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BIODIESEL FROM NYAMPLUNG (*CALOPHYLLUM INOPHYLLUM*) SEED OIL WITH A TRANSESTERIFICATION PROCESS USING A CONTINOUS FLOW SYSTEM IN THE REACTOR

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Abstract

Biodiesel production from *calophyllum inophyllum* be obtained via esterification and transesterification, using two continuous reactors with catalyst NaOH at a concentration (0.4 ;0.6,0.8; 1) wt%, *calophyllum inophyllum* seed oil and reaction temperature (40, 50,60)^{o}C. This research was to determine the effect of catalyst amount and reaction temperature on transesterification of calophyllum inophyllum seed toward *yield Fatty Acid Methyl Ester* . The last step is analysis yield of *Fatty Acid Methyl Ester* with *Gas Chromatography* (*GC*). The highest yield is obtained on the amount of 1% NaOH catalyst and at a temperature of 60^{o}C with yield of 87.036%.

Keywords **;** FAME, *calophyllum inophyllum* seed.

1. INTRODUCTION

Biodiesel in general is a diesel engine fuel made from renewable or specifically a diesel engine fuel consisting of alkyl esters of fatty acids. Biodiesel can be made from vegetable oil. Biodiesel is expected to replace diesel as a base for diesel engines. The advantages of biodiesel is *cetane number* higher than the current diesel fuel, exhaust gases from burning biodiesel is more environmentally friendly because it contains almost no SOx gas, better engine acceleration, and lighter pull (Nazef et al,2007). *Calophyllum inophyllum* seeds can be converted into biofuel with a high *yield* (estimated at 65%) and its use is not believed to be competing with an interest in food. Its plants grow and spread evenly *calophyllum inophyllum* naturally in Indonesia, easy regeneration and fruit throughout the year that showed a high survival ability of the environment (Ajie Rahmansyah, 2009) .

2. METHODOLOGY

This research is divided into several steps. The first stage is a preparatory phase which aims to get as much *crude* oil *calophyllum inophyllum* seed - which includes many mechanical presses calophyllum inophyllum seeds and gum removal. In the pressing process carried out using screw press by separating the seeds calophyllum inophyllum meat with shell beans, followed by drying the seeds calophyllum inophyllum under the sun for ± 1 week. And pressing using a screw press *calophyllum inophyllum* seed. In gum removal process is done by heating the 300 ml seed oil *calophyllum inophyllum* until a temperature of 50^{0}C with a hot plate (heater) was then added H_3PO_4 by weight ratio of 0.5% by weight of the seed oil and heating oil *calophyllum inophyllum* back while stirring for 30 minutes. After that separates calophyllum inophyllum seed oil (top layer) with no dissolved impurities contained in oil (bottom layer) in the separator funnel. The second step is esterification reaction, performed at a temperature of 60^{0}C with methanol (molar ratio of oil: methanol at 1: 6) and tested the FFA during the esterification process took place which aims to determine the value decreased FFA levels in raw materials. To the resulting decrease in FFA levels based on an analysis done of at t = 0 min value of% FFA of 0.23 ± 5.64% to 1.95% ±0.084 at t = 120 minutes at the end of the esterification process so that oil can be processed for the next stage. After that the esterified oil is separated using the separator funnel with settling for 12 hours, to form two layers of the upper layer is a residual methanol, water, residual catalyst (H_2SO_4) and the bottom layer is pretreated oil (methyl esters and triglycerides), then the bottom layer will be used for the transesterification process. The third step is transesterification process in two continuous reactors, followed by entering a solution of

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sodium methoxide (CH_3ONa) and the pretreated oil into their respective storage tank and set the flow rate of feed into the reactor. After the reaction mixture continuously at temperatures as variable (40^0C, 50^0C, 60^0C) for 45 minutes. Next to the separation of biodiesel products (*crude* FAME) and glycerol by using a separator funnel. The next step is the purification process of washing biodiesel is carried out by measuring the volume of crude biodiesel that is formed from the transesterification process and then wash with warm water (±60°C) by 30% by volume of biodiesel. After that do the stirring with a stirrer for 5 minutes, then separates FAME and impurities with a separator funnel. Desired product is located on the top, and bottom layer which is the remaining impurities and their reactants are removed. The washing process is done several times until the washing water is not turbid. After that reduce the water content in biodiesel by heating it to temperature around110^oC for 10 minutes. The process was stopped after FAME looks more clear color and have not seen more water content in biodiesel. And for the last step is analysis of ester content and the *yield* of *FAME* by using Gas Chromatography (GC).

3. RESULT AND DISCUSSION

Biodiesel product were analyzed *yield* by using the tools of gas chromatography (GC). Type of Gas Chromatograhy (GC) used was Chromatograhy Gas (GC) - 7900 with column diamensions namely TM-5 x 0.53 mm x 1 µm. Compounds used in this analysis of compounds myristic, palmitic, linoleic, oleic, and stearic metyl ester. Fig 1. A set of tools transesterification Caption : 1.Transesterification reactor stirred ; 2. The oil storage tank; 3.The storage of methanol + NaOH; 4.Underpinnings; 5.Heating jacket; 6.Outflow valve reactor;7.Temperature indicator; 8.Stative and clamp holder; 9.Pump; 10.Power button; 11.Temperaturecontrol; 12. Stirrer motor; 13.Power supplay motor.

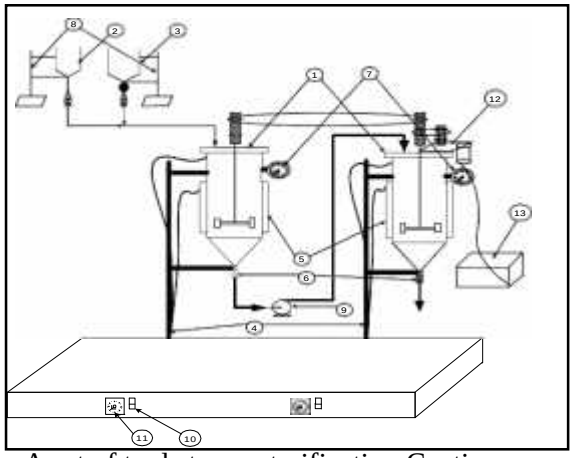

Fig 1. A set of tools transesterification Caption :

Table 1

Influence of concentration of (NaOH) catalyst to *yield* FAME at a temperature of 60^oC

No	Concentration of NaOH catalyst (% wt oil)	Mass Material (g)	Mass Product (g)	*Yield* (%)
1.	1	262,867	230,703	87,036
2.	0,8	262,867	185,726	68,806
3.	0,6	262,867	166,561	58,499
4.	0,4	262,867	157,163	53,317

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Table 2
Influence of concentration of (NaOH) catalyst to *yield* FAME at a temperature of 50^{o}C

No	Concentration of NaOH catalyst (% wt oil)	Mass Material (g)	Mass Product (g)	*Yield* (%)
1.	1	262,867	222,984	83,108
2.	0,8	262,867	183,354	66,416
3.	0,6	262,867	161,534	56,290
4.	0,4	262,867	154,305	52,187

Table 3
Influence of concentration of (NaOH) catalyst to *yield* FAME at a temperature of 40^{o}C

No	Concentration of NaOH catalyst (% wt oil)	Mass Material (g)	Mass Product (g)	*Yield* (%)
1.	1	262,867	197,053	69,863
2.	0,8	262,867	178,115	60,899
3.	0,6	262,867	160,591	52,369
4.	0,4	262,867	147,652	43,022

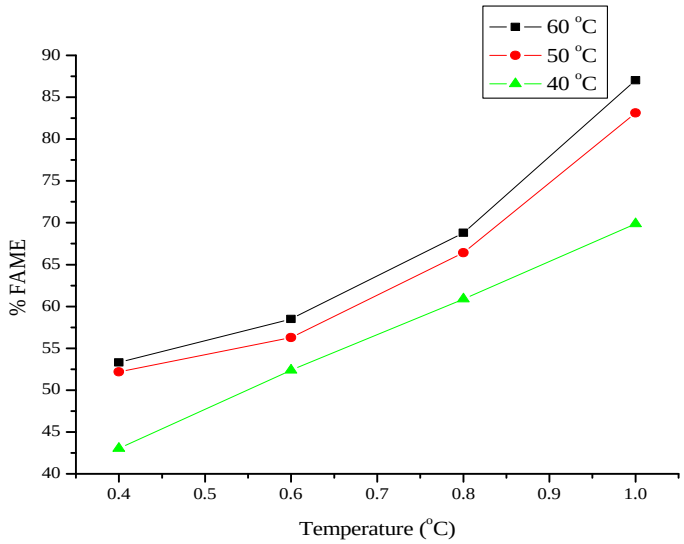

Figure 2 Trial

The addition of base catalyst carried on the process of making crude transesterification of seed oil FAME calophyllum inophyllum. Base catalyst used is sodium hydroxide (NaOH) with variable concentrations of catalyst (0.4, 0.6, 0.8; 1)% wt calophyllum inophyllum results esterified seed oil. Of these variables, NaOH will be dissolved into methanol (molar ratio oil: methanol is 1:6) to make sodium methoxide into

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the oil before it is reacted in the process of transesterification. The process of transesterification reactions carried out using two continuous stirred reactors mounted in series. Addition of base catalyst was carried out in the transesterification process of making crude FAME from nyamplung seed oil. The base catalyst used was sodium hydroxide (NaOH) with a catalyst variable concentration of (0,4; 0,6; 0,8; 1)% wt of dried seed oil as a result of esterification. From these variables, NaOH will be dissolved into methanol (molar ratio of oil: methanol which is 1: 6) to make a solution of sodium methoxide before it is reacted into the oil during the transesterification process. The process of transesterification reaction is carried out by using two stirred continuous reactors installed in series, indicating that the greater the addition of the catalyst, the higher the level of ester contained in crude FAME. The reaction temperature is very influential on the process of making crude FAME, the large or small temperature of the reaction given will affect the yield produced. In this study the transesterification reaction was carried out in two stirred continuous reactors arranged in series which operated at a certain temperature, while the reaction temperature variables used were 40°C, 50°C, and 60°C, from the results obtained, it can be seen that the optimum reaction conditions are the reaction at 60°C this is because at a temperature of 60°C is the temperature where it has approached the boiling point of methanol which is equal to 64.5 °C so that methanol can react entirely so that it can give the maximum ester yield so that it will increase the conversion value of the reaction

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