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by Sheilla Marendra

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Removal of Heavy Metal Cadmium (Cd) in Medical Wastewater Using Adsorbent from Water Hyacinth Leaves as Adsorption Material

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Abstract. The hospital is a health service institution for the community, besides that the hospital is also a producer of waste. Wastewater from hospital activities contains microorganisms, toxic chemicals and radioactive materials. Hospital medical waste water needs to be treated specifically. One way to remove organic substances that are difficult to degrade in liquid waste is the adsorption process using water hyacinth leaves. This study aims to analyze the performance of the adsorbent on water hyacinth leaves against laboratory wastewater in hospitals, and to determine the efficiency of heavy metal cadmium (Cd) removal. This study uses adsorption with a jartest tool for the stirring process. Variations in mixing speed (rpm) of 150 and 175 with variations in contact time of 15, 30, 45, 60, 75, and 90 (minutes), and adsorbent mass of 10 grams. The results showed that the optimum stirring speed of 175 rpm with a time of 60 minutes obtained a removal efficiency of 97,37%. The initial concentration of heavy metal Cd was 3.61 mg/L and after the adsorption process was 0.095 mg/L. One process that is quite effective in reducing heavy metal levels at an affordable cost is the adsorption process.

INTRODUCTION

The hospital is a health service institution for the community, in addition to the hospital as a source of liquid medical waste. Sources of hospital waste water come from activities including washing or laundry activities, kitchens, floor drains, laboratories, toilets, treatment rooms, emergency rooms, operating rooms, and others. In this case, hospital laboratory waste contains hazardous materials, especially toxic and radioactive chemicals. Due to the large amount of heavy metal content, wastewater in hospital laboratories must be watched out for and requires special attention and handling [5]. In general, heavy metals have lethal toxicity to organisms under different conditions. So that it can cause the death of several types of aquatic biota if the solubility in water bodies is high enough. One of the heavy metals that is dangerous and often pollutes the environment is cadmium (Cd).

One method to remove organic substances that are difficult to degrade in wastewater is the adsorption process. In this adsorption process, the adsorbent used comes from natural materials. The adsorbent used in this study is the adsorbent from water hyacinth leaves. Water hyacinth is one of the plants that can do adsorption. The ability of water hyacinth to absorb is due to water hyacinth having finely branched roots that function as a tool to absorb chemical compounds, so that the toxicity of dissolved chemical compounds decreases. Water hyacinth on the leaves is able to bind heavy metals because it has a functional group, namely as an active group. These groups are carboxylic groups and hydroxyl groups as well as amine groups [1]. The purpose of this study was to remove heavy metal Cd in hospital laboratory wastewater using water hyacinth leaves as adsorbent.

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METHOD

The tools used in this study were: SSA SpectraAA 220FS, heating oven, stirrer and magnetic stirrer, 10 mL and 100 mL measuring pipettes, 125 mL and 250 mL Erlenmeyer, 50 mL and 100 mL volumetric flasks, 500 mL beakers. Funnel glass.

The materials used in this study were: 250 ml of hospital laboratory wastewater, 10 grams of water hyacinth leaf adsorbent, 20 ml of H2SO4 solution, 5 ml of HNO3 solution.

Samples of water hyacinth leaves came from rivers in the Bekasi area, then flowed with running water to reduce the dirt contained in the water hyacinth leaves, then the leaves were cut into small pieces to speed up the drying process and dried for 5-7 days in the sun for drying. reduce the water content in the water hyacinth leaves. Furthermore, the dried water hyacinth leaves are put in a furnace at a temperature of 300˚C for 10-15 minutes until charcoal is formed. Then the water hyacinth leaves were ground and sieved using a 100-mesh sieve. The adsorbent was tested by means of carbonized water hyacinth leaves and activated with a 20% H2SO4 solution, with a ratio of 2 ml: 1 gram of the amount on the adsorbate and adsorbent. This comparison was taken based on previous research which stated that activated charcoal in a 2:1 ratio in the activation process resulted in a significant surface area [3]. Activation of the adsorbent was carried out by pouring a 20% H2SO4 solution into the water hyacinth leaf adsorbent and soaked for 24 hours, then the adsorbent was rinsed with distilled water and then removed the water content in an oven at 110°C for 2 hours. and the adsorbent is ready for use.

The adsorption stage is the main research of this stage. The beaker glass with a size of 600 mL was filled with 250 mL of hospital laboratory wastewater, then added with 10 grams of water hyacinth leaf adsorbent. Then stirred using a jartest with speed variations of 150 and 175 rpm for 15, 30, 45, 60, 75, 90 minutes. Then the adsorbate water was filtered using whattman filter paper no. 42 to separate the residue and filtrate. The obtained filtrate was measured using AAS with a wavelength of 228.8 nm.

The adsorption capacity or amount of copper ions that can be absorbed by adsorbent was calculated using the following equation:

$$q = \frac{[(C_o - c).\ V]}{W} \tag{1}$$

q was the amount of copper ions absorbed by adsorbent (mg/g), Co initial waste contains copper ion concentration (mg/L), C final waste contains copper ion concentration after adsorption (mg/L), V was the initial volume of waste containing copper ion solution (L), and W were the weight of the adsorbent (gr). Allowance efficiency can also be determined using the following equation (2):

$$RE = \left[\frac{(C_o - C)}{C_o}\right] \times 100\% \tag{2}$$

RESULT AND DISCUSSION

This research was conducted at the Environmental Laboratory, Department of Environmental Engineering, Building K, Trisakti University, West Jakarta. The hospital laboratory wastewater samples used in this study came from hospitals in the East Jakarta area. Hospital laboratory waste comes from chemical waste for testing (reagents), and residual specimen waste (blood and body fluids). This research uses water hyacinth leaf adsorption method. The method used for heavy metal analysis in hospital laboratory wastewater is the Atomic Absorption Spectrophotometer (AAS) method which is carried out in the laboratory. Atomic Absorption Spectrophotometer is a tool that can be used for quantitative analysis. Quantitative analysis is used to determine the content of a substance from a sample. In this analysis, Atomic Absorption Spectrophotometer was used to determine the Cd content of hospital laboratory wastewater samples. The results of the analysis of heavy metal content in hospital laboratory wastewater can be seen in Table 1.

Table 1. Concentration of hospital wastewater content

The content of hospital laboratory liquid waste	Concentration (mg/l)
Pb	-0,02
Cd	3,61
Cu	-0,90
Zn	0,49

Table 1 shows that the concentration of heavy metal Cd has not met the quality standard when compared to the Regulation of the Minister of the Environment of the Republic of Indonesia Number 5 of 2014 concerning Wastewater Quality Standards for Businesses or Activities that do not yet have established wastewater quality standards [4].

In this study, 10 kg of wet water hyacinth leaves were used. Water hyacinth leaves that have been cleaned by water, then cut into small pieces and dried in the sun for 5-7 days at an ambient temperature of 25˚C to 31˚C. The process under sunlight has the aim of reducing air. After the water hyacinth leaves dry, the next process the water hyacinth leaves are carbonized using a furnace at a temperature of 300˚C for 10 minutes to form charcoal. The choice of temperature is 300˚C because the carbonization process is generally carried out at a temperature of 300-800˚C. If the temperature used is lower than 300˚C, then the carbonization that occurs is not optimal and if the temperature exceeds 800˚C, the pores are damaged [2]. The carbonization process aims to expand the porosity of the adsorbent cell wall so that the adsorption surface area is greater. Carbon powder produced from the carbonization process was 1029 grams, from the weight of the wet adsorbent to the weight of the dry adsorbent produced as much as 12.9%. Then the carbon powder was sieved with a size of 100 mesh. The uniform size of the carbon powder aims to have the same size and have a smaller particle size. The smaller the particle size, the more pores are formed. The next process, activated carbon by soaking water hyacinth leaf carbon in 20% H_2SO_4 solution for 24 hours. The use of H_2SO_4 solution aims to expand the surface area of the adsorbent.

In this study, variations in stirring speed of 150, and 175 rpm were used with contact times during the stirring process, namely 15, 30, 45, 60, 75, and 90 minutes to reduce the heavy metal content of Cd. Determination of the optimum stirring speed aims to obtain the optimum stirring speed in the adsorption of heavy metal Cd by water hyacinth leaf adsorbent. The speed of stirring affects the absorption of the adsorbate more because of the movement of the particles that spread. The experimental results can be seen in Figure 1 and Figure 2.

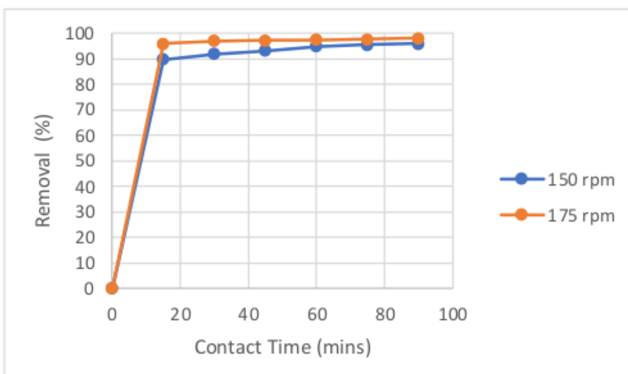

FIGURE 1. Effect of Stirring Speed Using Water Hyacinth Leaf Adsorbent and Contact Time to Percent Removal of Heavy Metal Cd

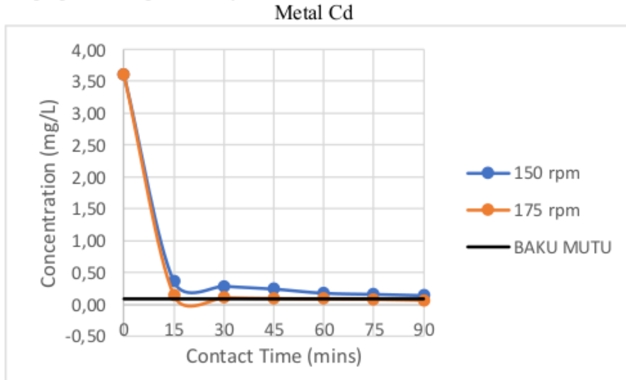

FIGURE 2. Effect of Stirring Speed Using Water Hyacinth Leaf Adsorbent and Contact Time to Concentration of Removal of Heavy Metal Cd

Figure 1 shows that the percentage of adsorption removal increases, this can be seen from the graph. At a stirring speed of 150 rpm with a time of 90 minutes the highest percentage of removal was 95.87%. At a stirring speed of 175 rpm, a contact time of 60 minutes, the ability of the adsorbent to absorb metal was obtained by the percentage of removal of 97.37%. When compared from different stirring speeds with variations in contact time, it shows that the stirring speed of 175 rpm at 60 minutes is very effective in reducing heavy metal Cd, this is because of the long contact time between the adsorbate and the adsorbent which is evenly distributed so that the ability to reduce water content heavy metal Cd becomes more effective. At the contact time of 60 minutes, the stirring speed of 150 rpm was able to reduce Cd metal, but it was not maximal compared to the contact time of 90 minutes. This is because the adsorbate and adsorbent at 60 minutes have not been able to absorb because there is a lot of space or the active side of the adsorbent has not been maximized in binding the heavy metal content of Cd evenly.

Figure 2 shows that the concentration of adsorption removal decreases, this can be seen from the graph. The initial concentration obtained was 3.61 mg/L. At a speed of 150 rpm for 90 minutes, the concentration removal of 0.14 mg/L was obtained, while at 175 rpm for 60 minutes, the removal speed of 0.095 mg/L was obtained.

Based on Figure 1 and Figure 2 show that the speed of 175 rpm is the optimum stirring speed in heavy metal Cd, and 60 minutes of contact is the optimum time. the concentration of effluent at the heavy metal content of Cd has met the quality standard if it is directly discharged into water bodies. The initial concentration of Cd metal is 3.61 mg/L, after processing it becomes 0.095 mg/L.

CONCLUSION

The adsorbent in water hyacinth leaves was proven to be able to reduce the heavy metal content of Cd in hospital laboratory wastewater. The efficiency of removing heavy metal levels of Cd with water hyacinth leaves as an adsorbent in laboratory wastewater obtained results of 97.37%. The absorption of heavy metal levels of Cd in laboratory wastewater with a contact time of 60 minutes was able to reduce the concentration of Cd from 3.61 mg/L to 0.095 mg/L.

From the results of the study there are still some findings for research development so the authors suggest adding other variations such as the weight of the adsorbent to see the ability of the adsorbent to adsorb heavy metal Cd, Using natural adsorbents from different wastes to reduce Cd heavy metal levels, Using other methods such as the deep column system remove heavy metal Cd.

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