Utilization Of Elephant Grass Into Activated Carbon As A Synthetic Metal Absorber

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Abstract: Elephant grass (Pennisetum Purpureum) is one type of underutilized plant. Grass is only used as fodder and is often considered a disruptive plant whereas elephant grass contains a high level of cellulose at 40.58%. plants that have high cellulose levels can be used as raw materials for the manufacture of activated carbon. Carbon is one of the materials in the form of granules or powders and the use of activated carbon is quite extensive, both in large and small industries. In addition to plants, activated carbon can be made from raw materials derived from animals, waste or minerals containing carbon such as: bones, softwood, husks, corn cobs, coconut shells, coconut husks, cane milling pulp, paper making pulp, sawdust, hardwood and coal. This study aims to determine the influence of the type and concentration of activator substances on the process of making activated carbon with an active temperature of 600, 700, 800 and a concentration of 0.2M 0.3M 0.4M 0.5M and 0.6M, the process of making activated carbon is carried out with a 24-hour activation time, a carbonization temperature of 750oC, a carbonization time of 15 minutes, and an active carbon size of 200 meshes and types of activator substances (HCl, NaOH, and NaCl) with concentrations (0.2M 0.3M 0.4M 0.5M and 0.6M respectively). The results showed volatile matter levels of 2,834%, water content of 4.1%, ash content between 0.271%, and absorption of iodium 1,243.62 mg/g. The optimum condition of activated carbon from elephant grass is in the HCl activator type concentration of 0.6 M.

Index Terms: Elephant Grass, Activated Carbon, Absorption, Synthetic Metals.

1 INTRODUCTION

Activated carbon is widely used for water purification and purification processes as well as gas purification processes. such as pure gases used for hospital needs, or gases commonly used for daily cooking. Activated carbon in the industry is often used as a filter for the food industry, such as soda drinking water companies that conduct water treatment using carbon. Carbon is made from plants containing cellulose. One of the plants that can be used as a raw material for making activated carbon is elephant grass plants. Elephant grass (Pennisetum purpureum) is a large, highly nutritious grass that is usually used as animal feeds such as cows, goats, elephants, etc. Elephant grass grows perpendicular, plant height can reach 7 meters, thick and hard stemmed, long leaves, and flowering like ice wax. The nutritional content of elephant grass consists of 19.9% dry ingredients; 10,2 % coarse protein; 1.6% fat; 34%,2 coarse fibers; 11.7% ash.

Figure 1. *Elephant Grass*

Activated carbon is a material in the form of amorphous carbon that has a very large surface area of 300 to 2000 m^2/gr. This very large surface area is caused by having a pore structure. It is these pores that cause activated carbon to have the ability to absorb. Activated carbon is composed by covalently bound carbon atoms in a hexagonal lattice. The ability of activated carbon to dissoscribe is determined by its chemical structure, namely the chemically bound C, H, and O atoms forming functional groups. Utilization of activated carbon in the industrial world in Indonesia is generally increasing. The need for activated carbon in the country is still met from imports. This is due to the lack of domestic production and low quality of activated carbon. The process of making activated carbon consists of two stages, namely carbonization and activation both chemically, and physics. There are various activator materials in the manufacture of activated carbon. According to Kirk and Othmer (1978), chemicals that can be used as activators include $CaCl_2$, Ca $(OH)_2$, NaCl, $MgCl_2$, HNO_3, HCl, $Ca_3(PO_4)_2$, H_3PO_4, $ZnCl_2$, and so on. All these active ingredients are generally water binders. The type of activeator used and its concentration will affect the quality of activated carbon produced. Carbon activation there are 2 namely thermal activation and chemical activation. Thermal activation is an activation process that involves the presence of oxidizing gases such as air at low temperatures, steam, CO_2, or gas flow at high temperatures (Pohan, 1993). Chemical activation is carried out to enlarge carbon pores so that their absorption can be maximized by using an activation solution (activator) (Kwaghger &Ibrahim, 2013). In this study researchers used a solution of strong acid activators namely hydrochloric acid (HCl). The purpose of their use is to remove metal oxides in charcoal that cover pores because the properties of this acid can damage tissues in plants to enlarge pores at the time of adsorption between adsorbats and adsorbents (Isnijah, 1990) Research conducted by Kwaghger et al (2013) Optimization of activated carbon synthesis from mango seed shells obtained that along with the increase in the concentration of HCl activators (25%; 50%; 75% and 100%) then the surface area of the pore will also increase. However, in the study mentioned that the maximum condition has not been achieved. This is characterized by a relatively low increase in pore surface area. On the other hand, in the research conducted by Djeni Hendra and Saptadi Darmawan produced the opposite. Increased concentration of H_3PO_4 activators (0%; 2.5%; 5% and 7.5%) in the synthesis of activated carbon shell hazelnuts produce a volatile pattern against absorption tests on chloroform vapor (Hendra &Darmawan, 2007). The pattern of active carbon absorption of hazelnuts against chloroform vapor in the range of 0% to 5% increased and at the use of concentrations of 7.5% decreased. In the study described the relationship between the absorption of activated carbon. Doni pandapotan (2016) makes activated carbon from the skin of plantains. In this research, the best

process conditions obtained were H_3PO_4 activators with a concentration of 7% and an activation time of 24 hours. Activated charcoal plantain skin can improve the physical quality of murky well water with a turbidity level of 10 NTU, water temperature of 27˚C and total dissolved solid substances of 306.7 mg / L that meets clean water quality standards while the watercolor value of 82 TCU and charcoal-smelling water. Sulistyo and Dina Fitriana (2016) make activated carbon from teak sawdust, the best process conditions obtained are H_3PO_4 activators with a concentration of 10% and a 24-hour activation time from the research that has been done obtained the conclusion that teak sawdust can be used as a Pb (II) metal ion adsorbent using simulated liquid waste with an adsorption capacity of 1.28 µg/g. Edwin-Arif (2007) makes activated carbon from cassava bark. In this research, the best process conditions obtained are HCl activators with a size of 115 mesh and a 24-hour activation time with an absorbency of 795,663 mg / g. Rio Gunawan W (2007) makes activated carbon from the shell of ketapang seeds. In this research, the best process conditions obtained were HCl activators with a concentration of 0.3M and a 24-hour activation time with absorption of 813,493 mg/g. Yuliusman (2004) makes activated carbon from corn cobs. In this research, the best process conditions obtained were $ZnCl_2$ activators with a size of 125 µm and a 24-hour activation time with an absorbency of 865.33 mg/g. In this study will be carried out the use of elephant grass as a raw material for the manufacture of activated carbon and the type of activeator and its concentration. With the difference in the concentration of the activeator, it is expected to be able to know the maximum ability of acids in expanding the pores of charcoal that will affect the asdorpsi power of the charcoal itself to produce good, activated carbon and in accordance with the quality standards of activated carbon.

2 MATERIAL AND METHOD

2.1 Material

The raw material used in this study is elephant grass taken in Jakabaring area, Palembang. Chemicals used include Hydrochloric Acid (HCl), Sodium Hydroxide (NaOH), Sodium Chloride (NaCl), Sodium Thiosulfate ($Na_2S_2O_3$) and Iodium (I_2). Equipment used include furnace brand Nabertherm Germany, sift size 200 mesh, crucible, Beacker Glass, Erlenmeyer, filter paper, blender, electric oven, centrifuge, balance sheet analytics, pH meter and titration tool.

2.2 Experimental Method

2.2.1Creation of carbon and activated carbon

Before the authoring, elephant grass is dried first in the sun until the conditions are dry. The elephant grass is then mashed using a blender. Then heated using furnace at 750˚C for 15 minutes. The resulting carbon is left first for 24 hours. The activation process is done with a 24-hour activation time using HCl, NaOH and NaCl activators with concentrations of 0.2M, 0.3M, 0.4M, 0.5M and 0.6M respectively.

2.2.2 Manufacture of activated carbon pellets

Activated activated carbon samples are then formed into pellet granules using acrylic molds. Activated carbon powders plus adhesives as much as 10% of the sample weight (Jupar, 2013).

2.2.3 Activated carbon quality testing

The activated carbon produced is tested for quality based on Indonesian Industrial Standard (SII No. 0258-79) which includes volatile matter test, moisture content, absorption to iodium and ash content.

3 RESULT AND DISCUSSION

The results of elephant grass-based activated carbon studies show that volatile matter levels, moisture content, absorption to iodium and ash content meet SII standard No. 0258-79. The best result is the treatment with hcl activator substance concentration of 0.6M with carbonization temperature of 750˚C. This can be seen in tables 1 through 3.

Table 1. *Effect of HCl Activeator Compound Concentration*

HCl (M)	Volatile Matter (%)	Moisture Content (%)	Absorption of Iodium (mg/g)	Ash Content (%)
0.2	2.529	4.030	1065.960	0.108
0.3	2.754	4.036	1116.720	0.193
0.4	2.766	4.042	1129.410	0.247
0.5	2.804	4.062	1230.930	0.255
0.6	**2.834**	**4.100**	**1243.620**	**0.271**

Table 2. *Effect of NaOH Activated Substance Concentration*

NaOH (M)	Volatile Matter (%)	Moisture Content (%)	Absorption of Iodium (mg/g)	Ash Content (%)
0.2	2.808	4.070	1015.200	0.131
0.3	2.834	4.080	1078.650	0.219
0.4	2.918	4.094	1104.030	0.244
0.5	2.922	4.100	1129.410	0.270
0.6	2.957	4.118	1167.480	0.275

Table 3*. Effect of NaCl Activated Substance Concentration*

NaOH (M)	Volatile Matter (%)	Moisture Content (%)	Absorption of Iodium (mg/g)	Ash Content (%)
0.2	2.848	4.154	913.680	0.144
0.3	2.939	4.170	939.060	0.187
0.4	2.944	4.180	977.130	0.227
0.5	2.959	4.208	1027.890	0.286
0.6	2.963	4.240	1078.650	0.291

3.1 Effect of active concentration on Volatile Matter Test results

The test results showed that variations in different activator solutions had an effect on the levels of flying substances produced. The lowest Volatile Matter levels are obtained from the treatment of activated activated carbon pellets using HCl activators with a concentration of 0.2 M of 2.529% and the highest obtained from activated activated carbon pellets using nacl activators with a concentration of 0.6 M of 2.963%. The graph of the effect of the concentration of the activeator on the results of the Volatile Matter test is shown in figure 2 below.

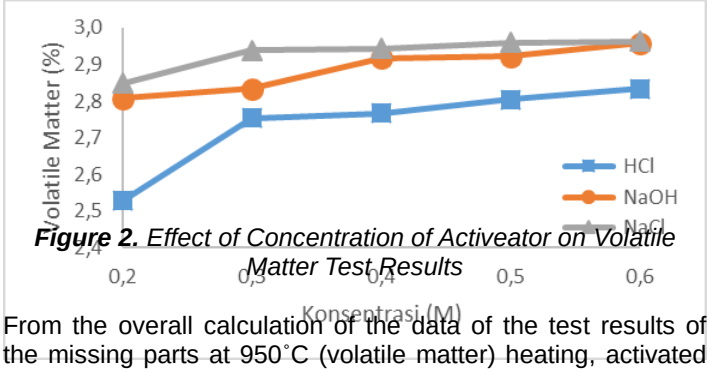
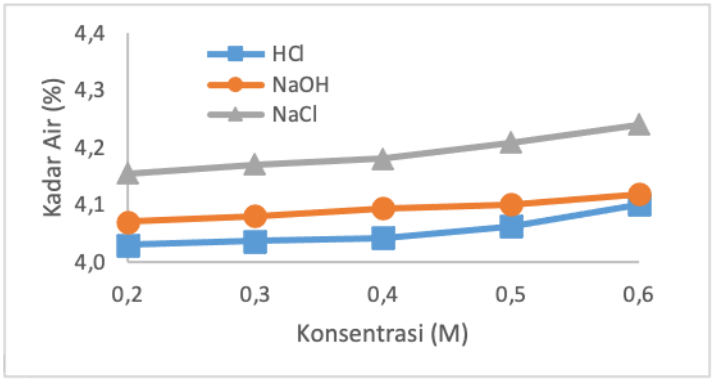


Figure 2. *Effect of Concentration of Activeator on Volatile Matter Test Results*

From the overall calculation of the data of the test results of the missing parts at 950˚C (volatile matter) heating, activated carbon pellets produced in accordance with the active carbon quality requirements set by SII No. 0258-79 due to the maximum volatile matter value of 15%, the results of research muharyani, Pratiwi and Asip (2012) showed the higher the carbonization temperature in rice straw then the resulting flying substance will be lower. Small levels of flying substances indicate the reaction between carbon atoms and water vapor forming volatile non-carbon compounds such as CO, CO_2, and H_2 during the activation process (Pari, Tohir, Mahfudin, &Ferry, 2006a). In this study there is a tendency that the greater the concentration of activator solution, the higher the level of volatile matter produced. The high levels of flying substances in this study can be caused by the characteristics of raw materials and the carbonization temperature used.

3.2 Effect of Concentration of Activators on Test Results

Determination of moisture content aims to determine the hygroscopic properties of activated carbon. The lowest moisture content is obtained from the treatment of activated activated carbon pellets using HCl active substances with a concentration of 0.2 M of 4,030 % and the highest obtained from activated activated activated carbon pellets using NaCl activators with a concentration of 0.6 M of 4.240%. The graph of the effect of the concentration of the activeator on the results of the Volatile Matter test is shown in figure 2 below.



Results of The Moisture Test

In this study from the chart, it appears that the larger thethe concentration of activatedfator, the moisture content contained in activated carbon increases. This is because the greater the concentration of activator, the more carbon activityf produced will be better inabsorbing water. This can be proven from the difference in the amount of moisture content in activated carbon from each concentration of the activeator compound used. Moisture content is the amount of water contained in a material. Moisture content can be used as a parameter to know the hygroscopic properties of an ingredient. In addition, moisture content can also affect the calorific value of an ingredient. High water content in biopelets can result in low biopelet calorific values and inefficient combustion (Hansen, Jein, Hayes, & Bateman, 2009). In this study, Level's water in accordance with activated carbon quality standards based on SII No. 0258-79 maximum 10% for activated carbon. Overall, the water content of this study is relatively small, this indicates that the water content is bound to the carbonized raw materials that first come out before activation. According to Soetarno and Soediro (1997) stated that if the sample has a moisture content of less than 10% can be said to be good and can be stored for a long period of time because at the level of water content less than 10% of the sample avoids the growth of fungi.

3.3 Effect of Activator Concentration on Absorption Test Results on Iodium

Determination of the absorption of activated carbon pellets to the absorption of iodium aims to determine the ability of activated charcoal to absorb colored solutions. The results of the literature study showed a tendency to be smaller in size of activated carbon, so the activated carbon produced has a high absorption. Activation is also important in increasing the absorption of activated carbon, where adsorbic molecules enter the adsorbent surface by relatively low intermolecular energy. The lowest absorption to iodium is obtained from the treatment of activated activated carbon pellets using NaCl activators with a concentration of 0.2 M of 913,680 mg/g and the highest obtained from activated activated carbon pellets using HCl activators with a concentration of 0.6 M of 1,243,620 mg/g. For iodium absorption, HCl activators are better compared to other activators.

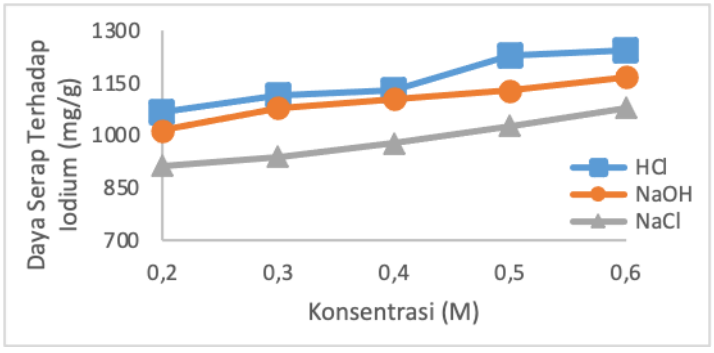


Figure 4. *Effect of Activator Concentration on Absorption Test Results on Iodium*

This is because hydrochloric acid which is a water binding substance can be more perfect to dissolve organic and inorganic substances bound in karbn material so that carbon is obtained with cleaner and open pores. This explanation was affirmed by Jankowska (1991). Water binding substances in addition to dissolving organic impure components, can also dissolve inorganic substances, such as aluminum, iron, magnesium, calcium silicate derived from the active carbon-forming base material that is strongly bound and does not escape during the carbonization process. The absorption of activated carbon to iodine resulting from this study is in accordance with activated carbon quality standards based on SII No. 0258-79 at least 750 mg/g. The amount of active charcoal absorption to iodium is likely due to hydrocarbon compounds left on the carbon surface wasted at the time of

activation, so that the surface becomes active.

3.3 Effect of Concentration of Activators on Ash Content Test Results

Ash content is the percentage of ash produced from the perfect combustion of an organic matter. Ash content in the form of organic matter or minerals that can not be burned or leftovers that remain left behind after burning, such as silica and oxide. Determination of ash content aims to determine the amount of oxide contained in activated carbon. The more oxides, the higher the activated carbon ash content. The lowest ash content is obtained from the treatment of activated activated carbon pellets using HCl activators with a concentration of 0.2 M of 0.108 % and the highest obtained from activated activated activated carbon pellets using NaCl activators with a concentration of 0.6 M of 0.291 %.

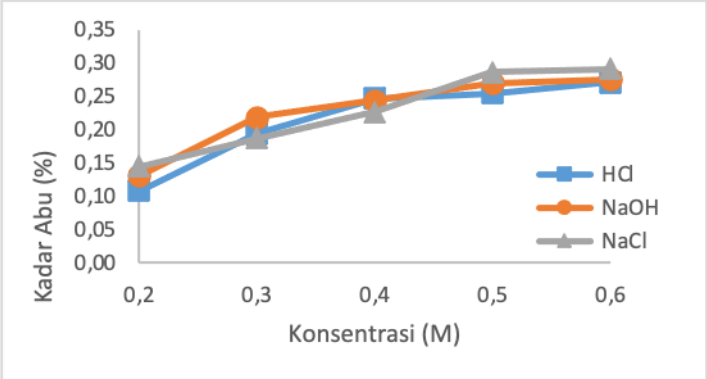


Figure 5. *Effect of Concentration of Activators on Ash Content Test Results*

In this study, activated carbon in accordance with SII quality standard No. 0258-79 maximum 2.5%. The results of this study showed that the greater the concentration of the activator, the greater the ash content. High ash levels are likely due to contact with the air at the time of activation so that a further combustion process occurs where the activated charcoal formed turns to ash. In activated charcoal, ash content is attempted as little as possible because it will decrease its absorption capability in both gas and solution form. Ash content can be calcium, potassium, magnesium, and sodium that can close and block the pores of activated charcoal (Benaddi et al. 2002) [19].

4 Conclusion

Elephant grass can be used as an active carbon material with moisture content, flying substance content, bonded carbon content, and active charcoal absorption to iodium meet SII No. 0258-79. The best and effective condition in the manufacture of activated carbon from elephant grass is to use activator HCl 0.6 M with a carbonization temperature of 750oC and activation time for 24 hours. Activated carbon meets the active carbon quality requirements according to SII No. 0258-79 with the following data: water content of 4,100%, ash content of 0.271%, absorption of iodium 1243,620 mg/g, and volatile matter of 2,834%.

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