2, 4, 6, and 8 minutes respectively obtained that reaction yield as much as 91.38%; 95.14%; 96.42%; 95.68%. The yield increased for increasing reaction time. At a reaction time of 1 minute for the first time revenue feeding frequency material, no result because the reaction process by microwaves was stopped at the time of 9 minutes. This cause that in the 9 minute, the sample in the vessel was going audible ripples of the last reactor tetupan louder and often heard in the 9th minute 10 seconds. Therefore it was decided to stop the reaction process to prevent damage to the equipment and materials used in the study. So that the irradiation time should be controlled to avoid overheating which could destroy some organic molecules that can cause damage to organic molecules[5]. The best yields were obtained at 97.06% obtained at minute 10 on the frequency of material income 2 times. The greatest results in a study done by Refaat and Sheltawy (2009) amounted to 99.63% with variable 1% KOH as catalyst, the molar ratio ratio of methanol: oil = 6: 1, the temperature of 65^0C, with a time of 2 minutes, and a power of 500 Watt , In comparison with Refaat and Sheltawy (2009) which uses a special microwave reaction types Start S (Milestone) Milestone Inc. For using domestic microwave, the biodiesel yield is high enough comparing by special microwave mentioned above..

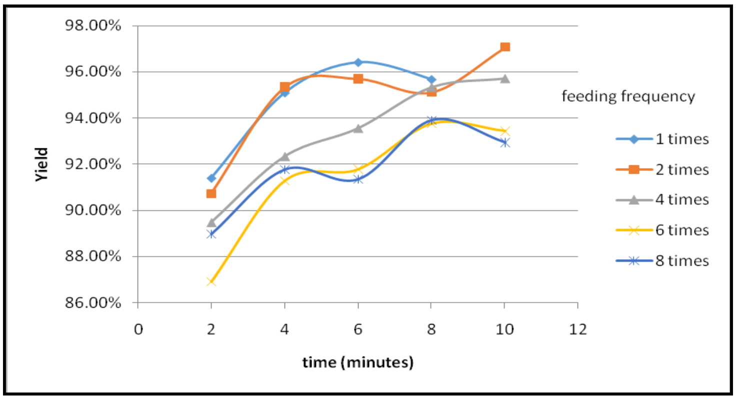

Figure1.Effect of reaction time to biodiesel yield

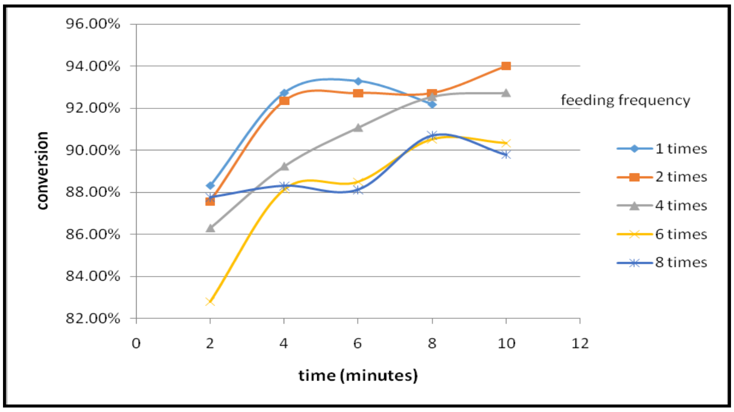

Figure 2.Effect of reaction time to biodiesel conversion

The conversion calculations use glycerol weight as reference because the product consist of several types of methyl esters that is diificult to analyze. So, glycerol is most easily separated component from methanol through evaporation. In figure 2, the reaction conversion decrease with increasing feeding frequency. While the frequency of the same ingredients contained revenue increase in conversion with increasing reaction time. The best conversion material is obtained at feeding frequency of 2 times revenue with a time of 10 minutes. On the revenue frequency 1 time with 10 minutes of the data obtained in the case because of overheating so that the reactionwas stopped.

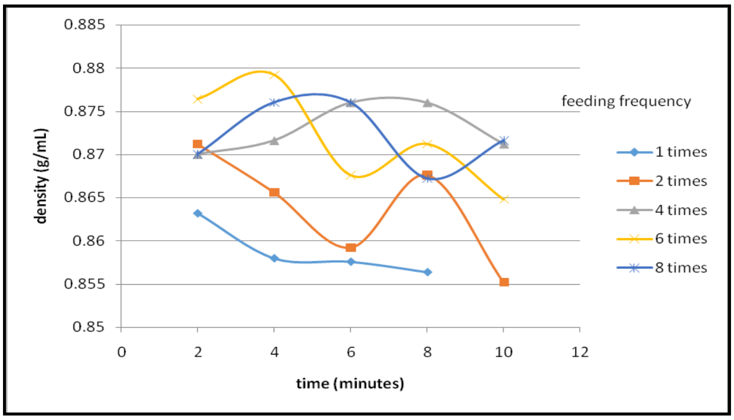

Figure 3.Effect of reaction time to biodiesel density on 40^0C

In figure 3, the viscosity of the reaction products obtained at a temperature of 40^0C the reaction products meet the standards of quality biodiesel SNI 04-7182-2006. Wherein the viscosity of biodiesel based SNI 04-7182-2006 at 40^0C in units of g/mL is from 0.85 to 0.89.

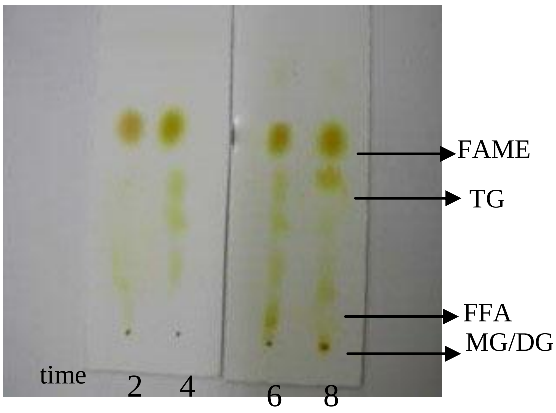

Figure 4. TLCanalysis foronce feeding

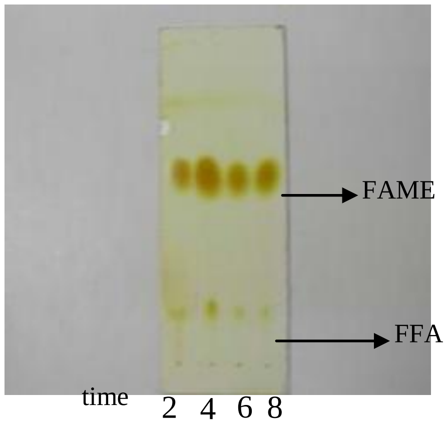

Figure 5. TLC analysis for twice feeding

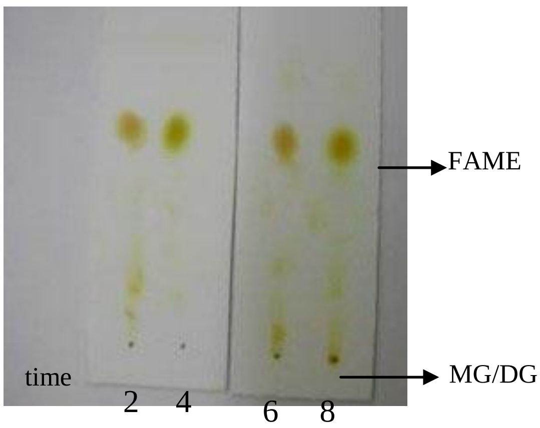

Figure 6. TLC analysis for 4x feeding

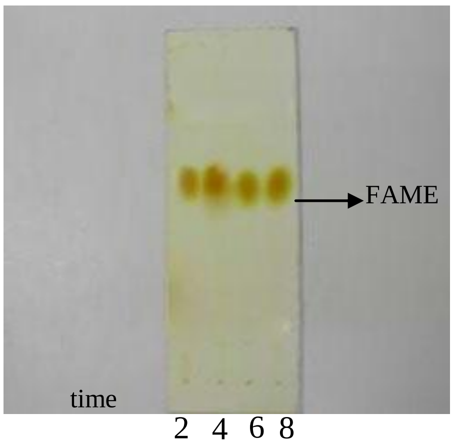

Figure 7. TLC analysis for 6x feeding

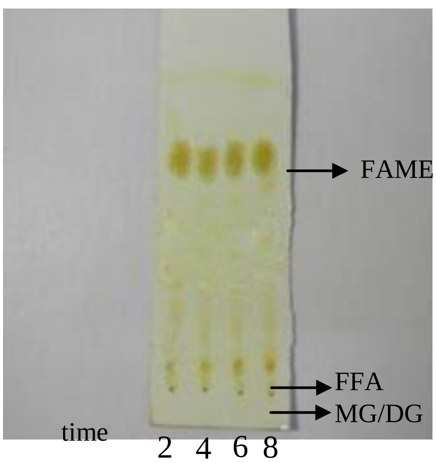

Figure 7. TLC analysis for 10x feeding

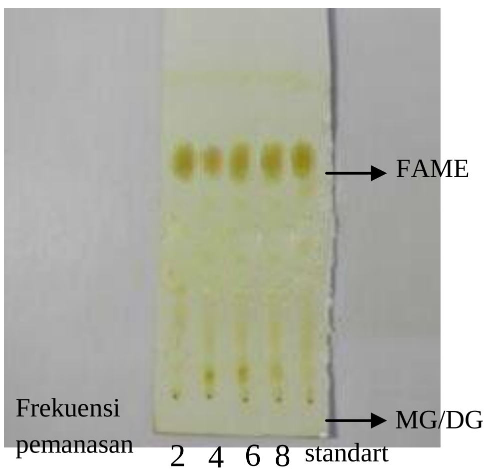

Figure 9.TLC analysiscomparison with standard biodiesel

From figure 4 until figure 9, TLC analysis results showed that the product sample containing methyl ester (FAME) with smaller amounts of Free Fatty Acid (FFA), monoglycerides (MG), triglycerides (DG) and triglycerides (TG).Maximum distance solvent riseis 7.2 cm from starting line, distance for biodiesel (FAME)

4.5 cm, triglycerides (TG) 3.6 cm, diglycerides (DG) 1 cm, monoglycerides (MG) 0.9 cm, and free fatty acids (FFA) 1.3 cm. Rf values for biodiesel (FAME) is 0.625; triglycerides (TG) is 0.5; diglycerides (DG) is 0,138; monoglycerides (MG) is 0.125; and free fatty acids (FFA) is 0.180. From the resulting value is not the same Rf value of the biodiesel standard, but they have a similar value. This result can be due to lack of accuracy in the measurement. Biodiesel standard is used in the preliminary study results, which are treated in long time reaction so that it can be assumed a complete reaction.

Table2.GCMS Biodiesel Component Analysisfor 2 timesof feeding,10 minutes

Peak#	R.Time	Area	%Area	Component
1	3.713	28613	1.09	Methyl myristate
2	6.033	32026	1.22	Myristic acid
3	7.731	8138	0.31	Lauric acid
4	11.873	786725	29.97	Methyl stearate
5	15.893	9983	38.03	Methyl palmitate
6	16.318	723199	27.55	Methyl oleate
7	17.336	16013	0.61	Methyl linoleate
8	19.834	32288	1.23	Linoleic acid
Total area		2625304	100	

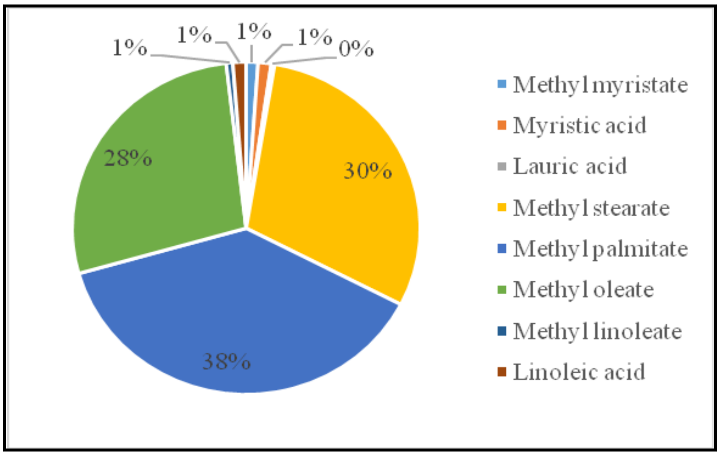

Figure 10.Biodiesel component analysis from GCMS

Product with highest yield according to TLC analysis, analyzed by GC-MS. Based on the results of the GC-MS analysis on a sample twice feeding frequency in 10 minute showed that the reaction results containing methyl esters. With methyl ester contents consist of methyl myristate, methyl stearate, methyl palmitate, methyl oleate and methyl linoleate. And residual acid consisting of myristic acid, genitalia acid, and linoleic acid

4. Conclusion

Microwave irradiation assisted for biodiesel production has more efficient in time and energy. It produces large enough yield that the best results feeding frequency of materials is 2 timesin 10minute thatgive 97.06% yieldand 94,01% reaction conversion. Increasing reaction time will increase yield and conversion. Increasing feeding frequency of material will reduce the risk of overheating which can damage organic compounds butdecrease yield and conversion.

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