# The Utilization of Kepyar Castor Oil (Ricinus Communis) and Alumina Silica Catalyst in Alcoholysis Process

*by* Kiagus Ahmad Roni, Netty Herawati Dian Kharisma Dewi, And Sri Martini

# The Utilization of Kepyar Castor Oil (*Ricinus Communis*) and Alumina Silica Catalyst in Alcoholysis Process

Kiagus Ahmad Roni[*1], Netty Herawati[1], Dian Kharisma Dewi[1], and Sri Martini[1]

[1]*Department of Chemical Engineering, Faculty of Engineering, Universitas Muhammadiyah Palembang, Jl. A.Yani 13 ulu Palembang, South Sumatra, Indonesia.*

[*]*Email: kiagusaroni@gmail.com*

***Article Information:***

Received:
*18 March 2021*

Received in revised form:
*222 May 2021*

Accepted:
*5 June 2021*

Volume 3, Issue 1, June 2021
pp. 31 – 34

http://doi.org/10.23960/jesr.v3i1.76

***Abstract***

*Castor oil is one of the vegetable oils that has not been used optimally. In the manufacture of biodiesel, vegetable oil is needed as a raw material. The aluminum silica catalyst used is a waste from the petroleum cracking process at PT. Pertamina RU III Palembang. This research aims to prove that the raw material for vegetable oil in the form of castor oil can be used as raw material for making biodiesel with the help of waste catalyst from the cracking process of Pertamina Unit III Palembang as a catalyst process and with the alcoholysis method. Based on the research that has been done, it can be concluded that castor oil can be used as raw material for making biodiesel using heterogeneous catalysts which are used as catalysts for fracturing crude oil at PT. Pertamina RU III, and with operating conditions at temperature 383°K, stirring speed of 300 rpm, ratio of oil and ethanol 5 mgek/mgek, and reaction time of 60 minutes. With the above operating conditions, the biodiesel conversion from the alcoholysis process was obtained at 94.08%. So that further research can be developed on the manufacture of biodiesel with castrol oil as raw material with the help of a waste catalyst from cracked crude oil from PT Pertamina RU III Palembang.*

***Keywords:*** *alcoholysis, castor oil, catalyst, vegetable oil*

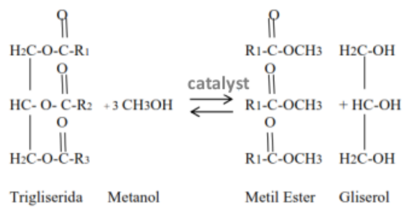
## I. Introduction

Oil supplies in Indonesia are running low, making several parties involved look for ways how the need for fuel oil can be met. There are two options to overcome this, the first is to import crude oil which is then processed into fuel oil, and the second is to use abundant natural resources to convert it into fuel oil [1]. For now in Indonesia bioenergy is developing, the purpose of bioenergy is to find alternative energy sources that can replace fossil fuels, one of which is biodiesel [2]. Raw materials that can be used to make biodiesel include animal and vegetable oils. Biodiesel itself can be used as an alternative energy from diesel which is a special fuel oil for diesel engines. For the advantages of biodiesel apart from raw materials that are easy to obtain and can be renewed, biodiesel has other advantages, namely the oil obtained is more environmentally friendly than fossil-based oil, has a low sulfur content, and is able to reduce exhaust emissions [3]. In addition, the selection of the right raw materials can save production costs. So that the raw materials used are prioritized which are cheap, the supply is available in the long term, and the raw materials used do not compete with food ingredients. For the raw materials used in the manufacture of biodiesel, among others, vegetable oil, of low quality, having low economic value, and not being widely used so that it has the potential to become waste if not used optimally[4].

One of the vegetable oils that can be used as raw material for making biodiesel is castor oil (ricinus communis), which is one of the vegetable oils that has the potential and can be used as raw material. castor oil (*ricinus communis*) does not compete with the food sector, because this castor oil cannot be consumed. Biodiesel made from vegetable oil in several countries has been produced and consumed in large quantities [1]. The following is the reaction equation for vegetable oil [5].

With alkyl groups present at R1, R2, R3, and Rr. Based on the above equation, it is known that for 1 mole of glycerides, there are 3 fatty acid groups that react with 3 moles of ethanol to form 1 mole of glycerol and 3 moles of fatty acid esters [6]. Under these conditions, it is known that for 1 mole of glyceride is directly proportional to 3 equivalents, and 1 mole of ethanol is equal to 1 equivalent, so that the equivalent equation is obtained as follows,

$$A + B \leftrightarrow D + F \quad (1)$$




If viewed from the reaction equation above, it is known that A and B are reagents, both of which are then absorbed and subsequently activated with the help of a catalyst, after which a chemical reaction occurs on the surface of the catalyst [7]. In this condition A which is a reagent is then absorbed and activated with the help of a catalyst, then the chemical reaction that occurs between A is absorbed by B. For reagent B here is still in the form of a liquid phase [8]. The catalyst used in solid form then releases hydrogen ions ($H^+$) contained on its surface into a fluid containing reagents A and B, so that the next step will be a chemical reaction between A and B. the reaction using the following equation,

$$r = k\, CAL\, CBL \quad (2)$$

If CBL is constant, and then kCBL is expressed as kr, then:

$$r = -\frac{dCAL}{dt} = kr\, CAL \quad (3)$$

Next, for the conversion value xA is then entered, and after that it is set and internalized, so the equation will be

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

Based on equation (4) the relationship between ln(1 - xA) and k' is the result of research based on time (t) so that a straight line equation is obtained. So that the value of k' is equal to the tangent to the direction of the line. [5]

The catalyst used in this research is a heterogeneous base. A catalyst with a heterogeneous base type is a substance that is able to trigger a reaction by lowering the activation energy, with the nature of the base and also the phase itself being different from the phase of the reactants [9].

Heterogeneous base catalysts can be used in the alcoholysis process in the manufacture of biodiesel. The transesterification reaction is a reaction that occurs between vegetable oils or animal fats with the result of the reaction in the form of esters and glycerol [10]. In the process of alcoholysis using methanol which reacts with vegetable oil, the results obtained from the reaction are in the form of esters or better known as Fatty Acid Methyl Ester (FAME). One of the purposes of this reaction is to reduce the viscosity of triglycerides. While for heterogeneous catalyst examples can be in the form of CaO, and MgO. [11]

There are several reasons for the use of heterogeneous catalysts by industry players, among others, this catalyst has non-corrosive properties so it is environmentally friendly, can be separated easily from the product by using the filtration method, besides that this type of catalyst can be used for a long time, because it can be washed. and reactivated. so operating costs will be much more efficient. [12]

The catalyst used in this study, namely heterogeneous catalysts which are waste or used catalysts from the use of the cracking process of crude oil into fuel oil at PT. Pertamina RU III Palembang. Petroleum cracking effluent catalyst (Spent Catalyst) PT. Pertamina RU III Palembang consists of elements of silica, alumina and iron. Catalysts that have been used in the petroleum cracking process still have activation energy that can still be utilized and are generally heterogeneous or solid catalysts with high surface and acidity and considerable thermal stability [13,14]. The solid materials include alumina, alumina oxide, silica alumina, zeolite and clay [15]. Because solid catalysts have several advantages, such as being easy to separate from the mixture so that it can be regenerated, being able to produce glycerol as a by-product with a high level of purity, in terms of cheaper prices and environmentally friendly. Alkaline earth metal ($Al_2O_3$) shows considerable catalytic activity in the transesterification process of vegetable oil by alcoholysis method [16].

Based on this explanation, this research aims to prove that the raw material for vegetable oil in the form of castor oil can be used as raw material for biodiesel production with the help of waste catalysts from the cracking process of Pertamina Unit III Palembang as a process catalyst and with the alcoholysis method. For the operating conditions based on research that has been carried out previously. which is the optimal condition in the process of making biodiesel with the alcoholysis method.

## II. Materials and Methods

This research was conducted at the Process Laboratory of the Chemical Engineering Department, Faculty of Engineering, University of Muhammadiyah Palembang. The equipment used in this research is a laboratory glass, magnetic stirrer, hotplate, thermometer, stopwatch, analytical balance, a set of qualitative analysis tools, and an autoclave. The materials used are castor oil, ethanol, and a catalyst in the form of solid catalyst waste from the petroleum cracking process at PT. Pertamina RU III Palembang.

This research was carried out in several stages, namely the preparation of castor oil ingredients, castor seed oil was obtained by pressing castor seeds. The second stage is the hydrolysis process, namely mixing castor oil with ethanol with operating conditions at a temperature of 383oK and a stirring speed of 300 rpm, with an equivalent ratio of oil/methanol 5 mgek/mgek, pressure 1 atm and catalyst. percentage of 2% [5]. The mixture was then reacted in a complexed three-neck flask by autoclaving. The mixture is reacted with a heating process and the use of used catalyst from the cracking process of Pertamina Unit III Palembang (which has been decarbonized at a temperature of 553 $^oK$). Samples are taken every 10 minutes which will then be analyzed for biodiesel conversion.

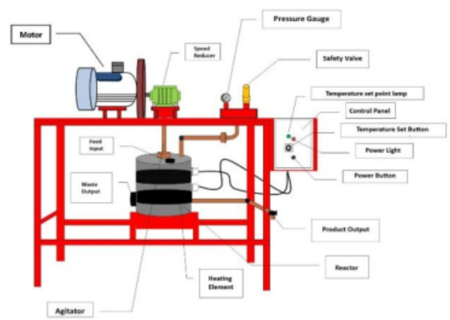



**Fig 1.** A set of autoclave tools with a pressure of 1 atm

## III. Results and Discussions

Based on Tabel 1, it is known that the biodiesel conversion obtained tends to increase with the higher the reaction temperature, this is due to greater movement of the reagent molecules. Further explanation can be seen in Fig 2. Table 1 data was the condition at 2% catalyst, stirring speed 300 rpm, oil/methanol 5 mgek/mgek.

**Table 1.** Conversion results of the effect of reaction temperature

| Reaction time (minutes) | Biodiesel conversion to temperature | | | | |
|---|---|---|---|---|---|
| | 353 $^oK$ | 363 $^oK$ | 373 $^oK$ | 383 $^oK$ | 393 $^oK$ |
| 10 | 0.17564 | 0.23715 | 0.30203 | 0.3268 | 0.3173 |
| 20 | 0.23715 | 0.27679 | 0.31785 | 0.35 | 0.3381 |
| 30 | 0.37089 | 0.41577 | 0.46275 | 0.4512 | 0.4149 |
| 40 | 0.48832 | 0.50979 | 0.5318 | 0.7441 | 0.4613 |
| 50 | 0.52195 | 0.55694 | 0.59352 | 0.8525 | 0.5665 |
| 60 | 0.64911 | 0.65785 | 0.66671 | 0.9408 | 0.6693 |
| $K(10^2)$ $min^{-1}$ | 0.0095 | 0.0087 | 0.0078 | 0.0139 | 0.0071 |
| b | 0.0733 | 0.1386 | 0.2072 | 0.1239 | 0.2121 |

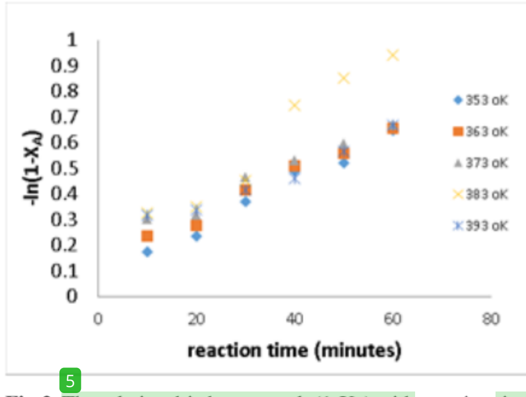



**Fig 2.** The relationship between $-\ln(1-X_A)$ with reaction time and temperature

Based on Fig. 2, it is known that the relationship $-\ln(1\text{-}xA)$ to the reaction time (t) in minutes, and can be seen in Table 1 and Figure 1. By using the least squares method. so that the equation $-\ln(1\text{-}xA) = k't+b$ can be used to calculate the value of k' and b. with increasing operating temperature greatly affects the results of the value of k', with an increase of 10$^o$K can make the value of k' increase from 0.0078 to 0.0139 this condition exists at temperatures of 373 K and 383 K. The increase in the value of k' at a sufficiently high temperature, in accordance with the statement proposed by Westerterp and colleagues in 1984. Therefore, it can be concluded that chemical reactions can control a process [13].

The relationship between the reaction rate constant (k') to the reaction temperature (T$^o$K), can be seen in Figure 2, with the following equation [14]:

$$K' = 10401.1132e^{-5081.9053/T} \quad (5)$$

with an average error of k the results of the study reached 0.04% and a deviation of x±0.96%. This also reinforces the notion that the chemical reactions that control the process are in accordance with those proposed by Westerterb and colleagues in 1987 [15].

## IV. Conclusions

Based on the research that has been done, it can be concluded that castor oil can be used as raw material for making biodiesel using heterogeneous catalysts which are used as catalysts for fracturing crude oil at PT. Pertamina RU III, and with operating conditions of 383$^o$K temperature, stirring speed of 300 rpm, ratio between oil and ethanol of 5 mgek/mgek, and reaction time of 60 minutes. With the above operating conditions, the biodiesel conversion from this alcoholysis process was obtained at 94.08%. So that further research can be developed on the manufacture of biodiesel with jatropha oil as raw material with the help of a catalyst reaction from the former cracking of crude oil from PT Pertamina RU III Palembang.

## ACKNOWLEDGMENT

This research is supported by PTUPT grant, DIKTI Indonesia contract Y2020/2021.

## REFERENCES

[1] Sulistyo, H., Minyak, A., Pagar, J., & Curcas, J. (2012). Pemodelan dan Simulasi Kinetika Reaksi Alkoholisis Minyak Jarak Pagar (Jatropha Curcas) dengan Katalisator Zirkonia Tersulfatasi. *Jurnal Rekayasa Proses*, *4*(1), 19–24. https://doi.org/10.22146/jrekpros.571

[2] Inggrid, O. M., Sc, M., Judy, I., Witono, R., Sc, M. A., & Penelitian, L. (2013). *Pembuatan biodiesel dari biji karet dengan metode katalis gula*.

[3] Savitri, S., Nugraha, A. S., & Aziz, I. (2016). Pembuatan Katalis Asam (Ni/γ-$Al_2O_3$) dan Katalis Basa (Mg/γ-$Al_2O_3$) untuk Aplikasi Pembuatan Biodiesel dari Bahan Baku Minyak Jelantah. *Jurnal Kimia Valensi*, *2*(1), 1–10. https://doi.org/10.15408/jkv.v2i1.3104

[4] Kusuma, R. I., Hadinoto, J., Ayucitra, A., & Ismadji, S. (2011). Pemanfaatan zeolit alam sebagai katalis murah dalam proses pembuatan biodiesel dari minyak kelapa sawit. *Seminar Nasional Fundamental Dan Aplikasi Teknik Kimia 2011*.

[5] Ahmad Roni, K. (2016). Alkoholis Minyak Goreng Bekas (Jelantah) Pada Tekanan Lebih Dari Satu Atmosfer Dengan Katalisator Buangan Proses Perekahan Minyak Bumi Unit III Palembang. *Jurnal Redoks*, *1*(1), 1–9.

[6] Roni, K. A. (2012). Pembuatan Biodiesel Biji Kepuh (Sterculia foetida L.) denganproses alkoholisis dengan katalisator buangan proses perengkahan minyak bumi pertamina unit II Palembang. *Jurnal Dinamika Penelitian Industri*, *23*(1), 21–29. https://media.neliti.com/media/publications/79341-ID-pembuatan-biodiesel-biji-kepuh-sterculia.pdf

[7] Santoso, H., Kristianto, I., & Setyadi, A. (2013). Pembuatan Biodiesel Menggunakan Katalis Basa Heterogen Berbahan Dasar Kulit Telur. *Disusun Oleh: Herry Santoso, ST, MTM, PhD Ivan Kristianto Aris Setyadi Lembaga Penelitian Dan Pengabdian Kepada Masyarakat Universitas Katolik Prahayangan*, 1–29.

[8] Rustamaji, H. (2010). Alkoholis Minyak Jarak Pagar Dengan Katalisator Asam Padat. *Seminar Rekayasa Kimia Dan Proses*, 4–5.

[9] Padil, P., Wahyuningsih, S., & Awaluddin, A. (2012). Pembuatan Biodiesel dari Minyak Kelapa melalui Reaksi Metanolisis Menggunakan Katalis CaCO3 yang dipijarkan. *Jurnal Natur Indonesia*, *13*(1), 27. https://doi.org/10.31258/jnat.13.1.27-32

[10] Ristianingsih, Y., Hidayah, N., & Sari, F. W. (2016). Pembuatan Biodiesel Dari Crude Palm Oil (Cpo) Sebagai Bahan Bakar Alternatif Melalui Proses Transesterifikasi Langsung. *Jurnal Teknologi Agro-Industri*, *2*(1), 38. https://doi.org/10.34128/jtai.v2i1.23

[11] Heriyanto, H. (2012). Kinetika Reaksi Alkoholisis Minyak Jagung Pada Temperatur Tinggi. *Teknika: Jurnal Sains Dan Teknologi*, *8*(1), 37. https://doi.org/10.36055/tjst.v9i1.6685

[12] Roni, K. A., Prasetyo, A., & Nugroho, D. P. (2020). *Alkoholisis Minyak Jagung (Zea Mays (L)) Dengan Menggunakan Katalis NaOH Pada Tekanan 1 ATM*, *5*(1).

[13] Djenar, N, S., & Lintang, N. (2012). Esterifikasi minyak kemiri sunan (. *Bionatura-Jurnal Ilmu-Ilmu Hayati Dan Fisik*, *14*(3), 229–235.

[14] Aziz, I., Nurbayti, S., & Rahman, A. (2012). Penggunaan Zeolit Alam sebagai Katalis dalam Pembuatan Biodiesel. *Jurnal Kimia VALENSI*, *2*(4), 511–515. https://doi.org/10.15408/jkv.v2i4.268

[15] Putri, S. K., Sudiyo, R., Studi, P., Pangan, T., Pertanian, P., Andalas, U., Kimia, J. T., Teknik, F., & Mada, U. G. (2013). Studi Proses Pembuatan Biodiesel dari Minyak Kelapa (Coconut Oil) dengan Bantuan Gelombang Ultrasonik. *Jurnal Rekayasa Proses*, *6*(1), 20–25. https://doi.org/10.22146/jrekpros.2453

[16] Asri, N. P., Budikarjono, K., Suprapto, & Roesyadi, A. (2015). Kinetics of palm oil transesterification using double promoted catalyst CaO/KI/γ- $Al_2O_3$. *Journal of Engineering and Technological Sciences*, *47*(4), 353–363. https://doi.org/10.5614/j.eng.technol.sci.2015.47.4.1

# The Utilization of Kepyar Castor Oil (Ricinus Communis) and Alumina Silica Catalyst in Alcoholysis Process

ORIGINALITY REPORT

| 11% | 8% | 8% | 5% |
|---|---|---|---|
| SIMILARITY INDEX | INTERNET SOURCES | PUBLICATIONS | STUDENT PAPERS |

PRIMARY SOURCES

| | | |
|---|---|---|
| 1 | Submitted to Universitas Bangka Belitung<br>Student Paper | 3% |
| 2 | docplayer.info<br>Internet Source | 2% |
| 3 | Elfidiah, Kiagus Ahmad Roni, Agustriono. "Corrosion Analysis of Oil Drilling Pipes On Mobile RIG 42.3 N1500 E In Prabumulih", Journal of Engineering and Scientific Research, 2020<br>Publication | 1% |
| 4 | Vera Agustriana Noorhidana Noorhidana, Laksmi Irianti Irianti, Tas'an Junaedi Junaedi. "Mechanical properties improvement of Self Compacting Concrete (SCC) using polypropylene fiber", Journal of Engineering and Scientific Research, 2021<br>Publication | 1% |
| 5 | A F A Raemas, J Cahyonugroho, A D Wicaksono, R L Dewi, Hadiyanto. "Ultrasound-assisted Esterification of Glycerol for Triacetin | 1% |

| | | | |
|---|---|---|---|
| | Production", IOP Conference Series: Materials Science and Engineering, 2021<br>Publication | | |
| 6 | Submitted to The University of Manchester<br>Student Paper | 1 % |
| 7 | users.encs.concordia.ca<br>Internet Source | 1 % |
| 8 | journal.uad.ac.id<br>Internet Source | 1 % |
| 9 | journals.itb.ac.id<br>Internet Source | 1 % |

| | | | |
|---|---|---|---|
| Exclude quotes | On | Exclude matches | < 1% |
| Exclude bibliography | On | | |