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Utilization of Bengkirai Wood Sawdust as a Heterogeneous Catalyst in Catalytic Cracking Process of Used Oil into Base Fuel

Muh. Irwan[1], Grace Putri Syalom[1], Alwathan[1], Nita Handayani[1], Febri Puspita Sari[1]
[1]Department of Chemical Engineering, Politeknik Negeri Samarinda, Jalan Dr. Ciptomangunkusumo Kampus Gunung Lipan Samarinda, 75131 Kalimantan Timur Province Indonesia
Email address: Muh.Irwan@polnes.ac.id

***Abstract*—*Used oil is waste dangerous and toxic (B3) which can damage the environment. Catalytic cracking is a processing method further from used oil which uses a catalyst to conduct the cracking reaction. Activated carbon from Biomass waste, namely bengkirai wood sawdust, can be an environmentally friendly and economical catalyst cost. This research aims to determine the effect of biomass-activated carbon catalyst mass on yield and properties of other liquid products through the catalytic cracking process and to determine changes the composition of used oil becomes the base fuel. The pyrolysis process is carried out by varying the mass of the resulting activated carbon carbonization and after chemical activation 5,10,15,20,25 grams at a temperature of 500 C for 15 minutes and chemically activated for 24 hours using an H3PO4 activator at a pyrolysis temperature of 350 C for 90 minutes. From the research, it was found that the mass of the activated carbon catalyst after chemical activation was 15 grams to produce fuel which enters the kerosene standard with the following physical properties: yield of 65%, density of 789.1 kg/m3, specific gravity is 0.7898, API degrees are 47.6593, and kinematic viscosity is 1.3821 mm2/s.*

***Keywords*—** *Coal, adsorbent, waste engine oill, adsorption, sulphur.*

I. INTRODUCTION

Along with the increase in the transportation sector the need for oil also increases. Based on Indonesia government regulation number 101 of 2014, oil has a certain period of use, and if after this period, it will become Waste engine oil or used oil which if not processed further can become hazardous and toxic. Therefore, used oil needs to be processed into useful products that can be reused (reusable). One of Further processing of used oil is carried out Processing used oil into base fuel using methods catalytic cracking which uses a catalyst to carry out a cracking reaction [1]. Catalyst which has low costs and is eco-friendly obtained from carbonized biomass waste and activated into activated carbon. In a few years Lastly, activated carbon has been used, among other things catalyst for chemical synthesis (n-butyl ester), production biofuels (e.g. biodiesel and syngas), tar cracking and pollution control Convertible activated carbon from bengkirai wood sawdust which is waste from the property industry which is rich in carbon especially cellulose and lignin (52.9% and 24%) [2].

Several other studies also examine the conversion of used oil into liquid fuel through the catalytic cracking process with the help of activated low-rank coal H_3PO_4-$NaHCO_3$ as a catalyst, some use biomass such as palm husks, woods, and coconut shells as a catalyst. The results obtained on average for liquid fuel soaking are in the range of 70 - 85% of the liquid product obtained has characteristics similar to diesel. In this research, the catalytic cracking process will be carried out by utilizing biomass derived from bengkirai wood, this is because bengkirai wood is very abundant in East Kalimantan, besides that because of its commercial use in the wood craft industry, there is quite a lot of bengkirai wood waste in the form of sawdust. underused. Seeing this, efforts are needed to increase the added value of bengkirai wood powder by using it as a bio-mass catalyst. Low-cost and ecofriendly catalysts can be obtained from biomass waste which is carbonized and activated into active carbon. In recent years, activated carbon has been used, among other things, as a catalyst for chemical synthesis (n-butyl ester), biofuel production (e.g. biodiesel and syngas), tar cracking, and pollution control. Activated carbon has good properties as a catalyst because it is inert, the surface can be modified and its porous nature [3].

Activated carbon can be converted from Bengkirai wood sawdust which is waste from the property industry. Bengkirai wood (Shorea Leavifolia Eudert) is a typical Kalimantan wood that is high quality, durable and long-lasting. However, the growth of the property industry in Indonesia has led to an increase in bengkirai wood sawdust waste. This waste is usually burned or thrown into rivers, which can pollute the environment. The potential solution is to convert this waste into active carbon, considering that bengkirai wood is rich in carbon, especially cellulose and lignin (52.9% and 24%). The content and quality of bengkirai wood shows that sawdust has the potential to be processed into active carbon [4].

This research focused on the catalytic cracking process through a pyrolysis process using bengkirai wood dust as a heterogeneous catalyst. This research aims to obtain yield and °API data on the liquid fuel obtained and it is hoped that this research can be used as a reference on how to do reduce the amount of environmental pollution caused by the presence of used oil and sawdust bengkirai wood.

II. METHOD

This research was carried out at the Basic Chemistry Laboratory of Chemical Engineering at the Samarinda State Polytechnic. Start with the preparation of raw materials in the form of bengkirai sawdust obtained from CV Mitra Wolo

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Marin Samarinda Company and other analytical materials obtained from the Basic Chemical Engineering Laboratory of Samarinda State Polytechnic.

In this study, a number of variables were determined as follows :

1. The fixed variables used in this research are used oil volume: 250 ml, pyrolysis temperature: 350ºC, pyrolysis time: 90 minutes, activator H_3PO_4 25% (1:1), Size bengkirai wood sawdust (-100+120) mesh
2. The changing variable used in this research is the mass of activated carbon resulting from carbonization and after chemical activation (5,10,15,20,25) grams.
3. The response variables in this study are: % Yield, Density, Viscosity, API Degree, Specific Gravity, GC-MS.
   Research procedures are divided into two part, namely:

1. Procedure for Making Catalyst from Bengkirai Wood Sawdust Activated Carbon

Prepare bengkirai wood sawdust. Dry the bengkirai wood sawdust using an oven at 150℃ for 1 hour. Carbonize bengkirai wood sawdust using a furnace at a temperature of 500℃ for 15 minutes. Sift to get a size of 100 mesh. Analyze the iodine adsorption test. Chemically activate wood powder activated carbon by soaking it in a H_3PO_4 solution with a concentration of 25% for 24 hours with a ratio of 1:1. Wash the activated carbon adsorbent with distilled water until the pH is neutral, then dry using an oven at 150℃ for 1 hour. Sift to obtain a size of 100 mesh. Analysed the iodine adsorption test.

2. Pyrolysis Procedure

Filter 250 ml of used oil. Prepare 250 ml of used oil. Then turn on the pyrolysis tool. Set the temperature of the pyrolysis furnace at 350ºC. Weigh the empty weight of the reactor tube, record the weight. Insert a 5 gram sample of activated carbon for the pyrolysis process into the reactor tube containing 250 ml of used engine oil. Weigh the reactor tube + contents, then record the weight. Insert the reactor tube into the pyrolysis distillation unit, if the pyrolysis unit temperature has reached the set point at 350ºC and is stable. Observe the process and record the temperature and time at which the first drop of condensate occurs. Collect the liquid product resulting from the pyrolysis process in a 100 ml measuring cup. Carry out the pyrolysis process for 90 minutes. Stop the pyrolysis process if the time has reached 90 minutes. Wait for the reactor temperature to drop and then weigh the collected condensate using a digital scale. Record the weight of the reactor tube + residue. Repeat steps 1-17 to vary the mass of activated carbon catalyst. Turn off the pyrolysis equipment circuit.

III. Results and Discussion

Based on the research that has been carried out, data was obtained on the initial raw material for engine oil and the raw material for bengkirai wood sawdust which was used as activated carbon, which can be seen in the table below

TABLE 1. Density and Viscosity of Waste Engine Oil

Parameters	Result
Density 15ºC	0.8963 g/mL
Kinematic viscosity at 40ºC	1.6397 mm^2/s

TABLE 2. Iodin Adsorption number on Activated carbon from Bengkirai wood sawdust

Bengkirai wood sawdust	Result
Carbonization	775.2773 mg/g
Activation	876.9597 mg/g

In the Table 1 above describes the results of the analysis of density and viscosity carried out on engine oil before the pyrolysis process is carried out. Then in Table 2 above are the results of the analysis carried out on bengkirai wood powder which was activated through the carbonization stage and the chemical activation stage to determine its absorption capacity based on iodine number parameter.

Effect of Activated Carbon Mass on the % Yield of Used Oil Pyrolysis Products

Based on the results obtained from variations in the mass of activated carbon, it was found that increasing the carbon dosage could affect the amount of yield obtained in the waste engine oil pyrolysis process as presented in Figure 1 below.

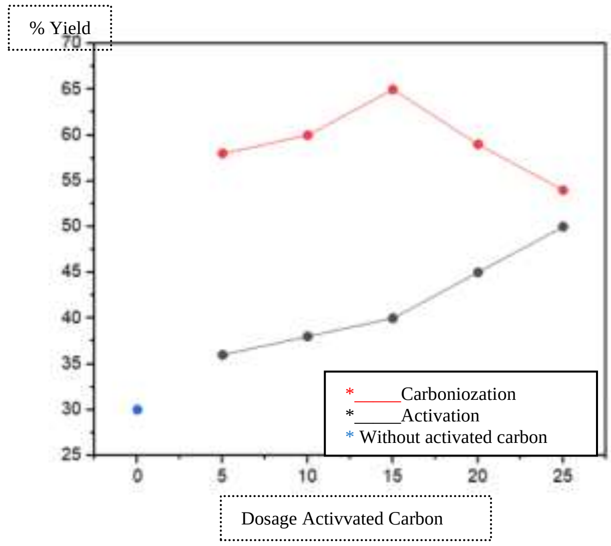

Figure 1. Effect of activated carbon dose on the yield from the pyrolysis process

From Figure 1, it can be interpreted that the yield percentage shows that the yield using activated carbon for pyrolysis results increases compared to pyrolysis results without using active carbon. This shows that the acidic activated carbon catalyst adds protons to the olefin molecules or attracts hydride ions from alkanes, causing the formation of carbonium ions. Carbonium ions are very reactive molecules that attack paraffin and naphthene to produce new carbocation. This causes the conversion value of the desired product to be higher [4].

The yield with activated carbon resulting from carbonization increased as the mass of activated carbon was added, namely 5, 10, 15, 20, and 25 grams, where the highest yield was obtained at a mass variation of 25 grams with a percentage of 50%. The addition of a catalyst to the catalytic cracking process will increase the opportunity for the reactants to react with each other more, thereby increasing the efficiency of the product produced. The yield with activated

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carbon after chemical activation treatment experienced an increase in yield of around 15% greater than the yield of activated carbon resulting from carbonization. The yield increased at masses of 5, 10, 15 grams, where the optimum yield was obtained at a mass variation of 15 grams with a yield percentage of 65%. However, after this increase there was a decrease in the yield of additional catalyst mass thereafter with a variation of 20 grams to 59%. The decrease in yield after increasing is due to the amount of product produced from catalytic cracking being directly influenced by the activity of the catalyst used. The more catalyst used, the more active sites available for the reaction [5]. However, the increase in product yield will decrease or even not increase at all when a certain amount of catalyst is added. So if too much catalyst is used, it can reduce the yield of liquid fuel, because the cracking process is more effective and produces light fractions that can form gas so that it cannot be condensed [6].

The addition of variations in catalyst mass will be directly proportional to the product yield, but if the product has reached optimum conditions, using too much catalyst will only cause reduced conversion and will not provide a comparable increase in catalytic performance [7]. It can be concluded that the optimum mass variation under constant process conditions is using chemically activated activated carbon of 15 grams with an optimum yield of liquid product of 65%. This happens because in catalytic fracturing the breaking of hydrocarbon bonds occurs due to the presence of carbonium ions which are produced from the interaction between the acid in the heterogeneous catalyst and the alkane/olefin [8].

Effect of Activated Carbon Mass on Density 15ºC, Kinematic Viscosity 40ºC, and API Degree of Liquid Products

Below is presented the effect of activated carbon mass in the waste engine oil pyrolysis process on density 15ºC, kinematic viscosity 40ºC, and degrees of liquid product API, as presented in Figure 2.

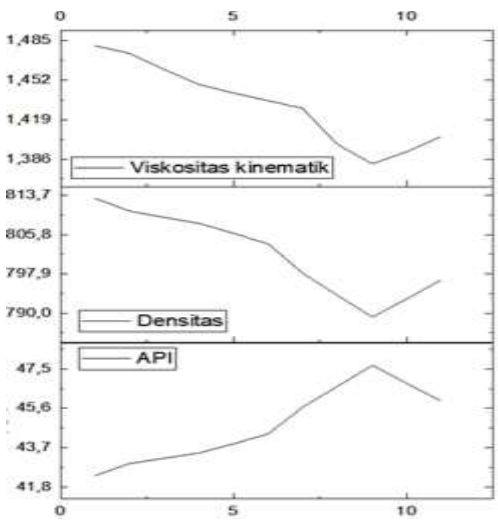

Figure 2. Effect of activated carbon dose on Density 15ºC, Kinematic Viscosity 40ºC, and API Degree of Liquid Products

From Figure 2 it can be seen that the data for the pyrolysis process without using activated carbon obtained a density value of 813.1 kg/m3, viscosity of 1.4808 mm2/s and API degree of 42.3756. Then, after carrying out the pyrolysis process using activated carbon, the optimum density and viscosity values decreased to 789.1 kg/m3 and 1,3821 mm2/s.

Along with the addition of carbon mass, there is a decrease in density and viscosity which can be seen in Figure 2, indicating that cracking has occurred which results in the breaking of the hydrocarbon chain to become shorter, resulting in a decrease in the density and viscosity of the liquid product [9]. The degree of API shows an inverse relationship with the density and viscosity of the liquid product resulting from pyrolysis [10].

After an optimum mass of 15 grams of chemically activated activated carbon with a yield of 65%, a decrease in yield was seen followed by an increase in density and viscosity again. This is due to the formation of carbon deposits in the cracking reaction so that the molecular weight of the compound being analyzed increases. These carbon deposits can be clearly seen in the cracking reaction products which are dark brown in color and carbon deposits. Carbon deposits or better known as coke, are intermediate cation products that are more stable and accumulate in the catalyst during the reaction. These carbon deposits are included in the density and viscosity test of the cracking reaction products so that the resulting density and viscosity are greater [11].

III. CONCLUSION

The addition of a catalyst from activated carbon from Bengkirai wood sawdust has an effect on the yield of liquid catalytic cracking products which is 35% higher than without using a catalyst.

A mass of 15 grams of chemically activated activated carbon catalyst produces base fuel that meets kerosene specification standards in the best conditions with the following physical properties: yield of 65%, density of 789.1 kg/m3, specific gravity of 0.7898, API degree of 47.6593, and kinematic viscosity of 1.3821 mm2/s.

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