

Biodiesel fuel from waste cooking oil using zeolite catalyst

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Abstract. The waste of household cooking oil is thrown away so that it causes environmental problems. Therefore, this problem must be responded to immediately, for example by processing household waste cooking oil into environmentally friendly biodiesel as an alternative method to address this problem. This household cooking oil waste treatment aims at reducing environmental problems, furthermore to discover a way for the waste of household cooking oil to be processed as an alternative fuel to replace diesel, which is biodiesel as a renewable energy source. This study aims to make biodiesel from household waste cooking oil to eliminate or reduce levels of free fatty acids (ALB) contained in used cooking oil catalyst, namely Zeolite Bayah catalyst, while the temperature and reaction time is a fixed variable esterification reaction. The results of this study indicate that the processing of used cooking oil using Zeolite Bayah catalyst can reduce the free fatty acid content contained in used cooking oil, and the physical characteristics of biodiesel generally meets the SNI-04-7182-2012 standard. So that it can be seen that the Zeolite Bayah catalyst influenced the process of reducing free fatty acids in used cooking oil, it can be concluded that some of the parameters are already included in the national standard 04-7182-2012, and it can be seen that the Zeolite Bayah catalyst density parameters obtained the results of 871, the density of NaOH catalysts obtained 862, while from the national standard 04-7182-2012, it was set at 850-890. Both of these results have met the standard for the quality of making biodiesel.

1. Introduction

Technological developments and world's population are increasing, significantly affecting market demand for energy. Therefore, new and renewable alternative energy is needed, one of which is biodiesel fuel. Biodiesel is a fuel that is environmentally friendly, clean and does not contain sulfur so it can reduce environmental damage caused by acid rain (Sara *et al.*, 2017). However, one of the problems faced in using biodiesel is the price that is relatively more expensive than diesel fuel. Hence, we need a way to reduce the production costs of making biodiesel. One method that can be used is by replacing biodiesel-producing energy sources that can reduce production costs, for example from waste cooking oil. Waste cooking oil is not suitable for consumption and commercially has no selling value, therefore it is included in the waste category. Furthermore, cooking oil can damage the image of food that is processed and can also impair the human health. If thrown into the environment is also a cause of environmental pollution. Making biodiesel by utilizing used waste oil is expected to reduce household or food industry waste and reduce biodiesel production costs so that it will ultimately reduce market prices.

The process of making biodiesel uses more homogeneous catalysts, such as KOH. But the use of this homogeneous catalyst raises new problems in the biodiesel produced, namely the biodiesel still contains a catalyst so that it must be re-segregated. The use of KOH catalyst can also cause side



reactions, such as the presence of saponification reactions thus affecting the process of making biodiesel (Tony *et al.*, 2016). In addition to homogeneous catalysts, heterogeneous catalysts such as zeolite can also be used. The advantage of using zeolite is that the process of purifying biodiesel is easier, the separation of catalysts can be done only by filtering because zeolite has molecular filtering properties (Fitriyah., 2017). Therefore, the utilization of Banten zeolite as a homogeneous catalyst is expected to increase the purity of biodiesel.

2. Methods

This research conducted in March 2018 until August 2018 at the Environmental Chemistry Laboratory, Universitas Banten. Analysis was carried out at the Quality Control Laboratory of Lotte Chemical Indonesia.

2.1. Tools and Materials

The tools used in this study are glass tools commonly used in laboratories (glass ware), pH meters, centrifuges, shaker, mortar, sieves 100-150 mesh, analytical balance sheets, stopwatches, thermometers, distillation flasks, GCMS, Materials used are concentrated HNO₃ cooking oil, 2M HCL solution, 0.2M NaOH, pH 7 Buffer and pH 4, GCMS, falling ball viscosimeter, picnometer, triple neck flask, stirrer, thermometer and condenser. The material used is cooking oil waste, methanol and Bayah Banten natural zeolite, this zeolite was obtained from the Bayah Mountains of Banten.

2.2. Research Procedure

Bayah Banten Zeolite Activation as a Catalyst

A total of 25 grams of natural zeolite was put into a glass beaker containing 125 ml of 6M HCl, Shaking for 30 minutes at a temperature of 50°C while stirring with a magnetic stirrer, then filtered with a size of 60 mesh and washed repeatedly until no Cl⁻ ions were detected AgNO₃ solution, dried at 130°C for 3 hours (Noor *et al.*, 2016)

2.3. Making Biodiesel

The 1% catalyst (KOH / H-Zeolite) is mixed with methanol (100 mL) and heated at 60 °C. Used cooking oil (400 mL) is also heated at a temperature of 60 °C in a three neck pumpkin which is equipped with a thermometer and stirrer. After the temperature of the two reactants was reached (60 °C) the catalyst solution and methanol was put into a three neck flask, the stirrer was run at a rotational speed (Noor *et al.*, 2016).

3. Results

3.1 Processing Cooking Oil Waste to Biodiesel with Zeolite Catalyst

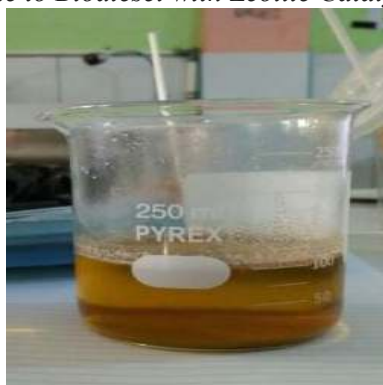


Figure 1. Biodiesel with zeolite catalyst.

The manufacture of biodiesel with zeolite catalyst obtained a density of 0.871 g/ mL, viscosity of 36.6 Cps, moisture content of 0.04%, flash point 136 ° C, pour point 18 ° C, acid number 0.42 mg KOH/g, setana number 55, composition of constituent compounds (sulfur 0.02 mg / kg, phosphorus 2.4 mg / kg, combustion time 2.7 seconds, combustion 15%. It can be concluded that biodiesel with zeolite catalyst has met the biodiesel standard.

3.2 Processing Waste Cooking Oil to Biodiesel with catalyst NaOH

NaOH catalyst is a base catalyst which is used as a zeolite comparison catalyst in making biodiesel. Making biodiesel using NaOH catalyst obtained results that national biodiesel standards, because in this esterification process NaOH can react to free fatty acid content using alcohol (methanol) with NaOH catalyst.



Figure 2. Biodiesel with NaOH catalyst.

The analysis of the examination of the manufacture of biodiesel from used cooking oil using NaOH catalyst was obtained as follow:

Table 1. Results of biodiesel with NaOH catalysts.

Analysis	Unit	Results	Methods
Density	g/ml	0.862	Vicnometer
Viscosity	Cps	29.7	DV-E Viscometer
Water Content	%	0.05	Calvisher
Flash Point	°C	120	-
Pour Point	°C	18	-
Acid Number	mg KOH/g	0.49	Titration
Setana Number	min 51	55	
Sulfur	mg/Kg	0.11	
Phosphorus	mg/Kg	1.7	
Burning Time	<50 detik	43	
Residue	5%	1.8	
Combustion Residue	40%	9.6	

Biodiesel samples obtained were analyzed (density, viscosity, moisture content, point, point of spill, acid number, setana number (sulfur, phosphorus), residual burn time, and residual combustion). The biodiesel produced will be compared with the biodiesel standard. Based on the table above obtained the following results, density and viscosity parameters at 40°C at 0.862 g/mL and 29.7, 0.05% moisture content, 120°C point, 18°C point, acid number is 0.49 mg KOH/g, setana number 55, sulfur 0.11 mg/kg, phosphorus 1.7 mg/kg, burn time 43 seconds, residue 1.8%, residual combustion 9.6%. From these results it can be concluded that the results of some of these parameters are close to the National Standard of Biodiesel in general because the amount obtained is approaching the Value Standard that is in the National Standard of Biodiesel

3.3 Zeolite catalyst biodiesel

Based on the results of the study, it can be concluded that the manufacture of biodiesel meets the average of the National biodiesel standard (SNI 04-7182-2012), because the results of the analysis that has been obtained can accelerate the esterification process. Reduce the free fatty acid content in used waste cooking oil.

Table 2. Analysis Biodiesel Results with zeolite catalyst.

Analysis	Spesification	Results	Method
density	g/ml	0.871	Vicnometer
viscosity	Cps	36.6	DV-E Viscometer
water content	%	0.04	Calvisher
Flash Point	°C	136	-
Pour point	°C	18	-
Acid number	mg KOH/g	0.42	Titration
Setana Number	min 51	55	Spectrometer UV 1601PC
Sulfur	mg/Kg	0.02	
Phosphorus	mg/Kg	2.4	
Burning Time	<50 detik	40	
Residue	5%	2.7	
Combustion residue	40%	15	

Based on the table, the results of biodiesel extraction with Zeolite catalyst were obtained, namely: density and viscosity at 40 ° C at 0.871 g/ml and 36.6 Cps, moisture content 0.04%, flash point 136%, pour point 18 ° C, acid number 0.42 mg / KOH/g, setana number 55, sulfur (0.02 mg/kg, phosphorus 24 mg/kg), residue 2.7% and burning 15%.

Based on the results of the study, it can be concluded that the manufacture of biodiesel met the average of the National biodiesel standard (SNI 04-7182-2012), because the results of the analysis that has been obtained, namely the base catalyst (NaOH) can accelerate the esterification process. reduce the free fatty acid content in used cooking oil.

Based on the research that has been done, if it is presented in graphical form the graph will be obtained as follows:

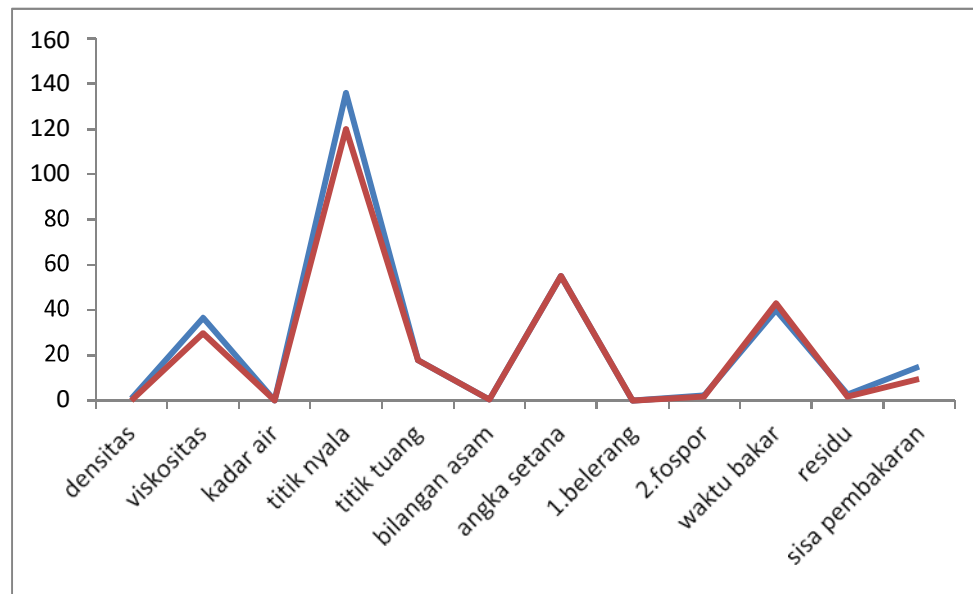


Figure 3. Graph of biodiesel results with catalyst NaOH and zeolite.

4. Conclusions

Based on these data, it can be seen that the results obtained from the production of biodiesel NaOH catalysts and zeolite catalysts have relatively different results. Where the results obtained from biodiesel with zeolite are likely to be faster and the results obtained are more maximal. Due to the function of zeolite itself which is to accelerate the esterification and transesterification process. The results obtained in the reaction are closer to the main purpose of biodiesel in general, where the characteristics of biodiesel itself can eliminate or reduce the content of fatty acids in used cooking oil, namely by using a zeolite catalyst. Esterification reaction conditions at the time of the study eliminated faster the content of fatty acids in used cooking oil, so that the fatty acid content of the oil turned into methyl ester, then methyl ester can break down alkaline groups from ester compounds using KOH (Potassium Hydroxide). Experimental variables that influence the yield of biodiesel during the esterification process are the weight of zeolite catalyst and mole ratio of oil: methanol, while temperatures of 60- 70°C and reaction time of 60 minutes are fixed variables.

Based on the table above obtained the following results, namely density and viscosity parameters at 40°C at 0.862 g/ml and 29.7, 0.05% moisture content, 120°C point, 18°C point, 0 acid number, 49 mg KOH/g, setana number 55, sulfur 0.11 mg/kg, phosphorus 1.7 mg/kg, burn time 43 seconds, residue 1.8%, residual combustion 9.6%. From these results it can be concluded that the results of some of these parameters are close to the National Standard of Biodiesel in general because the amount obtained is approaching the Value Standard that is in the National Standard of Biodiesel.

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