PREPARATION ANDCHARACTERIZATION OFACTIVATED CARBONFROMPALMSHELL

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ABSTRACT

Abstract. Palm shell is resulted waste from industry process of palm oil which its usage is not maximal. Treatment of palm shell as activated carbon is one of alternative way to treat solid waste of palm shell for giving economy value. The objective of this study is to know the effect of concentration of H_3PO_4 and activation time on characteristic of activated carbon that resulted. Four activator concentration of H_3PO_4 (10, 15, 20, dan 25%) during 18, 20, 22, dan 24 hours. The best characteristic based on the standard SII No. 0258-79 and SNI 06-3730-19, is by using activation time during 24 hours with concentration of activator 25%, result activated carbon with inherent moisture 3,76%; ash content 4,22%; volatile matter 10,88%; fixed carbon 81,14%, capacity on iod 877,71 mg/g.

Key words: Palm shell, Activated carbon, H_3PO_4

1. I. INTRODUCTION

Indonesia is thesecondlargest palm oilin the worldafterMalaysia. Indonesiajumpedto be the biggest palm oil exporter in the world. In the harvest Time 2009/10, This nationproduces21milliontonnes of palm oil, which isalmost half of theworld'spalm oilproduction which thetotal is45milliontonnes. A total of18milliontonnescome fromMalaysia. The projection ofthe next few yearsis estimatedIndonesiaoccupies thefirstposition. Market prospectsforthe processof palm oilis quitepromising, because the demandfromyear to yearhas increased quitelarge, notonly domesticallybutalso abroad[1].The increasing ofpalm oilproduction will result in increasing the amount ofwaste produced. The waste of palm oil plantis awaste that isproducedfromthe process ofpalm oil whichis a liquid, solid, andgasfor thatpotentially causeenvironmental pollution. The waste of palm oil plantcontainsa number ofsuspended solids, dissolved, andthefloatingorganic materialswitha high concentration.It was also statedthateverytonof fresh fruit bunches(FFB) of palm oilresultswasteof 900kg which isderivedfrom thesterilization,classification, andhydrocycloneunit[2].

Palm shells are part of the oil palm fruit that is located inside the coconut husk which has been utilized by burning it in the incinerator as a source of energy and is also used directly for road hardening in oil palm plantations. This technique turns out to be ineffective and even causes air pollution. There foranother alternatives is needed in the use of oil palm shell in order to obtain value addition economically. One of the alternatives that can be done is to cultivate oil palm shells into activated charcoal. Activated carbon is a material in the form of free carbon, each of which binds covalently or charcoal that has been made and processed exclusively through the activation process, so that the pores open and thus have the absorptive capacity significantly to other substances, either in the liquid phase or in the gas phase. Thus, activated charcoal surface is non-polar. Pore structure related to the surface area, where the smaller the pores of activated charcoal, resulting in greater surface area[3].

Some research on the manufacture of activated carbon from a variety of materials with a chemical activator has been done in some other areas where variables are used diverse. Research manufacture of activated carbon from coconut oil with chemical activation method. In this study the activator which is used was NaOH, NaCl, and HCl at a concentration of 2% and the activation time for 1, 2, and 4 hours at a temperature of 500°C and carbonization processes is done at a temperature of 300, 450, and 500°C with a time of 1; 1.5; 2; 2.5; and 3 hours. Carbonization process showed the best results at a temperature of 500^0C and 3 hours with a water content of 18%, yield 23%, volatile substances 3% and 61% bound carbon content. Activation with NaOH for 4 hours showed the best results with a 3.6% concentration of activated charcoal and I2 absorption of 851.8797 mg/g [4].A study of making activated carbon from bamboo by uncontrolled activation method using H_3PO4 and KOH activating agent with a mass ratio of activating agent/carbon mass of 1/1,

2/1, and 3/1. Activation is done at a temperature of 700°C for 1 hour. The highest surface area represented by iodine at 772.08 mg/g obtained by activation using H_3PO4 with a mass ratio of activating agent/carbon mass of 3/1, while the activation using KOH the highest iodine obtained is 744.92 mg/g with activating mass ratio agent/carbon mass of 3/1. A study on the effect of H_2SO_4 activator concentration on activated carbon absorption of oil palm shells at concentrations of 1, 2, 3 M with a particle size of 60, 170, and 200 mesh. The best conditions are obtained at a concentration of 3 M with a particle size of 200 mesh produce a water content of 2.69%; ash content of 1.85%; and the absorption of iodine by 888,370 mg/g [5].

In [5], A study on the effect of temperature and concentration of KOH activators to process of making the of palm shell activated carbon to treat POME at a temperature of 450 ° C and 500 ° C with a concentration of 5, 10, 15, 20, and 25%. The best conditions obtained on the active carbon at a temperature of 500°C and a concentration of 25% KOH activator produces water content of 6.34%; 3.506% ash content, volatile matter content of 10.163%, 78.991% carbon content; and the absorption of iodine by 457.828 mg/g.

A study the characterization of the BET surface area (Braunanear, Emmelt, and Teller) activated carbon from coconut shell and palm empty fruit bunches with the activation of phosphoric acid (H_3PO_4) with a concentration of 2.5; 2.75; 3; 3.25; and 3.5 M for 7 hours with carbonization temperature of 400°C for 3 hours. From the research that the best surface area of activated carbon is in coconut oil with a variety of 3 M with the results of 386.447 m^2/g [6].

Referring to some of these studies, this research is conducted in order to improve the quality of activated carbon. Activated carbon is made with an H_3PO4 activator with concentration of 10, 15, 20, and 25% at the time of activation 18, 20, 22 and 24 hours.

Methodology

In the preparation process of activated carbon from palm shells carbonization process needs to be done beforehand, analyze physical and chemical properties were generated and determine the optimum conditions of the concentration of activator.

2. II. Materials and Tools

The raw material used is palm kernel shells taken from PT Sawit Mas Sejahtera. Other chemicals that are used are phosphoric acid, starch, potassium iodide, iodine, sodium thiosulfate, sodium carbonate, isoamyl alcohol, sulfuric acid, potassium dichromate, phenolphthalein indicator, acetic acid, sodium hydroxide and distilled water as needed. While the tool used is a furnace, oven, analytical balance, disc pulverizer, Hardgrove grindibility Index, sieve, beakers, funnel cups, erlenmeyer, pH-meter, crusibel, saucer porcelain, desiccator, hot plate, spatula, stirrer, biuret, pumpkin measuring, measuring pipette, pipette, and a rubber bulb.

In this research, there are four basic stages, ie the preparation of raw materials, carbonization, activation, and analysis. There are two variables that are used, namely the independent variable and fixed variables. Independent variables, including the concentration of H_3PO_4 (10, 15, 20, and 25%) and the activation time (18, 20, 22, and 24 hours). While the permanent variable is carbonization temperature (550°C) and carbonization time (1 hour). The observed parameters for analysis is the yield, moisture content, ash content, content nudah substance evaporates, bound carbon content, and the absorption of iodine number.

III. Results and Discussion

Manufacture of activated carbonis developed by concentration variation ofH_3PO_4 activator, with the precentages are 10%, 15%, 20%, and 25% and activation time are 18, 20, 22, and 24 hours. The Activated carbon content is tested quality, which include yield, moisture content, ash content, volatile matter content, carbon content bound, iodine number. Based on the research that has been conducted, from 3000 gr palm oil shells were carbonized for 1 hour at 550°C temperature to produce yield of 30.04%. Whereas the water content, ash content, volatile matter content, carbon bound content, iodine number are ranging from 3.76 to 9.42%; 1.98 to 4.22%; 7.87 to 10.88%; 79.59 to 81.77%; 168.79 to 877.71 mg/g.

Discussion Yield

Determination of carbon yield aims to determine the amount of carbon produced after carbonization. Carbonization process is performed using a furnace at a temperature of 550° C for 1 hour.

The presence of a low yield that can be attributable to the increase in the rate of reaction between carbon and gases as well as the large number of compounds that vaporize substances apart.

Water Content

Determinationaims to determine the moisture content of hygroscopic feature of activated carbon. Hygroscopic is the ability of a substance to absorb water molecules from the environment either absorption or adsorption. High water levels can reduce carbon adsorption against liquids and gases.

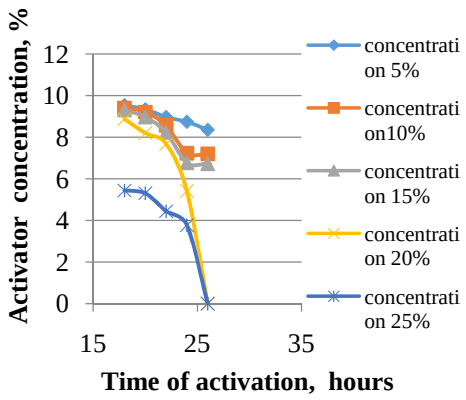

Figure 1 The relationship between time of activation time with water cntent at various concentration H_3PO_4

From Figure 1 can be discovered that the water content tends to fall with increasing activation time and concentration of H_3PO_4. At the time of activation of 18 hours, the water content reaches 9.42% at a concentration of 10%. This value is getting down and the decrease very evident at the time of activation of 24 hours, which amounted to 3.76% at a concentration of 25% H_3PO_4.

If seen by the graph, the interaction of the activation time and concentration of H_3PO_4 very influential so if the activation time longer and the concentration of H_3PO_4 higher, water content is getting smaller.According to [7], the concentration of activator effect on the activation process, if the concentration of the activator higher, so the influence is more greater to bind tar compounds (hydrocarbon substances which are sticky and stick on carbon) out pass the cavities or pores of the activated carbon, so that the more extensive pore volume.Increasing the surface area of activated carbon is resulting in the ability of activated carbon adsorption higher and the quality is more better.

However, not all interactions activation time and concentration of H_3PO_4 cause real change. Fore example, activated carbon for 22 hours at a concentration of 15% H_3PO_4 has a water content of 8.23% does not look real difference compared with activated carbon for 20 hours at a concentration of 20% H_3PO_4 which has a moisture content of 8.20%. The water content contained in the activated carbon is influenced by the amount of water vapor in the air as well as the duration of the cooling process, grinding and sieving. Cooling, grinding and sieving which longer be able to increase the water content of the activated carbon.

The best water levels have on the treatment concentration of 25% with a 24-hour activation time has fulfilled both SII No. 0258-79, below 10%, and SNI 06-3730-1995, below 4.5% for granular, ie 3.76%.

Ash Content

Determination of ash content aims to determine the content of the metal oxide contained in the activated carbon.According [8], The ash is inorganic substances wasteproducts of combustion of an organic material or substance that is not flew. Ash consists of a compound of the elements Si, Al, Ca, and Mg.

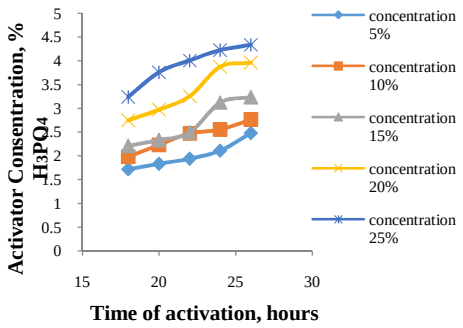

Figure 2 The relationship between Time of activation time with ash content at various concentration H_3PO_4

From Figure 2 can be discovered that the ash tends to increase with increasing activation time and concentration of H_3PO_4. At the 18-hour activation time, ash content reached 1.98% at a concentration of 10%. This value is getting rise and the rising very evident at the time of activation of 24 hours, which amounted to 4.22% at a concentration of 25% H_3PO_4. According to [9], high levels of ash content produced can reduce the adsorption capacity of the activated carbon, as activated carbon pore filled metallic minerals such as magnesium, calcium, and potassium.

If seen by the graph, the interaction of the activation time and concentration of H_3PO_4 very influential so if the activation time longer and the concentration of H_3PO_4 higher, the ash content greater. The increase in the value of the ash content of each activator concentration is not too far away. This could be due to the pH neutralization stage after stage of activation by washing using distilled water is not as much washing activated carbon with other concentrations, so it still contains tar and organic minerals that high so cover the pores of the activated carbon.According to [10], basically the more concentrated levels of activating substances are used, it is increasingly expanding the surface of activated charcoal because the pore produced more and more. In pore formation, during the heating process occurs combustion surface area of activated charcoal produces ash, so more pores generated then the resulting ash content is also higher.According to [11], the high ash content which can reduce the ability of activated carbon to absorb gases and solutions.

However, not all interactions activation time and concentration of H_3PO_4 cause real change. For example, activated carbon for 20 hours at a concentration of 10% H_3PO_4 has ash content of 2.23% does not look real difference compared with activated carbon for 18 hours at a concentration of 15% H_3PO_4 which has ash content of 2.21%.

Best levels of volatile matter contained in treatment concentration of 10% with a 18-hour activation time has fulfilled of SII No. 0258-79 and SNI 06-3730-1995, that is below 2.5%.

Levels of Volatile Matter

Determining levels of volatile matter known compound that it didn't evaporate yet in the carbonization and activation process, but it could evaporate at 950°C.According to [11], water, ash, carbon bound, nitrogen, and sulfur were component that contained in activated carbon. Nitrogen and sulfur would evaporate on heating above 900°C, and these components were volatile matter

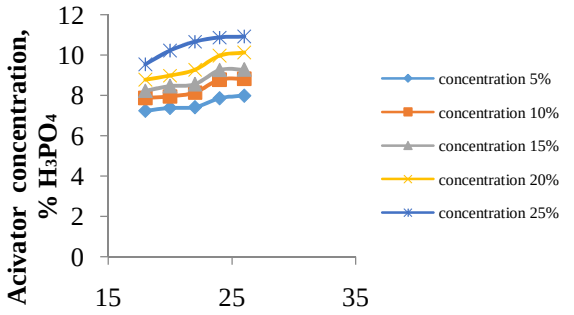

Figure 3 The relationship between Time of activation time with volatile matter content at various concentration H_3PO_4

From the figure 3, it can be known that levels of volatile matter tended to rise with increasing activation time and concentration of H_3PO_4. At 18 hours activation time, levels of volatile matter reached 7,87% with 10% concentration. These values would get up and rising were very clear that it happened at 24 hours activation time, it was 10,88% in the 25% concentration of H_3PO_4.

If it was seen by the graph, so interaction from activation time and concentration of H_3PO_4 that it was very influential so the longer of activation time and the higher of H_3PO_4 concentration, it tended to rise levels of volatile matter. It was caused H_3PO_4 that added carbon to seep, to coat, to protect the material from it was hot. The higher of concentration of H_3PO_4, so a few of sulfur and nitrogen in the materials that it burned and evaporated at 950°C or levels of volatile matter became high. Levels of volatile matter would reduce an ability active carbon to absorb gas and solution.

However, it was not all of interaction from activation time andconcentration of H_3PO_4, it caused real change. For an example carbon was activated for 24 hours with 15% concentration of H_3PO_4 that it had 9,26% levels of volatile matter and it was not visible a real difference that it compared with carbon was activated for 22 hours with 20% concentration of H_3PO_4 that it had 9,27% levels of volatile matter. All samples of levels of volatile matter were produced that it fulfilled actived carbon of standard SII No. 0258-79 and SNI 06-3730-1995 under 15%.

Levels of Carbon Bound

According to [12], carbon can be made to become active carbon if it contained the high of the levels of carbon bound around 70-80%.

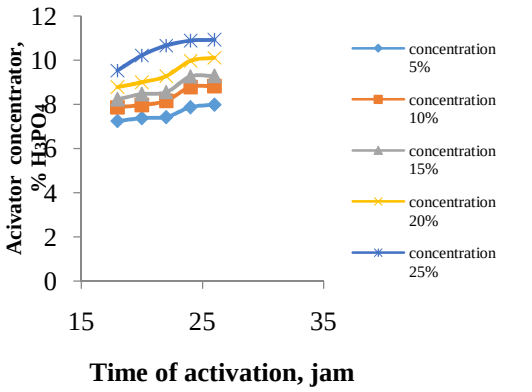

Figure 4 The relationship between Time of activation time with carbon bound content at various concentration H_3PO_4

From the figure 4, it can be known that levels of carbon bound tended with it was not fix in a row to increase it activation time and H_3PO_4concentration. The high and low it, this levels of carbon bound was affected with water content, ash, and volatile matter.

If it was seen by the graph, so interaction from activation time and H_3PO_4concentration that it was very influential so the longer of activation time and the higher of H_3PO_4 concentration, it tended to bring down levels of carbon bound. Levels of carbon bound was low to show many carbon atoms that it reacted with water vapor. The water vapor produced gas such as CO and CO_2so carbon atoms were back to form a few of hexagonal structure.

Determination of The iodine Number

Determination of active carbon absorption to iodine to know active carbon ability that it could absorb color solution or dirt.

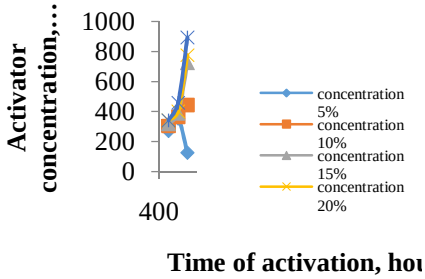

Figure 5 The relationship between Time of activation time with iodine number content at various concentration H_3PO_4

From the figure 5, it can be known that active carbon absorption to iodine tended to rise in a row to increase activation time and H_3PO_4 concentration. At 18 hours activation time, iodine number reached 168,79 mg/g at 10% concentration. This value would get up and rising was very clear that it happened at 24 hours activation time, it was 877,71 mg/g in the 25% H_3PO_4 concentration.

If it was seen by the graph, so interaction from activation time and H_3PO_4concentration that it was very influential so the longer of activation time and the higher of H_3PO_4 concentration, absorption to iodine that higher. Rising this absorption showed that carbon atoms formed so many hexagonal crystallites so gap or pore that it was formed between layer of crystallites that the higher too.This result in according with [13] where he conclude that there was P_2O_5 compound that it was H_3PO_4 decomposition result.It was caught in the charcoal that it gave rise to microporous structure and mesoporous in the structure. After that, the higher of H_3PO_4 concentration produced mesoporous structure that it had surface area and pore volume so big. Active carbon absorption to iodine was better in 25% concentration that it was soaked for 24 hours. It has filled up SII No. 0258-79 that it was 20% minimum and SNI 06-3730-1995 that it was 750 mg/g minimal, 877,71 mg/g active carbon standard.

3. IV. CONCLUSION

Based on the results were obtained from this researched, it had conclusion that preparation and characterization of activated carbon from palm kernel shells with 10, 15, 20, and 25% concentration variation of $H_3PO_4$and activation time 18, 20, 22, 24 hours were got characteristics that it had been fill up SII No. 0258-79 and SNI 06-3730-1995 standard, those were activated carbon with 25% concentration of $H_3PO_4$and 24 hours activation time where water content, ash, levels of volatile matter, levels of carbon bound and iodine number were 3,76%; 4,22%; 10,88%; 81,14%; and 877,71 mg/g.

This experiment needs more development about the use of H_3PO_4actived material, concentration variation of H_3PO_4 and the other of activation time so that the value of the active carbon and ash was got at a good condition and it can fill up for existing standard.

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