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Isotherm Study on Reduction of Cu using coconut coir pith activated carbon powder

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ABSTRACT

Batch method of adsorption study was implemented using Coconut coir pith activated carbon powder (CCPACP) to remove copper (Cu) presents in a Cu electroplating industry wastewater. The influence of adsorption dosages and agitation speed was studied against the Cu removal. The 86.5 % was observed as maximum Cu removal using prepared activated bio adsorbent. The experimental data were used to develop the isotherm model. The experimental data fitted well with the Freundlich isotherm model. Based on experimental and model studies, CCPACP is more effective to remove Cu from Cu electroplating industry wastewater.

KEY WORDS: Electroplating Industry Wastewater, CCPACP, Adsorption Process Parameters, Isotherms.

1. INTRODUCTION

The residue of heavy metals like chromium, copper, zinc, cadmium etc. are coming along with various organic compounds like phenols, formaldehyde etc. from the electroplating industry wastewater. The harmfulness of the wastewater depends on the concentration of the individual metals characteristics as well as method of discharge. The toxicity may arise due to excess usage of heavy metals in an electroplating industries. Because of reduce, reuse ability of adsorbent, it may be used instead of existing physical, chemical and biological methods.

Prepared activated carbon from the biomaterials has more capacity than raw biomaterial for reducing the contaminants. The activated carbon preparation cost are also negligible if it prepared using biomaterials when compared commercial activated carbon cost. Activated carbons like groundnut husk, corncob, rice husk, saw dust, tea leaves carbon, eucalyptus bark, and agricultural wastes are used by previous researchers for reducing the contaminants from various industry wastewater. Further, coagulant (*Moriga oleifera*) also used to reduce the contaminants in an industry wastewater. The other treatment methods used are electro-dialysis, filtration, ozonation, chemical precipitation, bioremediation, reverse osmosis etc.

This paper dealt with influence of Coconut coir pith activated carbon powder (CCPACP) to remove Cu from Cu electroplating industry wastewater for different dosages and agitation speed against the contact time. The isotherm model also fitted with experimental data.

2. MATERIALS AND METHODS

The entire experimental work was planned in three distinct phases which include preparation of CCPACP (Phase I), collection of wastewater (Phase II) and conducting experiments for determining the suitability of CCPACP to remove copper (Phase III).

Phase I: From the local coconut coir industry, Coconut coir pith was collected. It was dried, pulverized and sieved through 1 μm sieve. Activated carbon powder was prepared by heating the Coconut coir pith at a temperature of 300^{o} C and 3 hour duration in a hot air oven. It is then used for experimentation.

Phase II: Copper electroplating industry wastewater was collected using air tight glass bottles and the initial Cu concentration in a wastewater was determined as 183 mg/l as per APHA, 2005.

Phase III: For this study, the Phipps and Bird jar test apparatus was used for evaluating and optimizing adsorption process. Wastewater was filled in four glass beakers of 1 litre capacity and was kept in the apparatus for agitation. Influence of adsorbent dosage ranges from 20 g/l to 140 g/l, and different agitation speed ranges from 25 to 100 rpm was evaluated for this study.

The wastewater concentration before and after treatment by CCPACP was determined as per APHA, 2005. Further, equilibrium study was also conducted for different concentration dilution ranges from 0 to 4 and the same data was used to fit isotherm model. Using a mass balance, the concentrations of Cu at various time adsorbed by the adsorbent was calculated as

$$q_t = \frac{(C_0 - C_t)V}{M} \qquad (1)$$

where, qt is the quantity of Cu adsorbed by CCPACP at time t, C0 is the initial concentration of Cu, Ct is aqueous phase concentration of Cu at time t, V is the volume of the aqueous phase, M is the weight of CCPACP.

3. RESULT AND DISCUSSION

Influence of CCPACP: Fig.1 shows the influence of CCPACP dose for reducing the Cu from Cu electroplating industry wastewater against the agitation speed of 100 rpm. The original Cu concentration of 183 mg/l was taken for conducting the experiment. Fig.1 indicated that up to adsorbent dosage of 100 g/l, the Cu concentration decreases beyond which, it increases. The reduction in Cu concentration (in terms of percentage) for a CCPACP dosage of 20, 40, 60, 80, 100, 120 and 140 g/l respectively were found to be 25.7, 36.7, 49.8, 62.3, 70.5, 64.8, and 56.8 % and the maximum removal was observed for the dosage of 100 mg/l (Fig.1). As a result, the remaining Cu concentration found in a wastewater is 53.98 mg/l.

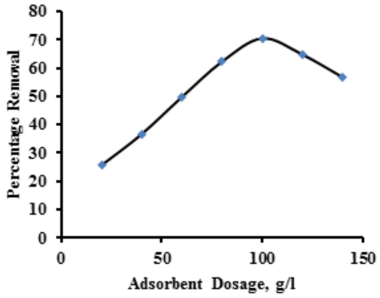

Figure.1.The influence of Adsorbent Dosage on Cu reduction in a Cu electroplating industry wastewater with an agitation speed of 100 rpm and an initial concentration of Cu of 183 mg/l

Influence of Agitation speed: Fig.2 shows the influence of agitation speed for reducing the Cu from Cu electroplating industry wastewater against an optimum adsorbent dosage of 100 g/l (Fig.1). The influence of agitation speed also conducted against the original Cu concentration of 183 mg/l. Fig.2 indicated that up to agitation speed of 50 rpm, the Cu concentration decreases beyond 50 rpm, it increases. The Cu reduction (in percentage) for an agitation speed of 25, 50, 75 and 100 rpm respectively were observed as 32.7, 55.7, 73.5, 66.3 % and the maximum speed observed for this study was 75 rpm (Fig.2). Thus, the observed residual Cu concentration in wastewater is 48.5 mg/l.

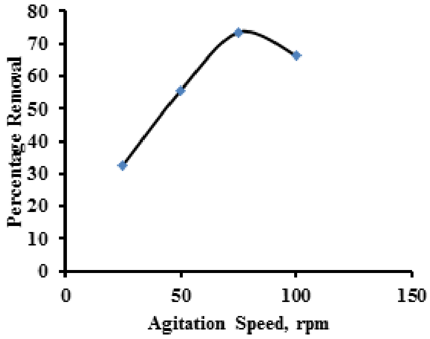

Figure.2.The influence of agitation speed on Cu reduction in a Cu electroplating industry wastewater with an optimum adsorbent dosage of 100 g/l and an initial concentration of Cu of 183 mg/l

Equilibrium Study: Adsorption isotherms models are describing the distribution of the adsorbate species among liquid and adsorbent, based on a set of assumptions that are mainly related to the heterogeneity/homogeneity of adsorbents, the type of coverage and possibility of interaction between the adsorbate species. The data obtained from the adsorption study are used in developing the adsorption isotherm models. For this study, Freundlich model is used for fitting the experimental data.

The Freundlich isotherm model is an empirical relationship describing the adsorption of solutes from a liquid to a solid surface and assumes that different sites with several adsorption energies are involved.

Freundlich adsorption isotherm is represented as

$$\mathrm{q_e} = K_f C_e^{1/2} \qquad (2)$$

and the logarithmic form of the equation (2) becomes,

$$\log q_e = \log K_f + \frac{1}{n}\log C_e \qquad (3)$$

where, q_e is the concentration of the copper at equilibrium C_e, C_e is the equilibrium concentration, K_f and n are the indicators of the adsorption capacity (Freundlich constant) and adsorption intensity (the characteristics of the system) respectively. K_f and n values are obtained by plotting the graph between log C_e vs log q_e. The optimum adsorbent dosage (100 g/l) and agitation speed (75 rpm) were used for conducting the equilibrium study against the various concentration of wastewater at various contact time. The influence of various initial concentration for reducing Cu from Cu electroplating industry wastewater is shown in Fig.3.

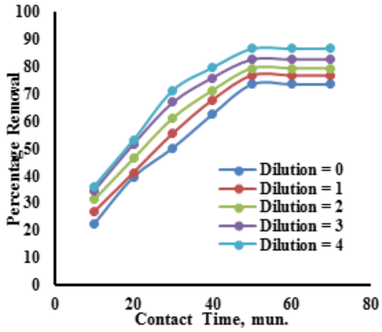

Figure.3.The influence of concentration on Cu reduction in a Cu electroplating industry wastewater with an optimum adsorbent dosage of 100 g/l and an optimum agitation speed of 75 rpm

Fig.3 indicated that adsorption capacity of CCPACP for removing Cu wastewater increased with decreased initial concentration. For the dilution factor 4, maximum removal percentage was observed for this study. Further, it was found that the adsorption of Cu by CCPACP occurred very rapidly within the first 20 min., but attained the equilibrium only at 50 min. for all dilution factors.

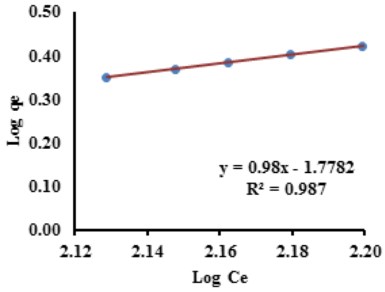

Figure.4.Freundlich Adsorption Isotherm for Cu in a Cu Electroplating Industry Wastewater

The removal efficiency observed from Fig.3 was used to fit the Freundlich isotherm model. The results of Freundlich isotherm for the Cu reduction from wastewater is shown in Figure.4 indicated that the equilibrium data fits well with the Freundlich isotherm model (R^2=0.999). The value of K_f and n was obtained from Fig.4 is 0.172 and 1.02 respectively. Thus, the results of Freundlich isotherm model indicated that it could be reproduced the experimental results for removing Cu from Cu electroplating industry wastewater.

4. CONCLUSION

The experiments were conducted to know the influence of CCPACP for removing Cu in a Cu electroplating industry wastewater. The maximum adsorption percentage by the CCPACP for removing Cu from wastewater was observed as 86.5 %, which could be obtained for an optimum dosage of 100 mg/l, agitation speed of 75 rpm and concentration dilution of 4. Further, contact time of 50 min. was found as the optimum contact time from this study. The experimental data were well fitted with Freundlich isotherm model. Thus, the results of both experimental and model studies concluded that the usage of CCPACP is more economical for removing Cu in a Cu electroplating industry wastewater.

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