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Effect of Adsorbent Dosage on Copper Ion Adsorption Using Activated Carbon of Langsat Shell (*Lansium domesticum* Corr) with Column Method

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ABSTRACT

Copper 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 adsorb heavy metals. Using a langsat shell as an adsorbent is used to adsorb copper because it is easy to obtain and its use is still minimal in people. Using the column method, the langsat shell was made into activated carbon with HNO3 as an adsorber of Cu2+ metal ions. The activated carbon obtained was tested for quality according to Standard Nasional Indonesia (SNI) No.06-3730-1995. In this research, we determine the effect of adsorbent dosage on the adsorption of copper ions. The results showed the activated carbon meets established quality standards of SNI and the optimum adsorption value of Cu2+ metal ions at an adsorbent dosage of 0.4 grams.

Keywords: adsorption, copper, activated carbon

1. INTRODUCTION

Environmental hygiene from industrial waste containing heavy metals, has become a major focus of the world for the last few decades. The main cause of this problem is the increasing waste from industrial production which is not handled properly. This industrialization process cannot be separated from the negative impacts, as well as the presence of industrial waste, both solid and liquid, which have an impact on the surrounding environment. If industrial residues are simply thrown into the environment, it will have an impact on decreasing the quality and quantity of an environment, so that the environment can be said to be polluted. Heavy metal wastes that can damage the environment and are harmful to our bodies include Hg, Cd, Zn, Pb and Cu. [1]

Copper (Cu^{2+}) is one of the essential metals found in industrial wastewater. Industrial wastewater containing copper is generally in the form of copper pentahydrate compounds, these Cu compounds are used in industrial fields such as textile coloring, electroplating, coating and rinsing in the silver industry.[2] Excess concentration of Cu^{2+} metal ions in the human body has various health effects, including the stomach, intestines, liver, kidneys, brain damage, decreased intelligence in children, and the worst impact is death.[3] According to the **Indonesian National Standard** (SNI) **No. 06-3730-1995**, it is expected that there will be

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no contamination of copper metal in the environment, while the minimum threshold allowed in the environment is 1 ml/l.

Given the danger presented by the presence of Cu^{2+}, various methods, like precipitation, ion exchange, evaporation, oxidation, and membrane filtering, have been developed to remove this heavy metal from industrial wastewater.[4] The aforementioned techniques have shown to be successful, however some of them are expensive to use. So a low-cost, secured, and definitely efficient treatment method is required, such as adsorption using waste fruit shell activated carbon.[5]

Adsorption is a process that occurs when a fluid (liquid and gas) binds to a solid and forms a layer on the surface of the solid. The advantages of this adsorption method are that it is cheap, the adsorption is highly effective in aqueous solution and is simple to regenerate.[6]

Langsat fruit waste (Lansium domesticum) is one of the environmentally friendly adsorbents. The functional groups found in langsat fruit are C-H, C=O, O-H, C-O, and N-H. The shell of the langsat fruit also contains triterpenoid glycosides, tetranortepenoi, onoceranoids, flavonoids and phenolic groups. Flavonoid compounds, terpenoids, and saponins. In terpenoid compounds, it contains lanceolate acid and lansiolic acid.[7] Activated carbon used as adsorption is very effective in reducing heavy metal contaminants in the environment. Several studies have used activated carbon as an adsorbent, namely activated carbon from the bark of salak on the adsorption of Cu^{2+} metal ions using KOH activator with the best adsorption at a dosage variation of 90 mg with a pH of 5.[8]

Based on the description of the background above, the researchers wanted to examine whether the activated carbon of the langsat shell had met the standards set by SNI and to see the effect of the adsorbent dosage on the column-based method's adsorption of copper ions.

2. EXPERIMENTAL

2.1. Chemicals, Equipment and Instrumentation

The tools used in this study consisted of a glass, blender, spray bottle, column, pH meter (HI2211), analytical balance (ABS 220-4), filter paper (Whatman number 42), micro filter (BS410), heat treatment furnace (Hofmann brand), oven, and desiccator. The equipment used for characterization was the Atomic Absorption Spectrophotometer (AAS) (Perkin Elmer AA-100). This study's materials included activated carbon from langsat shell, aquades, $Cu(NO_3)_2$, and HNO_3 p.a.

2.2. Research Procedure

2.2.1. Preparation of samples

The prepared langsat shell was washed with distilled water and dried at room temperature for 7 (seven) days. Then the langsat shell was cut into small pieces and heated in a furnace at a temperature of 350±0°C for 1 hour to obtain carbon. The obtained carbon is then ground into a powder. Finally sieved with a sieve of 250 µm. Then, the langsat shell that has been obtained is then activated with HNO_3 activator. A total of 20 grams of carbon was immersed in 80 ml of 5M HNO_3 reagent for 2 (two) hours. Then, the carbon that has been soaked is washed and filtered with distilled water until a pH value that corresponds to a value close to the pH value of distilled or neutral water is obtained. In addition, the carbon was dried in an oven at a temperature of 105°C with an interval of 3 hours. Finally, cool in a desiccator.

2.2.2. Carbon Quality Test According to SNI No.06-3730-1995

First, to test the water content, a porcelain cup with a known weight was added to one gram of activated carbon. Then heated in an oven at 105°C with an interval of 3 hours, then transferred to a desiccator until cool and weighed the obtained weight. The second test of ash content, porcelain cup with a known weight

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lid, added one gram of activated carbon. Then heated in the furnace for 2 hours at a temperature of 800°C. And cooled in a desiccator and weighed.

The third test is the level of volatile substances. A porcelain cup with a whose weight is known, one gram of activated carbon is added. Then heated at a temperature of 360 ° C in the furnace for 15 minutes. And cooled in a desiccator and weighed.

The fourth test of iodine adsorption, a closed Erlenmeyer flask was added to it with a sample of 0.500 grams. Then, add 50 mL of 0.1N iodine solution and shake for 15 minutes at room temperature. Next, filter with filter paper. Pipette the obtained filtrate into 10 mL, and titrate with 0.1 N sodium thiosulfate ($Na_2S_2O_3$) solution until the solution turns yellow. Then add 1% starch solution indicator, and titrate again until the blue color of the solution disappears.

Effect of adsorbent dosage

The next step is to determine the effect of adsorbent dosage on copper ion adsorption. Prepared langsat shell activated carbon with various variations of solution (0.2-0.5) grams for each was inserted into the column and added 15 mL of Cu^{2+} solution with pH and concentration into the column sequentially. The obtained filtrate concentration was measured using AAS at each dosage variation of the adsorbent, so that the adsorption at the optimum dosage could be determined.

3. RESULTS AND DISCUSSION

*3.1. Analysis of Carbon Quality Test According to **SNI No.06-3730-1995***

The water content in activated carbon shows the ease with which a substance or other compound can easily be separated from the carbon surface, thereby expanding the surface and increasing the pores. Activated carbon's ability to absorb more water molecules depends on how many water molecules the activator can bond.[9] The quality of the activated carbon is getting better along with the decrease in the water content of the activated carbon. Activated carbon always contains water even in small levels, because the bond structure of the C atoms that make up activated carbon is difficult to release all the water.[10]

Based on **Table 1.** the water content bound to the activated carbon of the langsar shell is 8.4%. The moisture content of this langsat shell activated carbon has met the standard of SNI 06-3783-1995, which is less than 15%.

Table 1. Quality Test Results of Langsat Shell Activated Carbon

Characterization	A	SNI
Water Content (%)	8.4	15
Ash Content (%)	1.45	10
volatile matter levels (%)	23.83	25
Iodine adsorption (mg/g)	788,43	750

The ash content in activated carbon indicates the amount of minerals in activated carbon, which are not burned during the carbonization process and are not released during activation. The quality of activated carbon is better if the ash content of the activated carbon is small. This is due to the large content of metal oxides that are decomposed by the activator. The pores on the surface of the carbon are open, which will have an impact on the adsorption of activated carbon the better.[9] The increase in ash content will have an impact on the weak ability of activated carbon sorption. This is due to metallic minerals such as K, Na, Ca, and Mg filling the pores of the activated carbon. Based on **Table 1.** The ash content contained in the activated carbon of the langsar shell is 1.4%. The ash content of this langsat shell activated carbon has met the standard of SNI 06-3783-1995, which is less than 10%.

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Determine the quantities of volatile chemicals present in activated carbon using a calculations of volatile substances(parts lost on heating) or volatile substance levels.[11] Volatile substances at high concentrations will hinder activated carbon's ability to adsorb them. This is due to the fact that the pores of the activated carbon are still covered by volatile chemicals, making the surface area available for adsorption of activated carbon still minimal.[9] This activated carbon's volatile chemical content was less than 25%, which was required by SNI 06-3783-1995.

The unit of measurement for iodine adsorption is mg/g. It represents the quantity of iodine (mg) that one gram of activated carbon can adsorb. Iodine's adsorption by activated carbon shows this material's capacity to take in smaller particles or molecules. The goal of determining the iodine adsorption is to determine the activated carbon's capacity to bind colored solutions with molecules smaller than 10 or 1 nm.[12] While the adsorption value of iodine from langsat shell activated carbon is 788,4284 mg/g, the adsorption of iodine in activated carbon has satisfied the standard of SNI 06-3783-1995, which requires that the adsorption of iodine is at least 750 mg/g.

3.2 Effect of Adsorbent Dosage

The dosage of the adsorbent is an important parameter in the adsorption process to evaluate the adsorption capacity of metal ions on the adsorbent. The adsorption of metal ions depends on the type of surface of the adsorbent and on the form of ions found in the metal in aqueous solution. This can be explained by the fact that if the mass is more the contact surface is offered for the adsorption of more Cu ions and hence becomes important in removing more adsorbate. The mass of adsorbent was varied from 0.2 to 0.5 gram.[5]

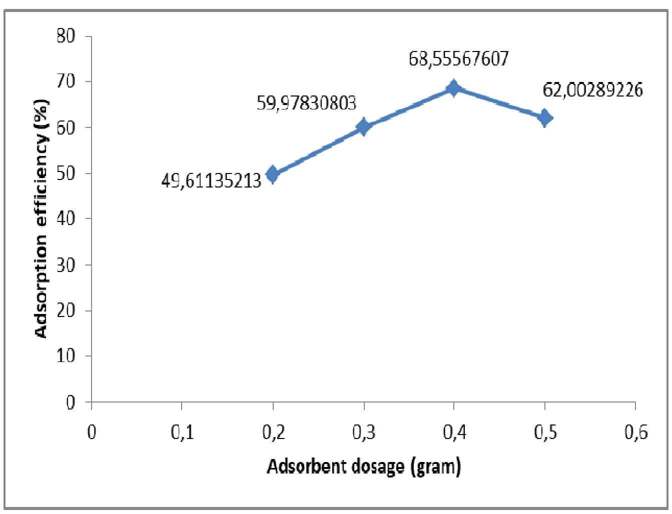

Figure 1. Effect of Adsorbent Dosage on Adsorption Capacity

The effect of dosage is carried out by keeping all other parameters at constant values, namely pH and concentration. The first removal efficiency increases, reaches a maximum, and then decreases. The effect of adsorbent dosage is shown in **Figure 1.** Where there is a decrease in adsorption capacity as the adsorbent dosage increases. At higher adsorbent dosage, the adsorbent provides more number of active sites. However, with increasing adsorbent dosage, particle aggregation occurs, as a result the efficiency and adsorption of Cu^{2+} decreases.[13]

According to **Figure 2**, with a dosage of 0.2–0.4 g and 0.5 g of adsorbent, the percentages of removal increased with the increase in adsorption efficiency. At 0.4 g of carbon dosage, in which the adsorption percent was 68.55%, the best adsorption percentage was noted. This pattern is caused by a rise in the area on the adsorbent or the availability of active sites, which facilitates Cu(II) complexation and increase the percentage of adsorption.[14] As the adsorbate molecules bonded to the adsorbent decrease after achieving equilibrium, the adsorption efficiency decreased at 0.5 g.[15]

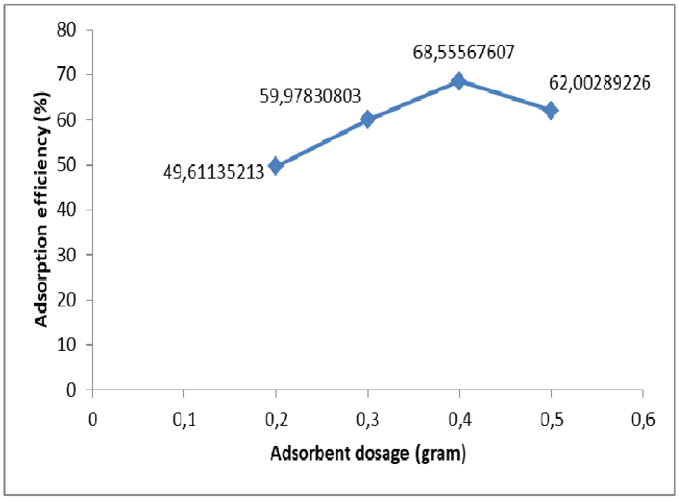

Figure 2. Effect of Adsorbent Dosage on Adsorption Efficiency

4. CONCLUSION

The conclusions obtained in this research are an activated carbon quality test based on SNI No.06-3730-1995 found that langsat shell activated carbon met the criteria set by SNI, where the water content was 8.4%, Ash content was 1.45%, volatile matter content was 23.83% and iodine adsorption of 793.1875.

The effect of adsorbent dosage obtained optimum results at 0.4 gram adsorbent dosage with an adsorption efficiency of 68.55%.

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