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Absorption of DOC and Fe activated carbon coconut palm oil activation results using h_3po_4 chemicals with grain size and longer immersion

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Palm oil shells can be useful as raw material for making activated carbon because they are very effective at adsorbing contaminants in water. Activated carbon is one of the adsorbents which has adsorption power. Adsorption power is the ability to absorb. The aim of this study was to determine the absorption capacity of activated charcoal by immersing H_3PO_4 and grain size of Mesh 200 palm oil shells. Variables observed were sorption and release DOC and iron (Fe) sorption. Analysis to get the sorption power and release of DOC is done. Making stock DOC solution, DOC sorption experiment, DOC sorption is analyzed using isotherm linear initial mass (IM) approach, and to get iron sorption (Fe) is done by making Fe concentration, iron sorption experiment (iron sorption experiment) Fe), the concentration of iron (Fe) in the filtrate is determined by AAS., Then presented in tabular and graphical form. The results of the maximum sorption and release of DOC were 0.9119 mg / l / kg, while the maximum iron sorption (Fe) was 0.959 mg / l / kg.

Keywords: Activated charcoal, absorbency, palm kernel shells, DOC, Fe, H_3PO_4

INTRODUCTION

Palm oil is one of Indonesia's mainstay commodities whose development is very rapid. Crude Palm Oil (CPO) processing industry will produce waste. Palm oil industry wastes can be classified as solid, liquid and gas waste. Production of solid waste from oil palm in 1 ton of oil palm fruit can produce 65 kg of oil palm shells. One type of palm oil solid waste is oil palm shells. Palm shells are one of the wastes which account for 60% of core oil production. Palm oil shell waste is grayish black, irregular in shape, and has a high level of violence (Purwanto, 2011). Palm shells can be used as activated carbon. Activated carbon can be made through the carbonization process at 550 ºC for approximately three hours. The characteristics of activated carbon produced through this process meet SII, except ash content. The level of activity of carbon is quite high. This can be seen from the absorption of iod by 28.9% (Andriati, 2003).

The palm shell has many uses and benefits for the business and household industries. Some of them are high economic value products, namely activated charcoal, liquid smoke, phenols, charcoal briquettes, and shell flour. Palm shells are the hardest part of the components found in oil palm. Judging from the characteristics of the raw materials, when compared to ordinary coconut shells, oil palm shells have many similarities. A striking difference is the ash content which usually affects the quality of products produced by coconut shells and palm shells. Charcoal is a porous solid material which is the result of combustion of materials containing carbon elements (Djatmiko, 1985), while activated charcoal is charcoal that is activated by immersion in chemicals or by flowing hot steam into the material, so that the pores of the material become more open with surface area.

Activated carbon pores need to be activated so that the performance in adsorption is more optimal. The purpose of the activation process is to increase or enlarge the carbon pore diameter and develop the volume absorbed in the pore and to open new pores (Prabarini and Okayadnya, 2014). Activation is a process of forming activated carbon that functions to add, open and develop carbon pore volume and can increase the diameter of carbon pores that have been formed from the carbonization process through chemical or physical methods. (Budiono et al, 2009; Kurniawan, 2014).

The wider surface of activated charcoal has an impact on the increased absorption of gas or liquid material (Kirk and Othmer, 1964). Absorption of activated charcoal is very large, which is 25-1000% of the weight of activated charcoal. Because of this, activated charcoal is widely used by industry. Nearly 60% of the production of activated charcoal in the world is utilized by the sugar industries and cleaning oil and fats, chemicals and pharmaceuticals (Arifin, 2008). According to Hendra (2010) the activation process in charcoal is generally three, including physical, chemical and physics-chemical combinations. The physical activation process is carried out by burning charcoal in a furnace with a temperature of 850 ^{o}C. The chemical activation process is carried out by adding certain chemical compounds to the charcoal. Chemical compounds that can be used as activating agents include KCl, NaCl, $ZnCl_2$, $CaCl_2$, $MgCl_2$, H_3PO_4, Na_2CO_3, and other mineral salts. The optimum conditions for making activated charcoal with the best quality from the raw material of palm oil shell is at a temperature of 850 OC. In research conducted by Faradina and Setiawati (2010) activated charcoal by using a chemical compound namely $ZnCl_2$ Prasetyani (2010) activating active kabron is done by adding $ZnCl_2$, as an activator so that the surface pores of charcoal become wider. This will facilitate the absorption process. Activated charcoal is used to remove impurities by absorbing or adsorping. The ability to absorb impurities is an indicator of the success rate of the activated charcoal process.

Charcoal can be used as fuel and can be used as an adsorbent (absorbent) in the gas separation process. Absorption of contaminants in water, recovery solvent, catalyst and catalyst support. In use as an adsorbent, the absorption of charcoal is determined by the surface area of the pore. The wider surface of the charcoal results in a higher absorption of gas or liquid material (Kirk and Othmer, 1964). The absorption ability of charcoal can be higher if the charcoal is activated with chemicals or by heating at high temperatures. Activated charcoal will experience changes in physical and chemical properties called activated charcoal (Meilita and Tuti, 2003).

Activated charcoal is charcoal that is activated by immersion in chemicals or by flowing hot steam into the material, so that the pores of the material become more open to the surface area. Activated charcoal can be made from porous carbon material which can be obtained from agricultural solid waste materials such as rice husks, coconut shells, palm shells, candlenut shells and urban solid waste materials such as plastics, paper and cardboard. One of the solid waste materials from plantations that are still underutilized is palm oil shells. In general, companies make palm oil shells as waste materials with little use. On the other hand the palm shell also has the prospect as a raw material for making activated charcoal.

The nature of activated carbon itself is influenced not only by the type of raw material, surface area, pore distribution and surface chemical characteristics of activated charcoal, but it is also influenced by the activation method used (Austin, 1984). According to Girgis et al. (2002) suggested that H_3PO_4 as an activation agent would give the best results when compared with $ZnCl_2$ and KOH. These activating agents are dehydrators which can reduce the remaining OH and CO from the carbonized carbon. Therefore it is necessary to do activation by immersing using H_3PO_4 on several sizes of palm shell charcoal grains to get the surface area of activated charcoal grains.

This research was conducted to assess the maximum absorption capacity of activated carbon from the shell of oil palm shells against peat water contaminants. Absorption test of peat water treatment plant is carried out for several parameters, namely the DOC and Fe absorption research parameters by activated charcoal and pH measurement, this study aims to determine the kinetics of absorption and release of DOC and

Fe as well as the color and odor by activated charcoal during immersion time and H_3PO_4 construction. Based on the kinetics of absorption parameters, especially the maximum absorption capacity can be known how long the use of activated charcoal as absorbent in simple drinking water treatment plants.

MATERIALS AND METHODS

The raw material used in the research is the palm shell (Elais guneensis Jacg) type of Dura from PT. Surya Cipta Perkasa, Sebangau Kuala District, Pulang Pisau Regency, Central Kalimantan Province, Phosphoric Acid (H_3PO_4) solution, 1000 mg/l Iron (Fe) solution, 200 gram peat material and Aguades.

The method of making charcoal is by way of charcoal and the activation of the charcoal is made. The making of charcoal from the Palm shell is done by means of a palm oil shell washed and dried in the sun. Each charcoal material was put into a coating oven and heated to 500 oC for 5 hours. Arrangement is considered complete when the smoke coming out of the chimney is thinned and colored red.

Activation of palm shell charcoal can be done by means of palm shells that have been made crushed charcoal to obtain the desired grain size or dimensions of charcoal. The charcoal is filtered by sieve analysis with a retained size in the Mesh 200 filter.

After obtaining charcoal with dimensions and mesh size of 200, then the charcoal is activated by immersing it in a 2.5% Phosphoric Acid (H_3PO_4) solution as an activator. The immersion activation time is carried out with a 16 hour immersion duration.

From the activation of activated charcoal above, then washed using distilled water so that it reaches a neutral pH. Furthermore, the activated charcoal is dried in the oven for 1 hour at a temperature of 120 ^oC and the activated charcoal is ready to be tested for absorption and release of DOC and Fe.

The observed variables are: (1) adsorption and release of DOC, and dan (2) Iron absorption from the activation of the activated palm shell.

Measurement of DOC absorption is divided into several stages: (a) Preparation of stock DOC solution, DOC stock solution used in absorption experiments was

obtained from peat layer extracts with a method adapted from Kaiser et al. (2000) and Kothawala et al. (2009). DOC was extracted by soaking 200 grams of peat material with 2 liters of distilled water for 18 hours, then filtered using filter paper with a 0.45 micron membrane pore (MF-Milipore Membrane Filters). DOC extract obtained from this immersion has a concentration of DOC > 100 mg/l. Dilution is carried out on the standard solution to get a solution with a DOC concentration of 0, 10, 20, 30, 40, 50 and 60 mg/l, using a solution that has ion concentrations that are relatively the same as the standard DOC solution (b) DOC absorption experiments, DOC absorption studies in this study were conducted using a batch experimental approach (Kothawala et al. 2008; 2009). The experiment was carried out by adding 50 ml of DOC solution with an initial concentration of 0 to 60 mg/l to 3 g of activated charcoal in a centrifuge tube. The jar is then shaken by hand to ensure the charcoal and solution are mixed evenly, and shaken in a cornering machine for 24 hours at 200 ^oC at a speed of 60 rpm. After being balanced for 24 hours, the solution is left for 30 minutes before filtering using filter paper with a 0.45 micron membrane pore. The filtrate was acidified to pH 3 using 2 M HCl and the DOC concentration was determined using a spectrophotometer at a wavelength of 591 nm. (c) Sniffy Isotherms, DOC Snakes are analyzed using the linear initial mass (IM) approach (Nodvin et al. 1986).

Iron absorption experiment is the amount and ability of activated charcoal to absorb iron content from peat water, Fe absorption measurements are carried out divided into several stages (a) Making Fe concentration by treating 2 grams of activated charcoal with 0.01 FeCl3 solution containing Fe in different concentrations (0, 10, 20, 30, 40, 50, 60, 70 and 80 mg.l-1). Incubation is carried out for 6 days while shaken 2x30 minutes per day (morning and afternoon). After completion of incubation, the mixture is centrifuged to get clear liquid. The concentration of Fe in the filtrate was determined by AAS. The amount of Fe absorbed per gram of activated charcoal (x / m) is calculated from the difference between the amount of Fe added to the concentration of Fe in the equilibrium solution. The data of Fe absorption by active charcoal are plotted according to the absorption equation that is the Langmuir equation and the Freundlich equation. The results of the analysis are presented in tabular and graphical form.

RESULTS AND DISCUSSION

1. Adsorption and release of DOC

The adsorption and release of DOC from

activated charcoal are presented in Table 1 and Figure 1. The absoptionl and release of DOC from activated charcoal (Table 1) can be presented in the form of pictures (Figure 1), to make it easier to interpret the results of data analysis.

Table 1 and Figure 1 are the result of absorption and release of DOC then plot c / x with c will produce a straight line with (*slope*) $1/x_m$ dan intersept $1/ax_m$, linear equation as follows: Y = 0.3655 x + 0.039, transformation to linear form becomes:

$$\frac{c}{x} = \frac{1}{ax_m} + \frac{c}{x_m} \quad \text{……….……… (1)}$$

Where c is the concentration of DOC in the equilibrium solution, x is the amount of DOC absorbed, xm is the maximum sorption and a is the coefficient related to "bonding energy". From the equation xm obtained by 0.9119 and c of 0.0355. thus obtaining a maximum sorption at DOC release of 0.9119 mg / l / kg.

Table 1. Results adsorption and release of DOC

No.	Concentration (%)	Vol. (ml)	Early DOC (mg/l)	Final DOC (mg/l)	DOC Absorbed (mg/l)	Charcoal Active (gr)	DOC absorbed (mg/l/gr)
1	10	100	10	8.46	1.54	3	0.51
2	11	100	11	5.37	5.63	3	1.88
3	12	100	12	5.95	6.05	3	2.02
4	13	100	13	7.36	5.64	3	1.88
5	14	100	14	10.94	3.06	3	1.02
6	15	100	15	9.28	5.72	3	1.91

Source: Research Results, 2019

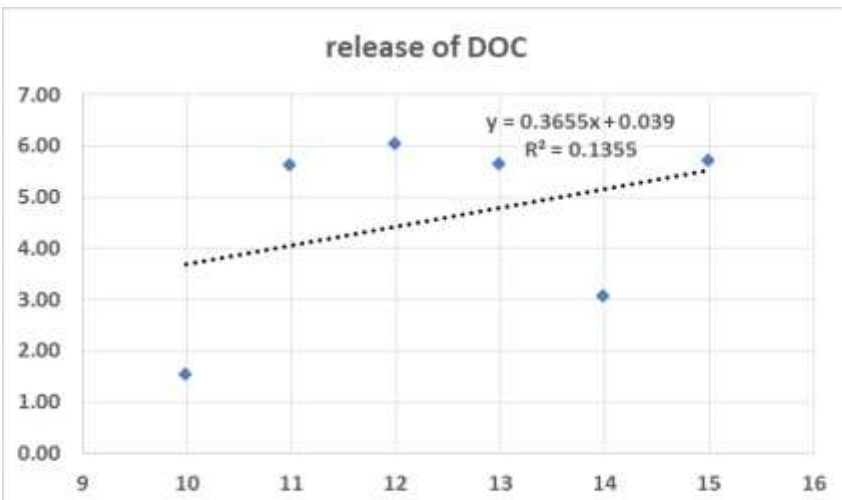
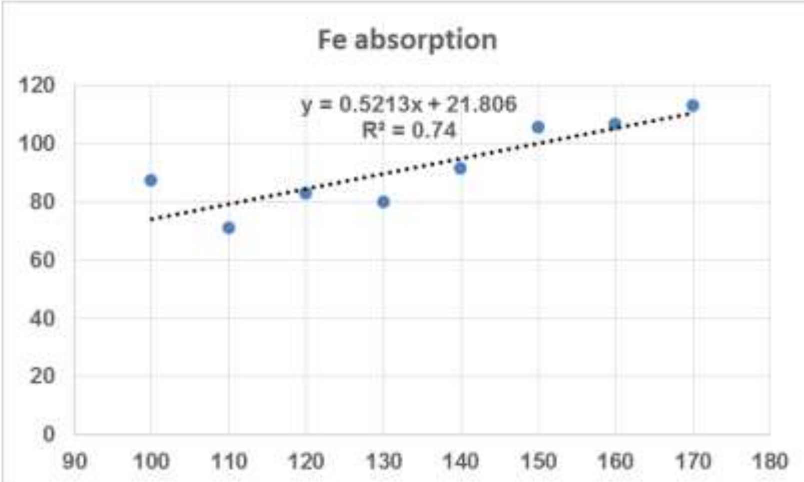


Figure.1:The absoptionl and release of DOC

Table 2 :Results Iron (Fe) absorption

No.	Concentration (%)	Vol. (ml)	Early Fe (mg/l)	Final Fe (mg/l)	Fe Absorbed (mg/l)	Charcoal Active (gr)	Fe Absorbed (mg/l/gr)
1	10	100	100	12.57	87.43	2	43.72
2	11	100	110	39.21	70.79	2	35.40
3	12	100	120	37.13	82.87	2	41.44
4	13	100	130	50.28	79.72	2	39.86
5	14	100	140	48.51	91.49	2	45.75
6	15	100	150	44.50	105.50	2	52.75
7	16	100	160	53.29	106.71	2	53.36
8	17	100	170	57.05	112.95	2	56.48

Source: Research Results, 2019



Figuure 2:Maximum iron (Fe) sorption of activated charcoal

2. Iron Absorption

Iron (Fe) absorption from activated charcoal is presented in Table 2 and Figure 2.

Iron (Fe) absorption from activated charcoal (Table 2) can be presented in the form of pictures (Figure 2), to make it easier to interpret the results of data analysis. Table 2 and Figure 2 are the results of the Iron (Fe) sorption then plot c / x with c will produce a straight line with slope 1 / xm and intersept 1 / axm, linear equation as follows: Y = 0.5213 x + 21.806 , transformation to linear form with equation (1) where c is the concentration of Fe in the equilibrium solution (mg Fe.L-1), x is the amount of Fe absorbed (mg Fe.kg-1), xm is the maximum sorption (mg Fe .kg-1) and a are the coefficients associated with "bonding energy". From the equation xm is 0.959 and c is 20.914, so that the maximum sorption of Iron (Fe) is 0.959 mg / l / kg.

CONCLUSION

The results of the absorption test and the release of DOC and iron absorption (Fe) can determine the absorption power produced from activated charcoal as a result of activation by immersion using Phosphoric Acid (H_3PO_4) and the maximum grain size of palm shell charcoal. For maximum absorption and release DOC is 0.9119 mg / l / kg. While the maximum iron absorption (Fe) is 0.959 mg / l / kg.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

D and S design and conduct research, data collection, data analysis and also manuscript writing. ZD dan SG designs and conducts research, reviewing manuscripts and sending manuscripts.

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