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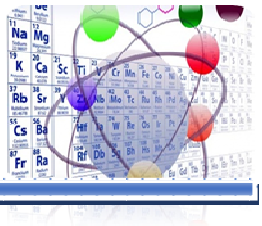

Effect of Flow Rate on Adsorption Cadmium Ion (II) Using Activated Carbon of Langsat Shell (*Lansium Domesticum* Corr)

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ABSTRACT

Cadmium is one of the dangerous heavy metals contained in industrial wastewater whose presence needs to be addressed. Adsorption is one method that can be used to reduce the levels of heavy metal ions contained in wastewater. Langsat peel activated carbon is used as an adsorbent to adsorb cadmium metal because it is easy to obtain and its use is still minimal in the community. The langsat peel was made into activated carbon with HNO_3 activator as a metal ion absorber Cd^{2+} using the column method. The activated carbon obtained has been tested for quality according to the Indonesian National Standard (SNI) No.06-3730-1995. In this study, we determined the effect of flow rate on metal cadmium absorption. The results showed that the activated carbon met the quality standards set by SNI and the optimum value of Cd^{2+} metal ion adsorption was at a flow rate of 1 ml/min.

Keywords : Adsorption, Cadmium, Activated Carbon, Column Method

1. INTRODUCTION

The increasing production of industrial waste every year causes environmental pollution. Industries that dump waste into waterways are not treated first, causing pollution that can damage aquatic ecosystems. Hazardous waste originating from industry can be in the form of heavy metal waste. Examples of industries that contain heavy metal waste are the mining industry, PVC/plastics, batteries, textiles, and metal coatings. Industrial waste that has been contaminated with heavy metals, if it continues to enter the waters, will slowly accumulate heavy metals, which will easily accumulate and cause biotoxic effects in the bodies of organisms around the polluted area. Heavy metals contained in industrial waste are Ag, Cd, Pb, Hg, Ni, Fe, Cu, and Zn.[1]

Cadmium metal is one of the heavy metals that have toxic and carcinogenic properties for humans. Cadmium (Cd^{2+}) can accumulate in the kidneys, causing dysfunctional kidney organs, lung cancer, and can

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interfere with the human skeletal system, causing osteoporosis. According to PP No. 82 of 2001, the maximum level of cadmium allowed in the water is 0.01 mg/L.

Considering the danger posed by the presence of Cd^{2+} metal, many methods have been developed in order to reduce the presence of these heavy metals from industrial waste, such as precipitation, ion exchange, evaporation, oxidation, and membrane filtration. However, the implementation of some of these methods requires considerable costs. So a cheap, safe, and certainly effective processing method is needed, namely adsorption using activated carbon from fruit peel waste.

Adsorption is a process of binding a solid with a fluid (liquid and gas) and on the surface of the solid a layer is formed. This adsorption process is a separation and purification technique used in industry because it is considered effective, safe, and economical for wastewater treatment in reducing heavy metal ion levels.

Activated carbon is a solid consisting of 85–95% carbon that has been activated and has pores due to the activation process. The surface area of activated carbon ranges from 300-3500 m2/g. Activated carbon, which is usually used as a fuel, can also be used as an adsorbent. One of the most commonly used adsorbents to date is activated carbon from natural materials [2].

Langsat skin waste (Lansium domesticum) is one of the environmentally friendly biosorbents, easy to find in Indonesia and can be purchased at a low price. This material was chosen because its utilization is still lacking and it is also one of the wastes that still has functional groups. The functional groups contained in langsat skin are C-H, O-H, C=O, C-O, and N-H. These functional groups are responsible for the absorption of metal ions. Activated carbon used as adsorption is very effective in reducing heavy metal contaminants in the environment. Research that uses activated carbon as an absorbent material from metal ions Cd^{2+}, namely the effect of adsorbent mass on cadmium removal in Siamese orange peel with optimum adsorbent mass [3].

Based on this description, the researchers are interested in conducting research that utilizes langsat skin that has been used as activated carbon to absorb Cd^{2+} metal using the column method. For later purposes, to determine whether it has met the standards set by SNI and to see the effect of the adsorbent flow rate on the adsorption of cadmium ions using the column method.

2. EXPERIMENTAL

2.1. Chemicals, Equipment and Instrumentation

The materials used in this study were langsat peel, aquades, $Cd(NO_3)_2.4H_2O$, and HNO_3 p.a. Equipment in this study consisted of glassware, mortar and pestle, column, pH meter, analytical balance (ABS 220-4), filter paper (Whatman number 42), micro sieve (BS410), heat treatment furnace (Brand Hofmann), oven, desiccator, and Atomic Absorption Spectrophotometer (SSA) (Perkin Elmer AA-100).

2.2. Research Procedure

In the first stage, the available langsat skin is washed and rinsed with distilled water. Then it dried at room temperature for 7 (seven) days. The dried langsat skin was then cut into small pieces and heated for 1 hour in a furnace at 350°C.The carbon obtained is crushed to form a powder. After that, it was sieved with a size of 250 m. The second stage, long skin carbon, is activated by HNO_3 activator. A total of 20 grams of carbon was soaked in 80 mL of 5 M HNO_3 activator reagent for 2 (two) hours. Then, the soaked carbon was

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washed and filtered using distilled water until the pH was neutral. Next, the carbon was dried at 105^0C for 3 (three) hours in the oven. Finally, it is cooled in a desiccator.

In the third stage, the langsat skin that has been obtained is tested for quality according to SNI No.06-3730-1995. The first test of water content, 1 gram of activated carbon, is put into a porcelain dish whose weight is known. Then, put it in the oven at a temperature of 105°C for 3 hours. After finishing in the oven, it was cooled in a desiccator, then weighed.

In the second test of ash content, into a porcelain dish was put 1 gram of activated carbon. Then, put it in the oven for 2 hours at a temperature of 800°C. Furthermore, it is cooled in a desiccator if all the carbon has become ash, and its weight is weighed. The third test is the level of volatile substances. In a porcelain dish whose weight is known, add 1 gram of activated carbon. Then, put it in the oven at a temperature of 360°C for 15 minutes. Then it was cooled in a desiccator and weighed.

In each of the four iodine absorption tests, 1 gram of activated carbon was put into an erlenmeyer and closed. Then add 50 ml of 0.1 N iodine solution and shake it for 15 minutes at room temperature. After that, the solution was filtered with filter paper. 10 mL of the obtained filtrate was pipetted and tritated using a 0.1 N sodium thiosulfate ($Na_2S_2O_3$) solution until the solution turned yellow. Then add 1% starch solution as an indicator and titrate until the blue color in the solution disappears.

The third step is to determine the effect of flow rate on the absorption of cadmium metal. Prepared aquades and a solution of Cd^{2+} at pH 5, a concentration of 350 ppm and a biomass weight of 0.4 grams, then the activated carbon of the langsat skin was entered into the column, then 10 ml of Cd^{2+} solution was flowed with a flow rate variation of 1 mL⁄minute, 2 mL⁄ minutes, 3 mL⁄minutes, 4 mL⁄minutes. The filtrate that flows out of the column is accommodated and its concentration is measured using AAS for each variation of the flow rate. Then the optimum absorption at the flow rate can be determined.

3. RESULTS AND DISCUSSION

3.1. Activated Carbon Quality Test Analysis

Table 1. Quality Test Results of Langsat Skin Activated Carbon

Charateristics	Activated Carbon	SNI
Water Content (%)	5,92	15
Ash Content (%)	1,45	10
Volatile Matter Levels (%)	18,14	25
Iodin Absorption (mg/g)	793,1875	750

Determination of water content. The purpose of the test is to determine the hygroscopic properties of activated carbon, which can be seen whether activated carbon can bind water vapor in the air [4]. So it is expected that there will be less water bound to the activated carbon, because the water will cover the pores of the activated carbon, which can affect the adsorption ability. The result of the analysis of the water content contained in activated carbon is 5.92%. After the test has been carried out, it can be said that it has met the

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standards set by SNI No. 06-3730-1995 on the moisture content of activated carbon, which is a maximum of 15%.

The ash content test has a very large effect on the quality of activated charcoal. High ash content can make activated carbon pores clogged and small, so that the surface area of activated carbon is reduced and will have an impact on the quality of activated carbon during the adsorption process [5]. which does not burn during the carbonization process and does not separate upon activation. The quality of activated carbon is better if the ash content of activated carbon is small. This is due to the large content of metal oxides that are decomposed by the activator. So that the pores on the carbon surface are open, which will have an impact on the better absorption of activated carbon. It can be seen in table 1. After testing, the ash content obtained, namely 1.45%, can be said to have met the standards set by SNI No. 06-3730-1995 on the ash content of activated carbon, which is a maximum of 10%.

Calculating the volatile matter content seeks to determine how much volatile matter is still present on the activated carbon. High concentrations of volatile chemicals will hinder activated carbon's ability to absorb. This is due to the fact that now the pores of the activated carbon still are covered by volatile chemicals, making overall absorption surface area of the carbon still relatively modest [6]. It may be concluded that it complies with the requirements set forth in SNI No. 06-3730-1995 for the ash content of activated carbon, which would be limited to a maximum of 25%, based on the calculation of the levels of volatile substances obtained in table 1, and that is 18.14%.

A typical requirement for assessing the quality of activated carbon is the measurement of its absorption to iodine solution. This test aims to determine the activated carbon's capacity to take in smaller molecules. The activated carbon's surface area will increase if the iodine solution's absorption test results are high, which will result in a high absorbance [7]. The adsorbent's iodine absorption values, which were 793.1875 mg/g, suggest that it has complied with the requirements of SNI No. 06-3730-1995, which ask for just a minimum of 750 mg/g.

3.2. Effect of flow rate on metal absorption of Cd^{2+}

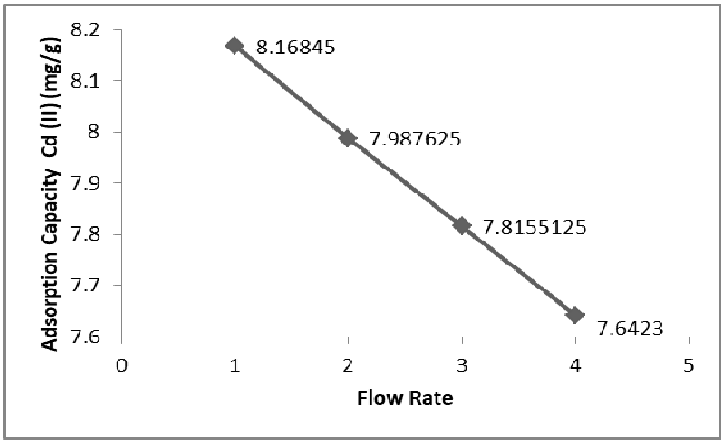

Figure 1. Effect of adsorbent flow rate on adsorption capacity

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See in figure 1. The absorption capacities at flow rates of (1-4) ml/min were 8.1684 mg/g, 7.9876 mg/g, 7.8155 mg/g, and 7.6423 mg/g, respectively. Based on the data obtained, it shows that the faster the flow rate, the smaller the absorption. Because small flow rates result in longer contact time in the adsorbent, ion exchange occurs more frequently than at high flow rates. The optimum flow rate obtained was at a flow rate of 1 ml/minute with an absorption capacity of 8.1684 mg/g. This is because the interaction between Cd metal ions and langsat peel activated carbon lasts quite a long time (all surfaces of the active center of the adsorbent have bonded or saturated) with the metal or have reached an equilibrium state [8].

4. CONCLUSION

An activated carbon quality test based on SNI No. 06-3730-1995 discovered that langsat peel activated carbon meets the SNI criteria and the effect of the optimum flow rate on the absorption of Cd^{2+} is 1 ml/min.

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