



Biodiesel from Jelantah Oil with Catalyst FCCU Base Chemical Al_2O_3 Based Speed of Statement and Comparison of Reaction

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Biodiesel could be a substitute for diesel fuel determined from vegetable crude materials since of the require for diesel oil in wrinkled, among others for family units, transportation and the mechanical side, in minimizing squander cooking oil that disturbs and harms the environment live occasion in the event that it proceeds to be devoured will be hurtful to wellbeing. The advantage of biodiesel compared to diesel is that biodiesel is more naturally neighborly whereas utilizing utilized oil from mechanical squander, family units, eateries and fricasseed nourishment sellers is an elective fuel that can be synthesized from udes cooking oil. In this consider the comparison of oil an alkohol shifted by five reactant tests included by including a FCCU Base Chemical Al_2O_3 catalyst to the weight percent of oil at a certain sum to speed up the reaction. This handle was carried out employing a blended autoclave (pumpkin neck) at a speed of almost 280 ppm–375 ppm time interim 10 minutes the fortague is taken to determinate the alter of process at each temperature rise of 50 °C of steady 110 °C. The enacting drive of the chemical response that controls the in general response speed. The alcoholisis oil udes cooking takes after a untrue to begin with arrange response to the glycerid. The reaction k and X deviation +9,01%th case the state of the method that moderately well found at 50 minutes temperature 110 °C percentage catalyst 2%, mixing speed 360 ppm and ratio of alcohol-oil mgek/mgek, within the transformation comes to 0,6902 parts

Keywords: Biodiesel, Waste Cooking Oil, Esterification, Transesterification, FCCU Base Chemical Al_2O_3 .

1. INTRODUCTION

At the side the expanding number of individuals within the world with different sorts of needs, the require for vitality is expanding, whereas the vitality supply, particularly non-renewable vitality, has decreased in quality. At present there are less petroleum saves in Indonesia whereas the populace proceeds to develop in conjunction with the expanding number of motorbike vehicles. The expanding utilize of motorized vehicles with fuel from petroleum increments the danger of definitely decreased petroleum fuel supplies so the require for fuel from petroleum is expanding. Subsequently an elective fuel is required to avoid and overcome this. Industry advancement in Indonesia will result in expanded fuel utilization, oil generation within the nation will increment the require for fossil powers cause Indonesia's reliance on imported materials to be expanded. Within the 2011–2030 period, it is evaluated

that residential oil request will twofold in measure from 327 million uncovered l in 2011 to 578 million uncovered l in 2030, but not so with oil generation. Petroleum generation amid this period declined from 329 million barrels to 124 million, which decreased by 62%. The most vitality source utilized in different nations nowadays is petroleum. With so much abuse being carried out, its presence is progressively debilitated and the cost will increment strongly. This is because petroleum is a natural resource that cannot be renewed. Of the various types of processed petroleum products that are used as the most widely used fuel is diesel fuel. This is because most transportation equipment, agricultural equipment, heavy equipment and power plant generators use this material. Fuel oil (BBM) in Indonesia is one of the products that are needed by many people. With the increase in population, the consumption of fuel will also increase, fuel oil itself produces a lot of exhaust gas which can cause environmental pollution so it is necessary to find environmentally friendly fuels. Biodiesel is

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Table I. Comparison of capacity of kerosene and biodiesel.

	Viscosity (CST)	Capillary (cm)
Kerosene	2.05	37
Biodiesel with Highest viscosity	2	37.5
Biodiesel with Lowest viscosotas	1.9	38.5

an alternative fuel from renewable sources (renewable), with a composition of fatty acids from vegetable oils and animal oils. Used cooking oil is one of the raw materials that has the opportunity to make Biodiesel because it still contains free fatty acids.

Biodiesel is also tested for ignition using a simple lantern and the results show that the lantern can ignite well as if using kerosene. Thus the biodiesel produced from this study has the potential to be used as a substitute fuel for kerosene for stoves or to modify the stove tank height. Oil fuels are currently getting smaller and more expensive various efforts have been made in finding Alternative Energy as a substitute for Diesel Fuel. Biodiesel is a material that is very potential to be used as a substitute for the originating raw material from vegetable oils can be renewed, can be produced periodically and easily obtained. To produce biodiesel in addition to its relatively stable price and its production can easily be adjusted to the needs of production costs, of course expensive is one of the obstacles.

Various efforts have been made to find alternative energy as a substitute for diesel fuel. Biodiesel is a material that is very potential to be used as a replacement because the raw materials derived from vegetable oils can be renewed, can be produced periodically and easily obtained. To produce biodiesel besides the price is relatively stable and its production is easily adjusted to the need for expensive production costs is one of the obstacles. During the frying process, heating occurs and the oil turns dark due to a chemical reaction that can produce about 400 chemical compounds which are generally carcinogenic, while the disposal of used cooking oil directly into the environment will cause pollution. Taking into account the reality, challenges and expectations, the idea arose of creating equipment to manage used waste oil into simple, efficient Biodiesel at affordable prices as a solution to prevent environmental pollution from waste used cooking oil while utilizing waste into alternative fuels. By using Naphtamax as a catalyst, catalytic cracking is a way to break complex hydrocarbons into simpler molecules that can improve the quality and quantity of products and can also reduce the amount of residue produced, so that the nature of the biodiesel produced is adjusted to the standard material diesel fuel and a way to reduce the cost of biodiesel production is needed. If it turns out diesel oil is no longer worthy to be used then the choice of a replacement alternative is biodiesel from used cooking oil

(ex) d ith take into account the advantages both in terms of economy and the resilience EQUIPMENT tan as an example of the calculation only on the use of autoclave (Pumpkin neck 3) with the stirrer as well as getting quality biodiesel maximally. Oil fuels are currently getting smaller and more expensive various efforts have been made in finding Alternative Energy as a substitute for Diesel Fuel. Biodiesel is a material that has the potential to be used as a substitute for raw materials derived from renewable vegetable oils, which can be produced periodically and easily obtained. To produce biodiesel besides the price is relatively stable and its production can easily be adjusted to the needs of production costs, of course, one of the obstacles, various efforts have been made to find alternative energy instead of diesel fuel. Purposes from research this is Reducing cooking oil (used/used) waste can have an impact on the environment that damages the ecosystem. Avoid people from high ah dar pressure disease, cancer and disorders of the intelligence and itching in the throat if persisted mengkons umsi used oil that is used repeatedly. The resulting biodiesel can later replace diesel oil because this fuel is directly used by the community. Increasing people's income as a self-production business. From this study can produce and determine the condition of the variable (stirring speed and optimum ratio of reagents (Oil and Ethanol) for Biodiesel using Catalyst FCCU Base Chemical Al_2O_3 and provide input to the home industry in terms of determining the ideal stirring time at an average stirring speed of 280 ppm–375 ppm. The use of used cooking oil can be used as diesel motor fuel, which is one way to reduce waste (used oil) and also produce economic value and create alternative fuels instead of diesel fuel because it has considerable potential if it is developed into biodiesel fuel because it has fatty acids high. Biodiesel production usually involves the use of catalysts and catalysts that are usually used are homogeneous and heterogeneous catalysts. Homogeneous catalysts have deficiencies including catalysts that are difficult to separate after the reaction, many by-products in the form of soap and less economical. Oil fuels are currently getting smaller and more expensive various efforts have been made in finding Alternative Energy as a substitute for Diesel Fuel. Biodiesel is a material that is very potential to be used as a substitute for the originating raw material from vegetable oils

Table II. Fatty acid composition of used oil.

No.	Criteria	Unit %	Value
1	Palmiat acid	Wt	21.47
2	Stearic acid	Wt	13
3	Oleic acid	Wt	28,64
4	Linoleic acid	Wt	13,58
5	Linoleneic acid	Wt	1.59
6	Miristic acid	Wt	3.21
7	Lauric acid	Wt	1.1
8	Etc.	Wt	9.34

Note: used oil from palm cooking oil.

Table III. Result of gas chromatography mass spectrometry, fatty acids contained in virgin coconut oil (VCO = virgin coconut oil).

No.	Criteria	Value %
1	Kaproat acid	0.187
2	Octanoic acid	1.12
3	Cyclopropanapentanoic acid	0.54
4	Lauric acid	32.73
5	Miristic acid	28.55
6	Palmitic acid	17.16
7	Oleic acid	14.09
8	Stearic acid	5.68

can be renewed, can be produced periodically and easily obtained. To produce biodiesel in addition to its relatively stable price and its production can easily be adjusted to the needs of production costs, of course expensive is one of the obstacles. Various efforts have been made to find alternative energy as a substitute for diesel fuel. Biodiesel is a material that is very potential to be used as a replacement because the raw materials derived from vegetable oils can be renewed, can be produced periodically and easily obtained. To produce biodiesel besides the price is relatively stable and its production is easily adjusted to the need for expensive production costs is one of the obstacles. During the frying process, heating occurs and the oil turns dark due to a chemical reaction that can produce about 400 chemical compounds which are generally carcinogenic, while the disposal of used cooking oil directly into the environment will cause pollution. Taking into account the reality, challenges and expectations, the idea arose of creating equipment to manage used waste oil into simple, efficient Biodiesel at affordable prices as a solution to prevent environmental pollution from waste used cooking oil while utilizing waste into alternative fuels. Vegetable oil (used/used) used repeatedly to endanger health due to

Table IV. Oil quality requirements for frying.

Test criteria	Unit	Terms
Baau, color and taste	–	Normal
Water	%b/b	Max 0.30
Free Fatty Acids (calculated as Lauric Acid)	% b/b	Max 0.30
Additional Food Ingredients	According to SNI. 022-M and permenkes No. 722/Menkes/Per/IX/88	
	Metal Contamination:	
Iron (Fe)	Mg/kg	Max 1.5
Copper (Cu)	Mg/kg	Max 0.1
Mercury (Hg)	Mg/kg	Max 0.1
Lead (Pb)	Mg/kg	Max 40.1
Tin (Sn)	Mg/kg	Max 0.005
Zinc (Zn)	Mg/kg	Max (40.0/25.0)
Arsenic (As)	% b/b	Max 0.1
Peroxide numbers	% mg 0.2/gr	Max 1

Source: Ministry of Industry (SNI 01.3741-1995*) from label product.

besides more and more dirt contained in cooking oil due frying previous food ingredients and more and more the amount compound-free carboxylic acid in oil and cooking oil that is increasingly unclear if used repeatedly so that it needs to be used as a renewable energy source. By using FCCU Base Chemical Al₂O₃ as a Catalyst, Catalytic Cracking is a way to break complex hydrocarbons into simpler molecules that can improve the quality and quantity of products and can also reduce the amount of residue produced, for which the nature of the biodiesel produced is adjusted to the standards of diesel fuel and a way is needed to reduce the cost of biodiesel production. Therefore, biodiesel production more often uses heterogeneous catalysts.

2. LITERATURE REVIEW

2.1. Theoretical Basis

Biodiesel is an alternative type of environmentally friendly diesel fuel derived from plant oil or animal fat produced through the esterylation and transesterification reaction process. Besides that, as a source of making biodiesel that is cheap and widely available around the community, used cooking oil is a waste that contains a lot of carcinogenic compounds. In view of this, biodiesel can be made from vegetable oils that do not have to be new, such as used cooking oil [1]. To identify the quality of the biodiesel produced, it is necessary to test its physical properties. This physical property test needs to be done to avoid equipment damage and other losses that may arise due to the use of this fuel. The biodiesel produced will be directed to replace diesel fuel, because this fuel is used directly by the community so that it is hoped that the community can produce it themselves. For this reason, the properties of the biodiesel produced are adjusted to the standards of diesel fuel. One of the obstacles faced in the use of biodiesel now is that the price is more expensive than diesel fuel. For this reason, a method is needed to reduce the cost of producing biodiesel. One way that can be done is to use raw materials derived from used cooking oil. The raw material in the form of used cooking oil (used cooking) before use is first filtered to separate the impurities contained in the oil. Then heated at a temperature of 30–110 °C to evaporate the water contained in oil. The process is carried out continuously in a Stirring Tank Flow Reactor (RATB)/autoclave/Pumpkin Neck Three. 200–250 ml of oil is heated to a temperature of 50–110 °C for 10–50 minutes. The oil-ethanol-Naphthamax solution is also heated forged. After the temperature of the two feeds is reached, the two solutions are put into the Reactor and the Stirrer is turned on. Simultaneously the Minyak feed and Ethanol Solution-FCCU Base Chemical Al₂O₃ is fed into the Reactor. The product exits the reactor continuously by evaporation. The resulting product is left alone for one night (12–24 hours) to completely separate biodiesel and glycerol. The top

layer is yellow biodiesel and the bottom layer is dark brown glycerol. After that biodiesel from glycerol is then washed with saturated salt solution until the biodiesel pH is neutral. Subsequently analyzed the physical properties of biodiesel include: gravity specific gravity, viscosity, flash point, pour point, remaining carbon, color and moisture content. As a comparison, the biodiesel produced can also be analyzed by the physical properties of Solar from the gas station. Biodiesel is also the same as other fuels that have advantages and disadvantages including the following:

Strengths/advantages:

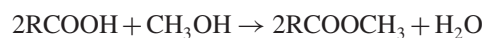
1. Non-toxic Biodiesel, as Biodegradable fuel, safer to use than conventional diesel, can be easily mixed with conventional diesel and can be used in most types of vehicles today even in the form of pure B100 biodiesel.
2. Biodiesel can help reduce our dependence on fossil materials and increase energy security and independence.
3. Biodiesel can be mass-produced in many countries, for example the USA which has the capacity to produce more than 50 million gallons of biodiesel per year.
4. Production and use of biodiesel releases less emissions than conventional diesel, around 78% less than conventional diesel.
5. Biodiesel has excellent lubricating properties, significantly better than conventional diesel fuel so it can extend engine life.
6. Biodiesel has a shorter ignition delay compared to conventional diesel.
7. Biodiesel does not contain sulfur so it does not contribute to the formation of acid rain.

Weaknesses of Biodiesel:

1. Biodiesel is currently mostly produced from corn which can cause food shortages and rising food prices, this could lead to increased hunger in the world.
2. Biodiesel is 20 times more susceptible to water contamination compared to conventional diesel, this can cause corrosion, damaged filters, pitting in pistons, etc.
3. Pure biodiesel has a significant problem with low temperatures.
4. Biodiesel is significantly more expensive than conventional diesel.
5. Biodiesel has a much less energy content compared to conventional diesel, around 11% less compared to conventional diesel fuel.
6. Biodiesel can release nitrogen oxides which can lead to the formation of smog.
7. Biodiesel, even though it emits significant carbon emissions safer than conventional diesel, it still contributes to global warming and climate change. (<http://www.indoenergi.com/2012/04/advantages-and-kelemahan-biodiesel.html>)

This oil is not economically calculated anymore and tends to be disposed of as waste because in addition to damaging the image processed foods can also damage human health. Used cooking oil has the main components in the

form of triglycerides and free fatty acids. In the esterification process free fatty acids are reacted with methanol to form Ester (Biodiesel) and Water, with the following reactions:

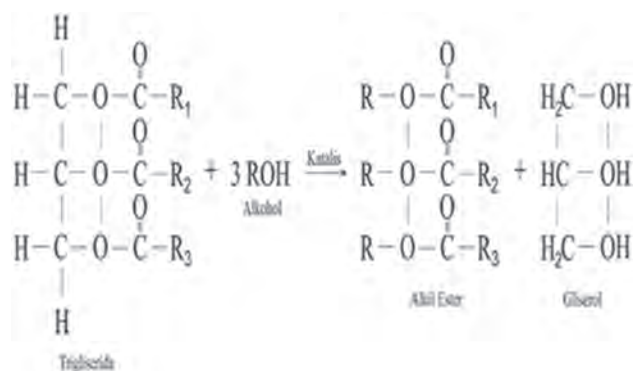


Making biodiesel is generally carried out with homogeneous base catalysts such as NaOH and KOH because it has a higher catalyst ability compared to other catalysts. The use of this catalyst has a weakness, which is difficult to separate from the reaction mixture so that it cannot be reused and will eventually be wasted as waste that can pollute the environment, to overcome this can be made biodiesel with heterogeneous catalysts. Making biodiesel from used cooking oil uses a transesterification reaction such as making biodiesel in general, with pretreatment in order to reduce the acidity of used cooking oil. The amount of acid that is too high will make it difficult to separate glycerol from biodiesel so that the production of biodiesel will be small. The most important provisions in making biodiesel are ester levels (minimum 96.5%), acid numbers (maximum 0.5 mg KOH/gr), ester content is affected by the quality of the technology and the process used and the composition of the raw materials used. In addition, other important parameters include sulfur, forpor, alkali metal, total kotaminasi and glycerol which do not react. The technology of the biodiesel production process that is currently developing can be grouped into a one-step process (transesterification) and a two-stage process (esterification–transesterification). While oil that has a value of Free Fatty Acid (FFA) above 1% such as used cooking oil should use a two-stage process (esterification–transesterification). Oils containing more than 1% free fatty acids will form a difficult soap emulsion formation when separating biodiesel. FFA is Free Fatty Acid (ALB) to show the amount of free fatty acids that exist after hydrolysis. Fatty acids can be free (due to hydrolyzed fat) or bonded as glycerides. Fatty acids together with glycerol are the main constituents of vegetable oils or fats and are the raw material for all lipids in living things. This acid is easily found in cooking oil (fried), margarine or animal fat. Factors that affect free fatty acids (FFA):

1. Absorption of Odor, Fat is easy to absorb odors.
2. Hydrolysis, in the presence of moisture, fat can be hydrolyzed to glycerol and free fatty acids.
3. Oxidation and rancidity, the main fat damage is the appearance of a rancid smell and taste called the rancidity process.
4. The activity of an enzyme lipase contained in the fruit and serves to break down fat or oil into fatty acids and glycerol.

Transesterification is a chemical transformation process of large triglyceride molecules, branching from vegetable oil and fat into smaller molecules, straight chain molecules, and almost the same as molecules in diesel fuel.

Vegetable oil or animal fat reacts with alcohol (usually methanol/ethanol) with the help of a catalyst (usually alkaline) that produces alkyl esters (or for methanol/ethanol, methyl esters). The transesterification reaction of triglycerides to methyl/alkyl acid-fatty acid esters is as follows:



2.2. History of Biodiesel

Biotanol and Biodiesel biofuels are two strong candidates to replace gasoline and diesel which have been used as Otto and Diesel engine fuels. The Indonesian government has launched the development and implementation of these two types of bahar materials, not only to overcome the energy crisis that plagued the nation but also as one solution to society's economic revival. Biodiesel was first introduced at.

South Africa before World War II as heavy vehicle fuel Biodiesel is defined as methyl/ethyl ester which is produced from plant or animal oils and meets the quality to be used as fuel in diesel engines. Whereas the oil obtained directly from milking or oilseed seeds, which is then filtered and dried (to reduce water content) is called crude fat oil. Raw fat oil which is processed further to eliminate phosphorus levels (degumming) and free fatty acids (with neutralization and steam refining) is called refined fatty oil or srtright vegetable oil (SVO).

Biodiesel is generally produced from refined vegetable oil using the transesterification process. This process basically aims to change [tri, di, mono] molecular weight and high viscosity glycerides which dominate the composition of refined fatty oils into methyl ester (FAME) fatty acids. Biodiesel is classified as renewable fuel because it is produced from agricultural products such as: Ration, coconut, oil palm, soybean, corn, rape seed, cotton, peanuts. In addition biodiesel can also be produced from animal oil and fish oil. The use of biodiesel is quite simple, biodegradable, non-toxic and basically free of sulfur (sulfur). Other advantages of biodiesel include:

1. Including renewable fuel.
2. No need for modifications to existing diesel engines.

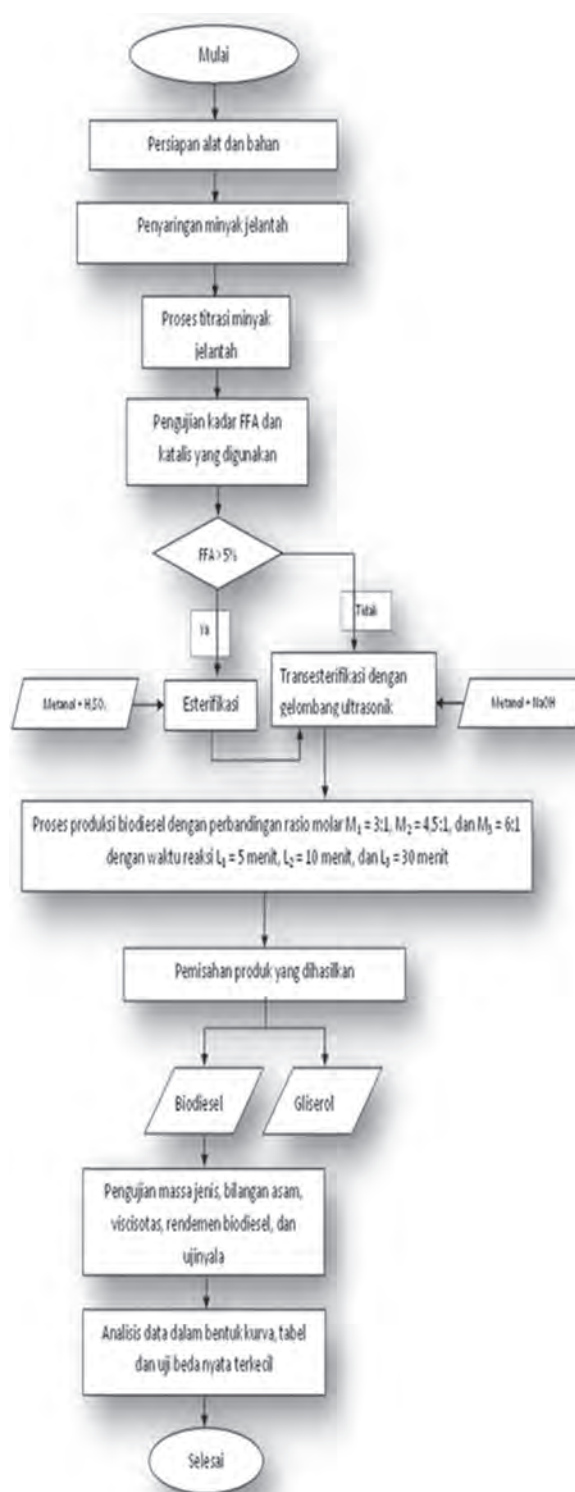


Fig. 1. Flow of biodiesel making process from used cooking oil esterification and transesterification.

3. It does not aggravate the greenhouse effect because of the short carbon cycle involved.
4. The energy content is almost the same as the energy content of petroleum diesel.

Table V. Characteristics of used cooking oil biodiesel.

No.	Description	Unit	Standard	
			Solar	Biodiesel
1	Viscosity at 40 °C	cSt	1.6–5.9	2.3–6
2	Density at 40 °C	gr/cm ³	0.62–0.87	0.85–0.90
3	Total acid number (TAN)	MgKOH/gr	<0.6	<0.8
4	Flash point	°C	>100	>100
5	Cloud point	°C	<18	<1.8
6	Micro carbon residue	%wt		<0.3
7	Water content	vol%	<0.05	<0.05
8	Sulfur	%wt		<0.0001
9	Phosphorus	%wt		<0.00001
10	Total glycerol	%wt		<0.024
11	Free glycerol	%wt		<0.02
12	Alkyl ester levels	%wt		<96.5
13	Iodine number	%		<115
14	Bi langan cetana	–	>45	>51
15	Lower calorific value (I, HV)	kJ/kg	45,300	–

Source: Pertamina, BPPT, SNI Biodiesel No. 04-7182-2006.

5. The use of biodiesel can extend the life of diesel engines because it provides more lubrication than petroleum fuels.

6. Has a high flash point, which is around 200 °C, while the flash point petroleum diesel fuel is only 70 °C.

7. Cetane number is higher than petroleum diesel.

Concept use oil plants as making material fuel has been started since 1895 when Dr. Rudolf Christian Karl Diesel developed the first compression machine that was specifically run with plant oil. The diesel engine or also commonly called the Compression Ignition Engine that it finds is a ignition motor that has a ignition concept caused by compression or compression of a mixture of fuel and oxygen in a motor engine under certain conditions.

2.3. Biodiesel Reserves

To identify the quality of the biodiesel produced, it is necessary to test its physical properties. This physical property

Table VI. Biodiesel quality requirements according to SNI.

No.	Test parameters	Unit	Requirements
1	Density at 40 °C	Kg/m ³	850–890
2	Viscosity	Mm ² /s (cSt)	2.3–6.0
3	Setana numbers	Min	51
4	Nyaka point (closed closed)	°C, min	100
5	Titi fog	°C, max	18
6	Corrosion of copper plates (3 hours at 50 °C)		Number 1
7	Carbon residue	%-mass, max	
	—In the original pilot or		0.05
	—In 10 °C distillation pulp		0.3
8	Water and sediment	%-volume, max	0.05
9	Distillation temperature 90%	°C, max	360
10	Centered ash	%-mass, max	0.02
11	Sulfur	Mg/kg, max	50
12	Phosphorus	Mg/kg, aks	4
13	Acid Number	Mg–KOHg, max	0.5
14	Free glycerol	%-mass, max	0.02
15	Total glycerol	%-mass, max	0.24

test needs to be done to avoid equipment damage and other losses that may arise due to the use of this fuel. The biodiesel produced will be directed to replace diesel fuel, because this fuel is used directly by community so that later it is hoped that the community can produce it themselves. For this reason the properties of Biodiesel produced are adjusted to the standards of diesel fuel. Used cooking oil is cooking oil which is used several times so that it still has fatty acids in triglycerides and contains compounds from decomposition of oil which are usually produced from frying food and the rest are not immediately discarded.

Petroleum is a non-renewable energy source. Increased use of fuel has resulted in depletion of petroleum supplies, so if new sources are not found, then in the not too distant future, petroleum must be imported. In some countries, biodiesel from vegetable oils has been produced and consumed in large quantities. In 2008 US biodiesel production reached 700 million gallons [2].

Biodiesel is a material that is very potential to be used as a replacement because the raw materials derived from vegetable oils can be renewed, can be produced periodically and easily obtained. To produce biodiesel besides the price is relatively stable and its production is easily adjusted to the need for expensive production costs is one of the obstacles. During the frying process, heating occurs and the oil turns dark due to a chemical reaction that can produce about 400 chemical compounds which are generally carcinogenic, while the disposal of used cooking oil directly into the environment will cause pollution. Paying attention to reality, challenges and expectations, the idea arises of creating equipment to manage waste. Vegetable oil (used/used) used repeatedly to endanger health due to besides growing number of dirt contained in cooking oil due to frying ingredients previous food and more and more the amount compound-free carboxylic acid in oil and cooking oil that is increasingly unclear if used repeatedly so that it needs to be used as a renewable energy source [3–7].

3. RESEARCH METHODOLOGY

This research was conducted to obtain a systematic, logical, structured work order and can be analyzed scientifically and by conducting literature studies to obtain the data needed. To be able to solve a problem so that it is solved if it is supported by a step of thought and poured in a research design concept or study of literacy studies in accordance with the objectives and benefits/uses.

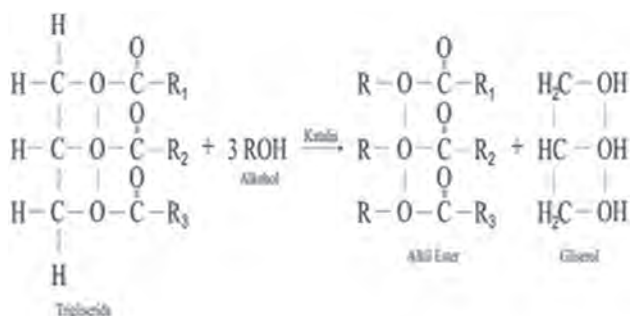
This concept makes it easier for researchers to carry out observations in the laboratory as well as being used as a reference frame during research or literacy study studies that take place through engineering methodologies [8–12].

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Table VII. Research Bibliography.

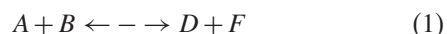
No.	Title	Researcher/Year	Results
1	Making biodiesel from used cooking oil continuous Process: Quality test	Erna Astuti et al./2017	The making of biodiesel from used cooking oil can be carried out continuously, kinematic viscosity test, type period and water and sediment content, the results of the comparison of used cooking oil and methanol meet the national standard of Indonesia (SNI)
2	Transesterification of used cooking oil uses continuous microwave biodiesel reactor	Ariwibowo et al., 2017	Acid values, total glycerol and free glycerol still do not meet the Indonesian national standard (SNI)
3	Feasibility study of biodiesel production from small scale cooking oil	Shofiatul Ula et al./February 2017	The physical test results of biodiesel from used cooking oil showed (in general the physical properties such as diesel) density 0.8789 gr/ml, viscosity 6.118 mm ² /s, flash point 178 °C, carbon residue 0.0006% wt, ash content 0, 0397% wt and gross heating value 19400 BTU/lb
4	Biodiesel from used oil uses heterogeneous base catalysts made from oil palm empty bunches (ATKKS)	Duafrizal Joycorleon Manik et al./February 2017	The duration of the transesterification reaction had a significant effect ($P > 0.05$) on acid numbers, water content, total glycerol content, flash point viscosity and gave no significant effect ($P < 0.05$) on the effect.
5	Transesterification of used cooking oil into biodiesel with calcium oxide catalyst	Nur Hidayati et al./April 2017	The reaction conditions such as the methanol and oil molar ratio, the amount of catalyst, temperature and reaction time affect the yield of biodiesel but the amount of catalyst does not affect the yield)
6	Analysis of used oil as biodiesel fuel with transesterification process	Hadrah et al./February 2018	Composition ratio of methanol and NaOH affects the quality of biodiesel from used cooking oil, biodiesel free fatty acid. The results of testing the viscosity value for used cooking oil 1:2, 1:4, 1:8, respectively 3.93; 4.01; 4.32 Cst shg kinematic viscosity values are smaller as the amount of methanol increases

The equation of reaction for Alcoholysis/Ethanolysis of vegetable oils can be written as follows:



With R_1 , R_2 , R_3 , and R' are Alkyl groups.

In Eq. (1) it is seen that 1 mole of glycerid, which has 3 groups Fatty acids react with 3 moles of ethanol to produce 1 mole of glycerol and 3 moles of fatty acid esters. In this case 1 mole of glycerid is equal to 3, so if expressed in equivalence, then Eq. (1) can be written as:



In this process, the possible reactions that occur are:

Reagents A and B are both absorbed and activated by the catalyst then followed by a chemical reaction on the surface of the catalyst. Only A reagent is absorbed and activated by the catalyst, then proceed with a chemical reaction between absorbed A and B which remain in the liquid phase. The solid catalyst releases hydrogen ions

(H⁺) from its surface into a liquid containing A and B, then follows a chemical reaction between A and B.

By looking at similar studies it turns out that chemical reactions occur in the liquid phase, so the equation is written with:

$$r = kC_{AL} \cdot C_{BL} \quad (2)$$

If C_{BL} is constant and then kC_{BL} is expressed as k , then:

$$rdt = -dC_{AL} = k' C_{AL} \quad (3)$$

Next, by entering the conversion of X_A , and after it is set and integrated, Eq. (4) changes to:

$$-\ln(1 - X_A) = k't + b \quad (4)$$



Fig. 2. Flowsheet of biodiesel making.

If the relationship between $-\ln(1 - X_A)$ the results of the study are painted against t , and it turns out that a straight line is obtained, then the value of k' is equal to the tangent of the direction of that line. The alcoholic process of used cooking oil is carried out at high temperatures, so that the reaction speed will be even greater in addition to the use of solid catalysts that will benefit the catalyst easily separated by filtration and higher yield purity after separating the catalyst can be reused. The use of an autoclave equipped with a stirrer causes the mixing of reacting substances to be more perfect than the rotating autoclave. In addition, sampling can be done without stopping the ongoing process. In the autoclave that is played in addition to the mixing is less than perfect, taking the footage must be preceded by stopping the process so that there may have been a separation during the sampling. Footage taken is less accurate for analysis purposes [13–16].

If later this study provides good results, the expected benefits are:

1. For the state and society, increasing the added value of used cooking oil converts the material into esters and glycerol
2. For science, obtained ethanolysis speed constant data of used cooking oil using a used catalyst with a pressure of more than 1 atm, studying the kinetics of the ethanolysis reaction.

3.1. Place and Time of Research

This research was carried out at the Chemical Engineering Instrument Laboratory, Faculty of Engineering, University of Muhammadiyah Palembang, and Manufacturing and Process Laboratory at PERTAMINA UP III Plaju. The research was conducted on December 4, 2018–March 13, 2019.

3.2. Tools and Materials

Magnetic Stirrer/electric motor stirrer; Thermometer; Analytical Balance Sheet; Picnometer; Heating/ Hotplate/ Heating Mantle; Viscometer oswald; Measuring cup; Separator Funnel; Erlenmeyer Glass; Pumpkin plastic separator; Beaker Glass; Cruses; Manometer; Heat Insulation; Autoclaf (Pumpkin neck 3) equipped with heat insulation; Pumpkin Neck 2; Reverse cooling/condenser; pipet volume/drops; glass stirrer; filter paper and filter; faucet taking trailer; Aluminum Foil.

3.2.1. Material Used

1. Used cooking oil is obtained from UMKM Fried Traders and Restaurants/Restaurants.
2. FCCU Base Chemical Al_2O_3 Catalyst from Pertamina R P. III.
3. Alcohol/Ethanol
4. Biodiesel Analysis; Acetic Acid, Oxalic Acid, As am Chloride, Sodium Hydroxide, Phenolptalein (PP) Indicator, Aquadest.

3.3. Research Variable

In this study, it will be known that the stirring rotation speed during the process takes place within 10 minutes (10'; 20'; 30'; 40'; 50'; 60'. The variations in stirring speed use 280 ppm, 320 ppm, 340 ppm, 360 ppm, 375 ppm in each sample/sample.

3.4. Research Procedure

Used cooking oil, ethanol, and solid catalyst are included in the autoclave with a ratio of the specified weight volume (3 neck flask complete with stirrer) with a maximum speed of 375 ppm. The lid is tight then the heater and stirrer are turned on, the constant temperature is 110 °C and the stirring speed is maintained by adjusting the power of each.

3.4.1. Variation

Determine the reaction kinetics, studied the effect of the number of catalysts, stirring speed, reaction temperature, and the ratio of oil-ethanol equivalents for a period of 10 to 60 minutes, the stirring speed varied to take samples with the specified time interval.

3.4.2. Analysis of Results in the Study

Samples taken were weighed at each interval of 10 minutes to determine the level of glycerol by acetone [17]. The footage is weighed and then inserted into a spinner (pumpkin with a stirring stirrer) to separate the top layer from the bottom layer. If the boundary between the two layers is clear, the top layer is taken with a pipette, and the bottom layer is weighed again, and the remaining ethanol is evaporated. Furthermore, the liquid is taken approximately 1.3 grams, put into the erlemeyer and then add 3 grams of sodium acetate and 7.5 mL of acetic acid anhydride. The mixture was boiled for 1 hour by installing a back cooler on the erlemeyer/neck gourd 2. After boiling, the mixture was cooled to a temperature of around 50 °C, then added 50 mL of distilled water (Aquadest) which was the same temperature through cooling back, and cooling continued. The mixture that has been cooled is neutralized with 3 N NaOH, uses the phenolptalin indicator until a red color



Fig. 3. Stirring process 340 ppm.



Fig. 4. Heating for 15 minutes after addition of NaOH and PP.

is formed, then add 50 mL of 1 N NaOH, then boil for 15 minutes, and continue with cooling. After cooling, the mixture is titrated with 1 N HCl until the red color disappears. Do the titration of the blank in the same way without snippets [18, 19].

3.5. Test Parameters

To get a good condition, the conversion of variations to the research variables is produced in the condition of the Speed of the Stirring Round and based on the Comparison of Reagents [20].

3.5.1. Comparison of Rasio Oil/Ethanol and Catalyst on Each—Each Sample Are as Follows

1. Used Cooking Oil, which is clean from dirt (filtered)
2. Alcohol/Ethanol 96%
3. FCCU Base Chemical Catalyst Al_2O_3 .

Comparison of the volume of 200 mL of each solution (1:6, 1:5, 1:4, 1:3, 1:2, 1:1) catalyst 2 gram heavy oil.

3.5.2. Biodiesel Quality Test Results

Preparation of researchers after conducting research in the Laboratory is obtained or calculated from Biodiesel testing with the following parameters:

1. Density of Biodiesel in units of gr/mol;
2. Free Fatty Acids in Percent (%);
3. Kinematic viscosity in units (mm^2/sec).

4. RESULTS AND DISCUSSION

4.1. Research Results

When the stirring process takes 10 minutes for the sample (1:1) at stirring at 280 ppm, the same number of biodiesel moles can be obtained because the pipette/hose hose is not too touching on the bottom layer, so does the second and third minutes, and at The fourth and next 10 minutes get the mole value of biodiesel and glyceride in the lower layer. At a stirring speed of 320 ppm using a solvent with a ratio (1:2) in the first 10 minutes the mole of biodiesel obtained is the same as stirring 280 ppm so it can. Reagents used in stirring 340 ppm by comparison (1:3), in the first 10 minutes, the second, third are also the

Table VIII. Results of stirring at varying speeds.

Time (minute)	Conversion, x part at speed of rotation of mixer, temperature 110 °C oil/ethanol 6 grek/grek, catalyst 2% by weight of oil				
	280 ppm	320 ppm	340 ppm	360 ppm	375 ppm
10'	0.3877	0.4199	0.4459	0.4777	0.5077
20'	0.4550	0.4650	0.4750	0.4850	0.5800
30'	0.4733	0.5253	0.5365	0.5733	0.5958
40'	0.5202	0.5366	0.5445	0.5802	0.6437
50'	0.6202	0.6302	0.6402	0.6902	0.7482
60'	0.6402	0.6524	0.6602	0.7102	0.7662
$k'(10^2)$ minute ⁻¹	0.0053	0.0040	0.0052	0.0045	0.0005
b	0.4558	0.3029	0.3356	0.3929	0.4076

same because the samples taken by biodiesel and glyceride are only very few, in our observation oil samples/ethanol ratio of 1:4, 1:5, 1:6 and stirring 360 ppm the results are good and optimal.

4.2. Discussion

From table conversions were calculated, the linear graph formed depending on the results of research and calculations are accurate. Previous researchers obtained a more optimal value compared to the new research done by the author because the type of catalyst used was the same while the number of sample solutions was different and the stirrer speed was carried out from low to larger. Effect on the volume of sampling in every 10 minutes with a maximum temperature of 110 °C starting at 50 °C.

The picture above shows that the variation of Stirring Speed rotation shows a maximum value of 0.7662 at a speed of 375 ppm, but there are still deviations in determining sampling.

In Table 4.1.1 it can be seen that the conversion gliserid progressively increased with increasing stirrer speed, because the movement of reactant molecules sehigga greater collision also beramah. But the increase in conversion is not large and it can be said that the reaction determines the overall reaction speed.

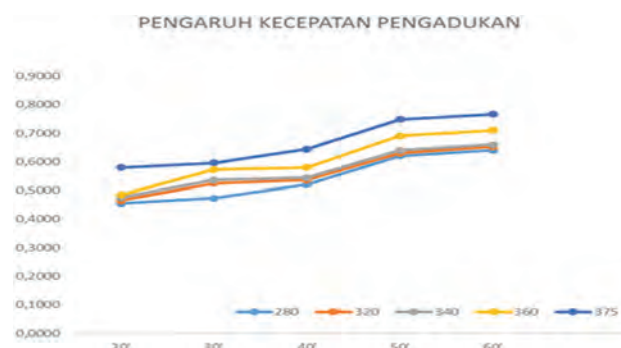


Fig. 5. Graph of stirring speed with time.

Table IX. Calculation of conversion $-\ln(1 - X_A)$ at varying stirring speeds.

Time (minute)	Conversion, x part at speed of stirrer rotation, temperature 110 °C oil/ethanol 6 grek/grek, catalyst 2% by weight of oil				
	280 ppm	320 ppm	340 ppm	360 ppm	375 ppm
10'	0.9475	0.8677	0.8077	0.7388	0.6779
20'	0.7875	0.7657	0.7444	0.7236	0.5445
30'	0.6411	0.7451	0.6227	0.5563	0.5179
40'	0.6535	0.6022	0.6079	0.8679	0.4405
50'	0.4777	0.4617	0.4559	0.3708	0.2901
60'	0.4459	0.4771	0.4152	0.3422	0.2663
$k'(10^2)$ minute ⁻¹	0.8100	0.8150	0.8293	0.8382	0.8500
b	0.0081	0.1060	0.0110	0.0390	0.0900

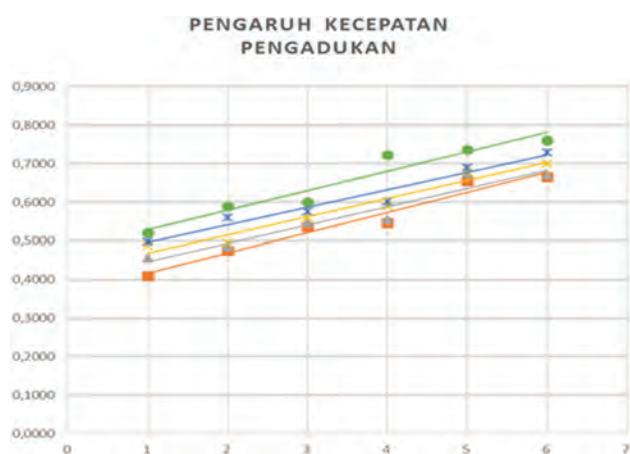


Fig. 6. Graph of stirring speed $-\ln(1 - X_A)$ to time.

The graph of the relationship $-\ln(1 - X_A)$ with a time of 1 minute, shows that the points obtained do not deviate much from the straight lines that are formed (Fig. 6). It can be concluded that the alcoholis reaction of used cooking oil with a solid catalyst is controlled by a quasi-first-order chemical reaction to glycerides.

$$k' = 1.3108(10^{-2})N^{0.0574} \quad (5)$$

Table X. Comparison of reagents, temperature 110 °C, stirring speed 360 ppm, catalyst 2% by weight of oil, ethanol-oil = 6 mg/mg.

Time (minutes)	X section conversion, on the effect of the ratio of reagents, oil-ethanol 6 mg/mg, temperature 110 °C, stirring speed 360 ppm, catalyst 2% by weight of oil					
	1	2	3	4	5	6
10'	0.3977	0.4099	0.4559	0.4877	0.4977	0.5207
20'	0.4650	0.4750	0.4850	0.4950	0.5600	0.5889
30'	0.4833	0.5353	0.5465	0.5600	0.5758	0.5993
40'	0.5302	0.5466	0.5545	0.5902	0.6018	0.7223
50'	0.6332	0.6545	0.6545	0.6802	0.6902	0.7366
60'	0.6502	0.6654	0.6702	0.7002	0.7302	0.7602
$k'(10^2)$ minute ⁻¹	0.0260	0.0026	0.0204	0.0033	0.036	0.0221
b	0.3706	0.6186	0.0619	0.4748	0.4532	0.0669



Fig. 7. Comparison graphs of reagents to time.

Table XI. Conversion calculation tables in reagent comparison.

Time (minutes)	X section conversion, on the effect of the ratio of reagents, ethanol-oil (temperature 110 °C, stirring speed 360 ppm, catalyst 2% by weight of oil)					
	1	2	3	4	5	6
10'	0.9221	0.8918	0.7855	0.7181	0.6978	0.6558
20'	0.7657	0.7444	0.7236	0.7032	0.5798	0.5295
30'	0.7271	0.6249	0.6042	0.5798	0.5519	0.5119
40'	0.6345	0.6040	0.5897	0.5273	0.5078	0.3253
50'	0.4569	0.4239	0.3937	0.3854	0.3708	0.3050
60'	0.4305	0.4074	0.4002	0.3564	0.3144	0.2741
$k'(10^2)$ minute ⁻¹	0.9709	0.8364	0.7860	0.7408	0.7211	0.7234
b	0.0210	0.0341	0.0293	0.0177	0.0156	0.0122

The error of the results of the study averages 0.39% and the deviation of $x \pm 0.21\%$ from Eq. (5) shows that the index Reynolds has a value of 0.0574 far lower than 0.5. This shows clearly that chemical reactions play a role [21].



Fig. 8. Graphs of calculation of conversions $-\ln(1 - X_A)$ comparison of reagents effect of stirring round speed.

Table XII. Comparison of ethanolysis.

	Kepuh oil	Nyampung seed oil ****	Rubber seed oil *	Jatropha seed oil **	Kapok seed oil	Used oil ***
Time, minute	60	60	60	60	60	60
Lowest temperature high °C	120	120	120	120	120	120
Pressure, atm	3.37	3.6	2.6	5.01	1	4.5
Catalyst	Used (solid)	Amberly	HCl	NaOH	K ₂ CO ₃	Natural zeolite
Number of catalysts	2%	0.1071 g/g of oil	11,6707 mg/L	0.7138%	0.5%	2.31%
Ethanol/oil mg/mg	6	10.3317	7,7459	10.4	3.34	6
Order of reaction	1	1	1	1	1	1
% Conversion	72.20	70,47	83,51	84.6	67.7	74,47

Notes: *Refs. [22], **[23], ***[24], ****[25].

4.3. Effect of Comparative Equivalents of Ethanol-Oil

The greater the ratio of the equivalent of ethanol-oil, the greater the possibility of collisions between reagent substances (Table 4.1). The relationship between $\ln(1 - X_A)$ with time, t , in the form of straight lines as well and the k value is shown in Table 4.1. This shows that the pseudo-one-order reaction to glyceride. If $-\ln k'$ and $\ln P$ are graphed, a straight line is obtained (Fig. 7), and by the way quadrants are obtained, get the equation:

$$k' = 1.2578(10^{-2})P^{0.2032} \quad (6)$$

In fact, the average k' of the results of the study of Eq. (6) is 1.00% and the deviation $x \pm 0.87\%$.

4.3.1. Variable Effect

By paying attention to the trends shown by each variable separately, the combined effect of variables:

$$k' = \beta_o e^{\beta^{1/T}} N \beta_2 P \beta_3 \quad (7)$$

By means of the least squares obtained the value of β_o , β_1 , β_2 , β_3 , so that Eq. (10) becomes:

$$k' = 1659.2162e^{-4668.74/T} (7.4976 \times 10^{-3} + 4.6455 \times 10^{-3}H)N^{0.0529}P^{0.1824} \quad (8)$$

with the average experimental results of the equation $\pm 13.66\%$ for k'' , and deviation $x + 9.01\%$.

4.3.2. Per Comparison of Results

The results of this study, when compared with the results of other studies, turned out that everything was pseudo-first order and glycerid conversion was not much different.

Result Biodiesel Quality Test

Density of Biodiesel in units of gr/mol;

Blank Picnometer weight = 30,908

Content Weight = 4.7769

Volume = 50 mL

Density:

Fill Weight—Blank Weight

Volume = (74,7769–30,908)

50 mL = 0.8965 gr/ml

Free Fatty Acids in Percent (%);

After calculating the free fatty acid (ALB) or FFA in used cooking oil is 0.163%.

Kinematic viscosity in units (mm²/sec) and flame test = 0.02353 mm²/sec.

5. CONCLUSIONS

The conclusions obtained in this study are The Ethanolysis reaction of used cooking oil at a pressure above 1 atm, with a Naphthamax catalyst, is controlled by a chemical reaction to glycerides and takes place in the Liquid phase. The relatively good condition reached the temperature of 110 °C, the percentage of catalyst 2% by weight of oil, stirring speed of 360 ppm, with 6 samples resulting in griserid 7.81%. Esters obtained have physical properties that are close to diesel oil specifications. For further research, it can vary the temperature, type of catalyst, stirring speed in order to see the effect of the solvent used as a mixture of WVO into Biodiesel [26–29].

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