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Study On Reaction Kinetics Transesterification Coconut Oil By Using The Catalyst NaOH PLUG Flow Reactor (PFR)

Hadi Saroso
Department of Chemical Engineering, State Polytechnic of Malang
Jl. Soekarno Hatta PO Box 04 Malang, Indonesia, 64145
s.hadisaroso@yahoo.com

***Abstract* – Transesterification reaction of vegetable oil into biodiesel (methyl ester) typically use a batch reactor. This study used a type of plug flow reactors Reactor (PFR) using NaOH catalyst and methanol with palm oil feedstock. This reactor has the advantage can stream continuously feeds. Transesterification process stages in this study conducted by flowing oil and methanol continuously in a reactor in the form of a hose pipe along 17 m included in waterbath. The reaction temperature of 60 ° C, the feed flow rate of 15 mL / min, 20 ml / min, 25 ml / min and the concentration of methanol in the oil by 20%, 25%, 30%, 35% (w / w of oil). The resulting products were analyzed by GC and then obtained the highest FAME% at 90.75% at a flow rate of 25ml / min and a methanol concentration of 25% w / w of oil amounted to 90.75%. Then obtained for the transesterification is reaction is of first order and obtained k = 0.00223 s-1, -rA = 0.00223.**

***Keywords* – Biodiesel, Coconut Oil, Continuous Transesterification, Plug Flow Reactors.**

I. INTRODUCTION

Fuel oil (BBM) is still the main energy source in Indonesia. Based on government data needs Indonesia's energy consumption in 2010 reached 3.3 million barrels of oil equivalent per day. It is estimated that 15 years later, it would need to triple or 7.7 million barrels of oil equivalent per day [1]. Therefore if you want to suppress the amount of use of fossil fuels, then the way is to reduce the use of diesel fuel by switching to biodiesel.Biodiesel an alternative fuel from renewable raw materials (renewable).

The scope of the problem of this research is to learn about the making of biodiesel from palm oil. Limitation of problem in this research is to investigate the reaction kinetics% FAME and palm oil into biodiesel transesterification with variable feed flow rate and the concentration of methanol using a flow reactor pipe (Plug Flow Reactor).

Formulation of the problem in research is how the results of making biodiesel from coconut oil using a flow reactor pipe (Plug Flow Reactor), the influence of feed flow rate and the concentration of methanol on the results of biodiesel obtained, how coconut oil transesterification reaction kinetics using a flow reactor pipe (Plug Flow Reactor). The purpose of this research is to know the result of making biodiesel from coconut oil using a flow reactor pipe (Plug Flow Reactor), determine the effect of feed flow rate and the concentration of methanol on the results of biodiesel obtained, knowing the kinetics of the transesterification reaction of palm oil using the rector of the flow pipe (Plug Flow reactor).

Biodiesel is one type of biofuels (liquid fuels from processing plants) in addition to Bio-ethanol. Biodiesel is alkylester compound produced through the process of alcoholysis (transesterification) between triglycerides with methanol or ethanol with the aid of an alkaline catalyst into alkyl esters and glycerol; or esterification of fatty acids (free) with methanol or ethanol with the aid of an alkaline catalyst into alkyl esters and water. Coconut oil is an ester of glycerol and coconut oil. Fatty acid based fatty acids are classified into the oil lauric acid, as lauric acid content is greatest when compared to other fatty acids.

Transesterification is the reaction between fats or other material which contains a fatty acid ester with fatty acids, alcohols, esters or other followed by the exchange of fatty acid groups to produce new esters.

Things that affect the transesterification reaction include:

a. Effect of water and free fatty acids
   Transesterified vegetable oils will have to have acid numbers smaller than 1.
b. The influence of alcohol with a molar ratio of raw materials
   Stoichiometric, amount of alcohol needed for the reaction is 3 moluntuk every 1 mole of triglyceride to obtain 3 moles of alkyl ester and 1 mol general gliserol. Generally shown that the more the amount of alcohol used, the conversion obtained will also increase. The best comparison value is 6 ; 1 because it can provide maximum conversion.
c. The influence of alcohol
   At a ratio of 6 : 1, methanol will provide the highest ester acquisition compared to using ethanol or butanol.
d. The influence of this kind of catalyst
   Alkali catalyst (alkaline catalyst) will accelerate the transesterification reaction when compared with the acid catalyst. The most popular base catalyst for the transesterification reaction is sodium hydroxide (NaOH), potassium hydroxide (KOH), sodium methoxide (NaOCH3), and potassium methoxide (KOCH3). Transesterification reactions will produce a maximum conversion with a catalyst amount of 0.5-1.5% vegetable oil.
e. Influence of temperature

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The transesterification reaction can be carried out at a temperature of 30-65oC (boiling point of methanol around 65oC). Flow reactor pipe (Plug Flow Reactor, PFR) is used for treating a dalamhal reactants is fluid and convert it into produkdengan way the fluid flow in a sustainable pipasecara (continuous) [2].

In a PFR, one or more reactants (the fluid) is pumped through a pipe or tube and a chemical reaction occurs along the PFR. In the reactor PFR speed of reaction to enter at breakneck speed. Some important aspects of the PFR reactor is:

1. In a PFR, the fluid flows with the same treatment so the time to stay the same for all elements of the fluid. Fluid flowing through the kind of ideal reactor called a plug. When plug flow along PFR, miscible fluid in the radial direction is not in the axial direction (from front or rear). Each plug with different volume expressed as a separate entity (almost like a batch reactor) as it flows down through the pipe PFR.
2. The reagent can be included in the PFR through a different location from the infeed. In this way a high efficiency can be obtained or PFR size and cost can be reduced.
3. A PFR has a higher efficiency than the RATB on the same volume. At the same time space, a reaction will result in the conversion of the PFR is higher than the RATB.

II. EXPERIMENTS

This is a form of research experiments conducted in a laboratory scale. The study began by designing a pipe flow reactor (PFR). Then oil was tested beforehand FFA after that when the% FFA obtained in accordance with the desired standards then followed by a transesterification process using PFR (Plug Flow Reactor) with a fixed variable operating temperature of 60 ° C and the NaOH concentration of 0.5% w/w oil and variable changes in the form of methanol concentration and flow rate of the reactants. Once the product is formed of washing and heating at biodiesel. Later analysis using Gas Chromatography to obtain % FAME.

For specifications of reactor used in accordance with Mas'udah study [3] that the reactor has a volume of 0.525 L. Reactors in this study a 17m long hose with a diameter of ¼ in.

Table I : Fatty Acid Composition of Coconut Oil Vapor (± 250°C)

Fatty Acid	No.carbon::No. double bond	Formula	Composition (%)
Lauryc Acid	12 : 0	$C_{12}H_{24}O_2$	40.35
Myristic Acid	14 : 0	$C_{14}H_{28}O_2$	11.45
Caprylic Acid	8 : 0	$C_8H_{16}O_2$	18.13
Capric Acid	10 :0	$C_{10}H_{20}O_2$	14.63

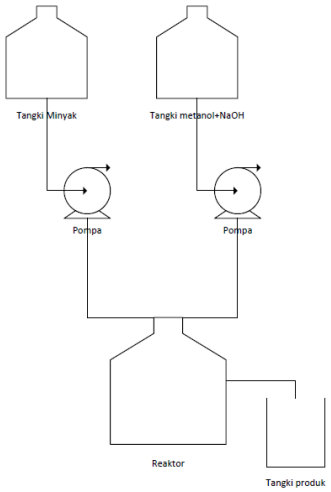


Fig. 1. Schematic of the experimental set up

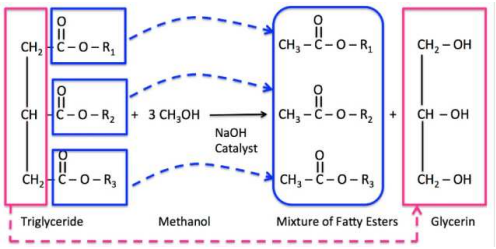


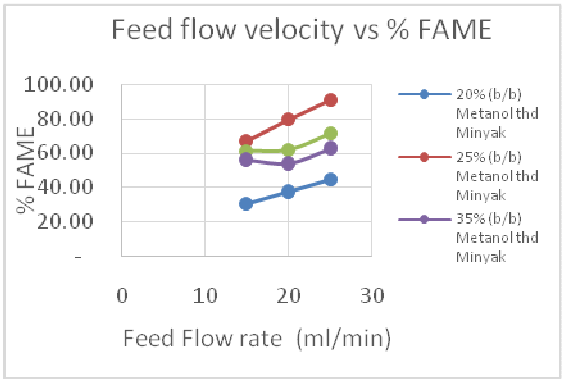
Fig. 2. Alkoholis Reaction of Triglyceride

III. RESULTS AND DISCUSSION

Of biodiesel products obtained subsequently analyzed% FAME GC (Gas Chromathography).

1. Effect Flow Speed Feed Against % FAME

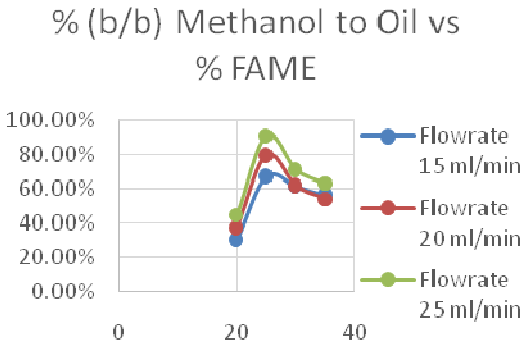
Feed flow rate in the reactor associated with the intensity of stirring and residence time. So that the flow rate of feed can affect% FAME formed



This is consistent with the literature Mas'udah [3] that the greater the flow rate used eat the greater the% FAME produced. It is also valid for% Yield produced. It is caused by the greater speed of the feed flow in the reactor, then the higher the intensity stirring so the reaction runs fast. The higher the stirring speed will increase molecular movement and cause a collision. At the beginning of the reaction, stirring will cause diffusion between the oil or fat to form methyl ester [4].

2. Effect% weight Methanol On Oil Against% FAME

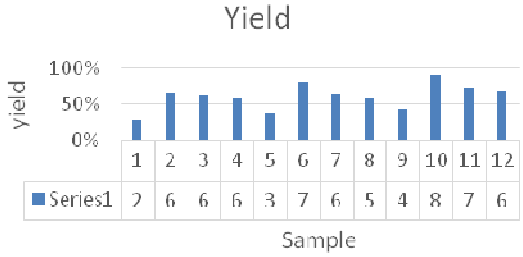
The concentration of methanol in the oil also affects the transesterification reaction. Excessive alcohol consumption will drive the reaction towards the formation of methyl esters and the greater the possibility of collision between moolekul molecules that react methanol and oil [5]. However, the higher the weight% methanol to the oil above the optimum limit it will produce a yield slightly.



N the graph proves that the highest yield of% FAME at 25% (w / w) methanol to the oil flowrate setap variable that is equal to 90.8% at a flow rate of 25 ml / min, 79.49% at a flow rate of 20 ml / min and 67.12% at a flow rate of 15 ml / min.

Because according to the theory, the optimal ratio to get the maximum yield obtained in the oil and methanol mole ratio of 1: 6, equivalent to 25% methanol by weight in oil. It is also almost aligned with the research Berchmans [6] which shows that the transesterification reaction is best obtained in% by weight of methanol to oil of ± 25%.

3. % yield



Based on the graph above it can be seen that the greatest yield gains that the sample with the code 10 (25/25) to 25% (w / w) methanol to the oil, and a flow rate of 25 ml / min by 89%.

Determination of Reaction Order and Reaction Kinetics First evidenced by assuming that the transesterification reaction is a first order reaction. Proof of this is done by plotting the -ln C_A / C_A0 vs. t, where slope = k (reaction rate constant) in all samples based on their respective codes.

Based on the chart that was created in an integrated manner for the case of first order can be seen that the whole graph indicates a linear line. According Levenspiel [7] (1967) gk ada di reference, if the graph of -ln C_A / C_A0 vs. t gives a straight line (linear), then the data meet the criteria for a first order reaction.

Based on the price of each code sample k shown in the table k values obtained in addition to the average for the transesterification reaction is first order in the manufacture of biodiesel with NaOH catalyst as much as 0.5% in the amount 0,00223s-1 with -rA = 0.00223 s-1 , Can.

IV. Conclusion

From the research that has been done, get some conclusions as follows:

1. Transesterification reaction in the manufacture of biodiesel made from palm oil and methanol reactants with the catalyst NaOH is a first order reaction. Transesterification reaction rate constants in the manufacture biodiesek made from coconut oil and methanol reactants with the catalyst of 0.5% in the amount of 0,00223s-1dengan -rA = 0.00223 s-1. Can.
2. The higher the feed flow rate then further increase the intensity of agitation so as% FAME produced also higher, in this study, the highest FAME% 90.84% at flowrate 25 ml / min.
3. The maximum concentration of methanol were obtained at a concentration of 25% w / w of oil equivalent mole ratio of 1: 6. In this condition, obtained the highest FAME% 90.84% while the concentration of 30% and 35% of the results obtained have decreased in the amount of 71.34% and 62.86%.
4. Obtain the largest yield in this study was found in 25% (w / w) of oil with methanol at a mole ratio of 1: 6 and a flow rate of 25 ml / min which is 89%.

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Author's Profile

Hadi Saroso
(Dr. Dept of Chemical Engineering, State Polytechnic of Malang, 2016)

Hadi saroso born 8 November 1956 in surabaya. He earned Bachelor's degree form Department of Chemical Engineering, Sepuluh November Institute of Technology Surabaya in 1987. After graduation he now a lecturer on Department of Chemical Engineering, State Polytechnic Malang. His Master's degree from Department Mechanical Engineering, Brawijaya University Malang in 2010. and the last education Doctor's degree from Department Mechanical Engineering, Brawijaya University Malang in 2015. His dissertation about premixed combustion of coconut oil in a hele-shaw cell.