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Effectiveness of Adsorbents Chicken Eggshells and Cassava Skin to Reduce Pollutants in the Electroplating Industry

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ABSTRACT

The electroplating industry has toxic content that is toxic to living things and the environment. This study aims to examine the values of Cu and Cr levels in the electroplating industry based on variations in adsorbent weight comparison. Adsorbents used are chicken eggshell and cassava skin with a contact time of 90 minutes. Adsorbent comparison used is 20:10, 25:10, and 30:10. After processing by applying the adsorbent system in the electroplating industry wastewater obtained the results of research it appears that the comparison of the weight of adsorbents influenced the decline of Cu and Cr metals with a decrease in Cu by 0.003 mg / l or with the efficiency of 99.43% and a decrease in Cr by 0.962 mg / l or with an efficiency of 95.44%.

Keywords: *Adsorbent, Chromium, Copper, Electroplating wastewater*

Introduction

Electroplating wastewater generally contains several heavy metal ions that are highly reactive and could pollute the environment. The wastewater is discharged directly into the environment and causes contamination between the river and electroplating wastewater (Chen *et al.*, 2018; Huang *et al., 2019)*. Physical and chemical methods such as ion exchange, precipitation, adsorption filtration, and membrane technology have been widely used to purify electroplating wastewater such as Cu and Cr. However, the technology is subject to constraints due to high energy consumption in its operation process (Hosseini *et al*., 2020; Shu *et al*., 2019; Ye *et al.,* 2019). The removal of non-maximum pollutants and the growing production of toxic sludge will affect the environmental quality (Xing *et al.*, 2020). This method cannot be used to process heavy metal polluted wastewater on a large scale (Jobby *et al.,* 2018; Pathak, 2017).

Heavy metal levels such as Cu and Cr in the waters are widespread in the body of water and mostly contained in water biota if consumed has the potential to cause health problems that harm humans and the environment (Ong *et al.,* 2017). Many environmental problems are caused by industrial wastewater from electroplating, an alternative exploration approach must eliminate pollutants in industrial wastewater of electroplating in an efficient and environmentally friendly way.

Wastewater management with an adsorption sys-

tem of chicken eggshell and cassava skin is a method that has not been developed and interesting to follow up because of environmentally friendly management, easy operation, and low cost because most adsorption materials are used to make use of materials that are easily obtained from the environment. The purpose of this study is to examine the efficiency of removal of Cu and Cr levels in the electroplating industry based on the variation comparison of the weight of adsorbents. Where the adsorbents used in the study are chicken eggshells and cassava shells.

Materials and Methodology

Natural Adsorbent Creation Process

This research phase includes preparation of tools and materials, manufacture of adsorbents, and testing of the initial characteristics of Cu and Cr Total levels. The making of adsorbents from the chicken eggshells is to soak the eggshell in water for 15 minutes and separate the skin in the oven at a temperature of 120 ºC for 20 minutes to remove the moisture content. The next step is to mash using a blender and sift with a 60 mesh sieve. Then done adsorbent activation by soaking eggshell into HCl 3M solution for 3 hours, then twisted skin, filtered, and washed with distilled water until pH 7, after which eggshell in the oven for 45 minutes with a temperature of 180 °C. After that adsorbent is stored in aluminum foil.

In the manufacture of adsorbents from cassava skin that is used skin is thick skin and white. Then the cassava skin in small pieces resembles a matchstick and washed with distilled water then dried using the oven at a temperature of 150 °C for 2 hours. The dried cassava skin is burned using a furnace with a temperature of 350 °C for 1 hour. After that mashed using mortar and pestle and then sifted with a sieve of 100 mesh. After becoming powder then activated with NaOH 10% for 3 hours. Then filtered using filter paper, then neutralized using HCl 0.1 M and distilled water until pH 7. Then dried using the oven at a temperature of 180 °C for 45 minutes.

Research Design

This research was conducted on a laboratory scale using a 600 ml plastic bottle reactor each filled with electroplating wastewater that has been adjusted to pH 3-4. The weight of adsorbents used for cassava skin is the same as 10 g while the different one is on chicken eggshells. Comparison of adsorbent weight variations used consists of (A) 20:10 (20 g of eggshell: 10 g of cassava skin), (B) 25:10 (25 g of eggshell: 10 g of cassava skin), and (C) 30:10 (30 g of eggshell : 10 g of cassava skin). Stirring using flocculator at 100 rpm speed and do contact for 90 minutes. The data collection of the research was conducted for 5 days. Furthermore, the samples that have been desorption are filtered using filter paper and tested Cu and Cr levels using spectrophotometry. The process of connecting electroplating wastewater waste with adsorbents is presented in Fig. 1.

Fig. 1. Process of Laying Wastewater Samples and Adsorbents for 90 minutes

Results and Discussion

The Efficiency of Cu Removal

After processing with adsorbents chicken eggshell and cassava skin with variations in weight comparison of different adsorbents showed a decline in the concentration of metal Cu as shown in Table 2. Moreover, the efficiency of Cu removal is shown in Fig. 2 in percentages.

Table 2. Concentration Removal Cu

Day	A (mg/l)	B (mg/l)	C (mg/l)
1	0,390	0,319	0,274
2	0,237	0,211	0,186
3	0,149	0,138	0,117
4	0,104	0,092	0,061
5	0,042	0,012	0,003

Table 2 shows a fall in Cu concentration in electroplating wastewater after treatment by using adsorbent variations. From the first day of the study until the 5th day showed a substantial decrease. Where on the first day of the study the final removal of Cu concentration was highest at 0.274 mg/l at a weight ratio of adsorbent 30:10. The removal of Cu concentration continued until the 5th day with the highest decrease of 0.003 mg/l in the same adsorbent ratio of 30:10. The high removal of Cu levels in the 30:10 adsorbent comparison is due to the comparison of more chicken eggshell adsorbents when compared to the number of other adsorbents.

Fig. 2 depicts that the removal efficiency of Cu in the electroplating industry after doing treatment by using three comparations heavy variation as in the remark. It appears that the comparison is reported in percentage over sometime for 5 days of treatment. Overall, the removal efficiency of Cu experienced a substantial upward trend to removal of Cu from the first-day treatment until the last treatment. From the first day of treatment, the higher removal of Cu happened at adsorbent comparison 30:10 with removal of Cu reaching more than two-fifths. Moreover, the lowest removal of Cu is at the adsorbent comparison 20:10 with the removal of Cu reached more than a fifth. Throughout the study, removal of Cu allowance experienced climbs to the last study. In the last study, the removal of Cu reached more than 90% for adsorbent comparison 30:10. Furthermore, at adsorbent comparison 20:10 and 25:10, the removal of Cu is more than four-fifths.

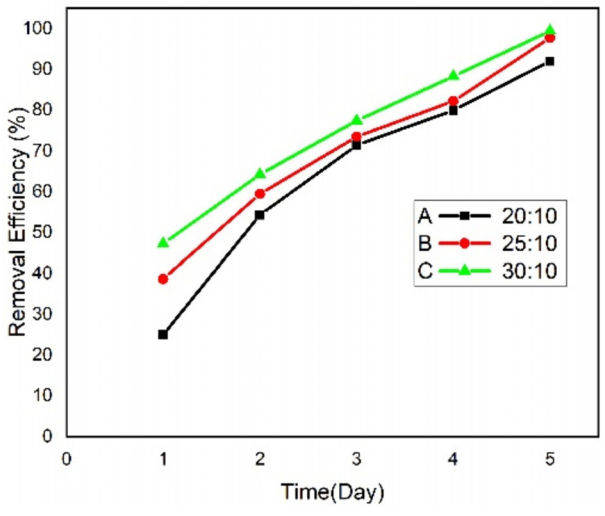

Fig. 2. Efficiency Removal Cu in Wastewater Electro plating Industry

The isolation of heavy metal wastewater Cu^{2+} by applying *Trichoderma lixii* CR700 is quite successful. *Aspergillus australensis* can lower initial Cu^{2+} levels reaching 2000 ppm. Nigraspora, Diaporthe, and Xylaria showed a fall in Cu^{2+} levels to a concentration of 1000 mg/l (Wong *et al.*, 2018). The influence of the incubation period is also an important factor that affects the growth and metabolic processes of applied organisms (Kumar and Dwivedi, 2019; Palanivel *et al*., 2020). Similarly, fungal growth increased with increased incubation periods leading to higher biomass production (Prasad *et al.*, 2018). Meanwhile, high concentrations of Cu^{2+} can reduce the growth and metabolic processes of *Aspergillus niger* IOC 4687, Gibberella stain NT-1, and Penicillium sim Plicissimum (Chen *et al.*, 2018; Dias *et al.*, 2019).

The Efficiency of Cr Removal

In the initial data before treatment, the pH of electroplating wastewater is shown in figure 3.46. In this study, pH was controlled in Figures 3-4 to maximize the efficiency of decreasing Cr levels. The removal concentration of Cr is shown in Table 3, and Crl efficiency is shown in Fig. 3.

Table 3. Concentration Removal Cr

Day	A (mg/l)	B (mg/l)	C (mg/l)
1	20,980	20,794	20,574
2	16,810	15,240	10,263
3	7,710	7,209	5,516
4	5,327	4,566	3,976
5	3,567	2,582	0,962

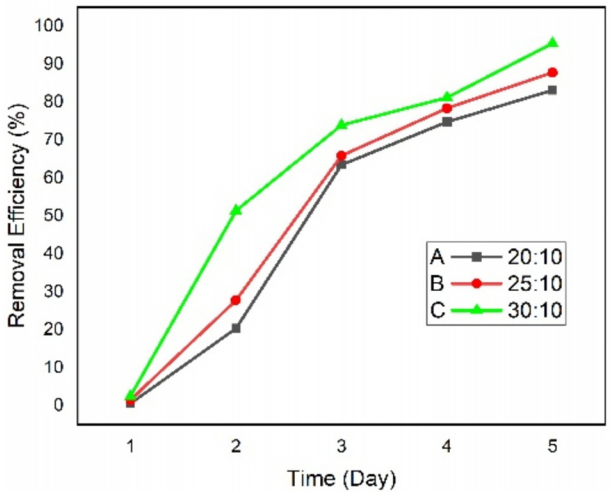

Fig. 3. Efficiency Removal Cr in Wastewater Electro plating Industry

The decrease in Cr levels as shown in Table 3 shows a significant decrease in Cr concentration since the first day of the study. Similarly, Table 2 results on the decrease in Cu levels, where at 30:10 the rate still shows the highest decrease compared to the ratio of 20:10 and 25:10. On the first day of the study, the use of chicken eggshell adsorbents and cassava skin with a ratio of 20:10, 25:10, and 30:10 was able to lower cr levels in a row by 20,980 mg/l, 20,794 mg/l, and 20,574 mg/l. Cr's rate decline continued until the last day of the study. Where on the 5^{th} day of the study the highest figure for cr level decrease was 0.962 mg/l in the 30:10 adsorbent ratio.

It is not different from the removal Cu in Fig. 2, the efficiency removal Cr appeared also in Fig. 3. The efficiency removal Cr since first-day treatment has not shown the number of substances for the three adsorbents. The efficiency removal Cr just rises to experience more than a half for the adsorbent comparison of 30:10. Furthermore, for adsorbent comparison 20:10 and 25:10 have reached more than a fifth. Efficiency removal of Cr was more significant at five days where the higher efficiency removal of Cr happened in adsorbent comparison 30:10 which reach 95.44%. Moreover, in adsorbent comparison 20:10 and 25:10, the efficiency of Cu removal is more than four-fifths.

The increase in Cr^{+6} removal efficiency is due to the increased density factor as well as the anode dissolution rate resulting in ferrite hydroxide acting as coagulants. An increased quantity of coagulants and Fe^{2+} can help the removal of Cr^{+6} to Cr^{+3}. Cr^{+6} removal efficiency even reaches 100% at 100 mA cm^{-2} for electrolysis 25 minutes (Verma *et al.,* 2013). The change in concentration is due to the difference in the mass of adsorbents used as well as the difference in the day or time of treatment. The concentration of adsorption increases with the increasing mass of adsorbents. This happens because, with the addition of the number of adsorbents, there is an active side addition on the surface side of the adsorbent, so the more the number of adsorbents, the more concentrations of Cr absorbed. But under certain conditions, the percentage of absorption will be constant and even decrease due to the condition of adsorbents that have been saturated.

The results showed that Cu and Cr Total metal adsorption with chicken eggshell powder adsorbents and cassava skins were influenced by the number of adsorbents as well as the length of sample treatment in the study. The larger the number of adsorbents added and the longer the research time, the better the absorption. The weight of the adsorbent can be attributed to the surface area of the adsorbent. Increased adsorbent weight affects the increase in the surface area of the adsorbent, resulting in the availability of binding areas for adsorptions more widely. The maximum adsorption is reached after the addition of a certain number of adsorbents. At that point, the amount of Cu and Cr metals bound to the adsorbent and the number of Cu and cr free will remain, even with the subsequent weight gain of the adsorbent (Jeyakumar and Chandrasekaran, 2014).

Conclusion

The results showed a difference in adsorption efficiency in each comparison of adsorbents used. However, the highest figures for Cu and Cr levels allowance occurred at a ratio of 30:10. The highest Cu level allowance reached 0.003 mg/l with an efficiency of 99.43%. While the highest level of cr allowance reached 0.962 mg / l or with an efficiency of 95.44%. The high efficiency of Cu level allowance is almost 100% due to the low initial characteristics of electroplating wastewater at the Cu level itself.

Acknowledgments

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