

## Removal of Cd (II) and Cr (VI) from Electroplating Wastewater by Coconut Shell

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### Abstract

Electroplating units mostly scattered in urban areas. The electroplating wastewater industry is one of the major industries which generates a large portion of wastewater containing heavy metals. As effort has been made in the present study to evaluate potentials of raw coconut shell for the elimination of cadmium and chromium from the synthetic and factory electroplating wastewater were used as the samples. The effects of various parameters such as adsorbent dosage, solution pH, contact time, and initial Cd concentration on adsorption efficiency were studied during bath experiment. The removal was effective at low values and low concentrations. Cd removal efficiency was found to be 94 percent at initial Cd concentration of 7.5mg/l at pH 6.5, and Cr(VI) removal efficiency was found 83percent for an initial concentration of 50mg/l at pH=1.5.. The adsorption data obtained during the study fitted well with the Freundlich and Lanjmuir isotherms, respectively.

**CR:** adsorption, electroplating wastewater, cd concentration, Cr(VI), coconut shell.

### 1. Introduction

Electroplating units mostly scattered in urban areas[1]. Electroplating is one of the three main industries that discharge heavy metals in the world[2-3]. The electroplating wastewater industry is one of the major industries which generates a large portion of wastewater containing heavy metals. Rapid industrialization has led to increased disposal of heavy metals into the environment. The tremendous increase in the use of

the heavy metals over the past few decades has inevitably resulted in an increased flux of metallic substances in the aquatic environment. The metals are special because of their persistency in the environment. At least 20 metals are classified as toxic, and half of these are emitted into the environment in quantities that pose risks to human health [4]. Various treatment techniques available for the removal of Cd and Cr(VI) from wastewater include precipitation, coagulation and flocculation, ion exchange, and reverse osmosis. Most of these methods require high investment of capital and also expensive chemicals, making them unsuitable for treating cadmium containing wastewater. Adsorption is by far the most effective and widely used technique for the removal of toxic heavy metals from wastewater[5].

## 2. Materials and Methods

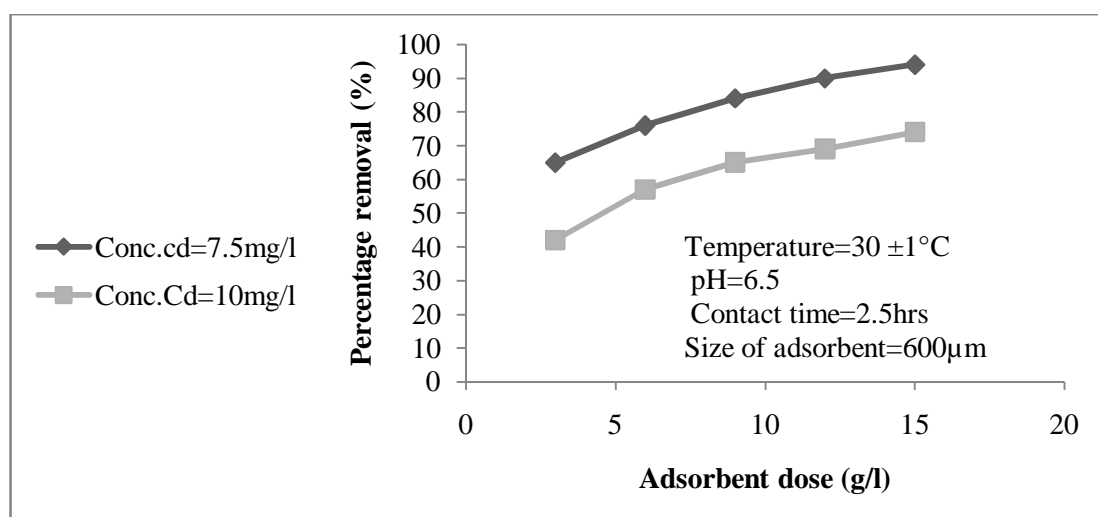
In the present work coconut shell have been used as adsorbents for the investigating the removal of cadmium and chromium from the electroplating wastewater using batch adsorption process. These adsorbent are widely available in India. It was cut into small pieces, washed several times with distilled water and dried in an oven at 100°C for a period of 24 hours. The adsorbent was then ground and sieved to get the desired particle size of 150 to 600 µm. The adsorbent was dipped in 1N NaOH for a period of 10 hrs and washed several times with distilled water to remove the lignin content and then dried. The adsorbent was again washed separately with double distilled water two to three times and dipped into 0.1 N H<sub>2</sub>SO<sub>4</sub> for the period of 10 hrs to remove traces of alkalinity. The acid treated adsorbent is washed thorough with double distilled waters, there after the materials was dired in sun and stored in a desiccators. The stock solution of cadmium (1,000 mg/L) was prepared by dissolving 2.74 g of cadmium nitrate (Cd (NO<sub>3</sub>)<sub>2</sub>.4H<sub>2</sub>O) in 1,000 mL of double distilled water, moreover, and for chromium solution was prepared similarly. All working solutions of different concentrations were prepared by diluting the stock solution with distilled water. The pH of the test solutions (synthetic wastewater) was adjusted using reagent grade sulphuric acid and sodium hydroxide solutions. All reagents were of AR grade chemicals. A pH meter was used to measure the pH of solutions. The effect of agitation time was studied by shaking the solution in an orbital shaker. After agitation, the adsorbate and adsorbent were separated using a 0.45-µm membrane filter (Schleicher & Schuell, Federal Republic of Germany). The cadmium concentration was determined by Atomic adsorption GBC 902. All the analyses were performed according to standard methods for the examination of water and wastewater (1992). Glassware was cleaned by overnight soaking in nitric acid followed by multiple rinsing with distilled water. The adsorption experiments were carried out by batch technique. The adsorption method consisted of mixing the ground and sieved coconut shell with a known volume (50 mL) of synthetic wastewater in conical flasks of 100-mL capacity. The samples were adjusted to the desired pH by using reagent grade sulphuric acid and sodium hydroxide solutions. The samples were then agitated in a shaker at 150 rpm at room temperature (30 ± 1°C). After prescribed contact times, the solutions were

filtered and the concentrations of cadmium in the solutions were determined Atomic Adsorption GBC 902.

### 3. Results and Discussions

#### 3.1 Effect of adsorbent dose

The effect of adsorbent dose on removal of Cd(II) at different metal concentrations (7.5 and 15mg/l) has been shown in Figure 1. The results shown in the figure indicate that the percentage removal of Cd(II) increase with increase in adsorbent dose. This is due to increase in the surface area of coconut shell and hence more active sites are available for the adsorbent of the metal ion. It is also evident from the figure that at an adsorbent dose of 15g/l the removal efficiency of Cd(II) is found to be 94% at an initial metal concentration of 7.5mg/l at pH=6.5 and 2.5hours contact time. But the removal efficiency drops to 74% when the Cd(II) concentration is increased to 15mg/l at above experimental conditions. This amounts to a maximum of 83% Cr, respectively.

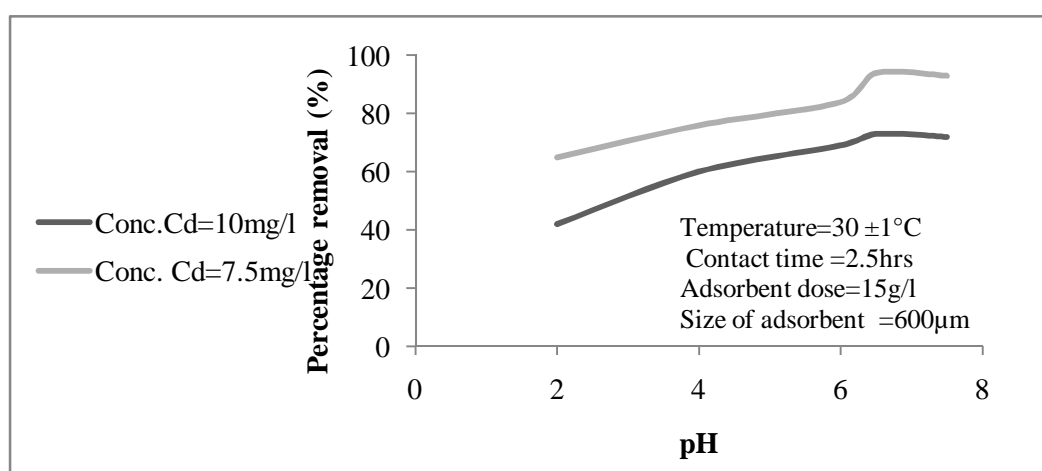


**Figure 1:** Variation of Cd(II) removal versus adsorbent dose at different metal concentrations.

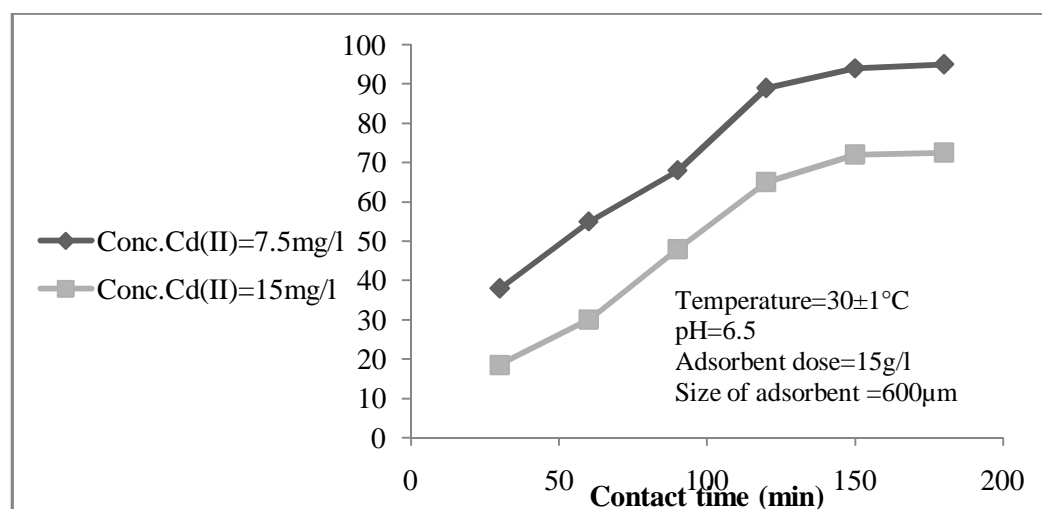
#### 4. Effect of pH

Variation of Cd (II) removal versus pH at different metal concentrations is depicted in Figure 2. The percentage removal of Cd (II) increases with increase in pH value. At an initial Cd (II) concentration 7.5 mg/L the percentage removal is 94% as compared to its adsorption at higher concentration (10mg/L) which is recorded as 73% at pH 6.5. While at pH 2 the percentage removal efficiencies were found to be 65% and 42% at an initial Cd (II) concentration of 7.5 and 15 mg/L respectively. The value of optimum

pH is found to be 6.5. To study the effect of contact time on Cd (II) removal from wastewater at different initial Cd (II) concentration (7.5 and 15 mg/L), the experiments were carried out at different contact time (30-180min) with a fixed adsorbent dose (15 g/L) and pH 6.5 at room temperature ( $30\pm 1^\circ\text{C}$ ). The response of contact time on Cd (II) removal is shown in Figure 3. The percentage removal increased from 38% to 94% when the contact time was increased from 30 to 150minutes for initial metal concentration of 7.5 mg/L at pH 6.5. While an increased in the removal efficiency was noted from 18.5% to 72% when the contact time was varied from 30 to 150minutes at initial metal concentration of 15 mg/L at pH 6.5 and the pH value was obtained for removal Cr(VI) was pH=1.5.



**Figure 2:** Variation of Cd(II) removal versus pH at different metal concentrations.



**Figure 3:** Variation of Cd(II) removal versus contact time at different metal concentrations.

### 5. Effect of Initial Concentration

The effect of initial metal concentrations (7.5 – 15 mg/L) on Cd (II) removal by coconut shell is depicted in Figure 4. The adsorption of Cd (II) decreases from 94 to 73% when the initial metal concentration was increased from 7.5 to 15 mg/L at an adsorbent dose of 15 g/L for 2.5 hours contact time at pH 6.5. Coconut shell adsorbed cadmium ions best at lower Cd (II) concentrations in the range 7.5 to 10 mg/L and for removal Cr(VI) in the range at pH=1.5. At lower concentration, the ratio of initial number of moles of metals ions to the available surface area is larger and subsequently the fractional adsorption becomes independent of its minimum initial concentration [6].

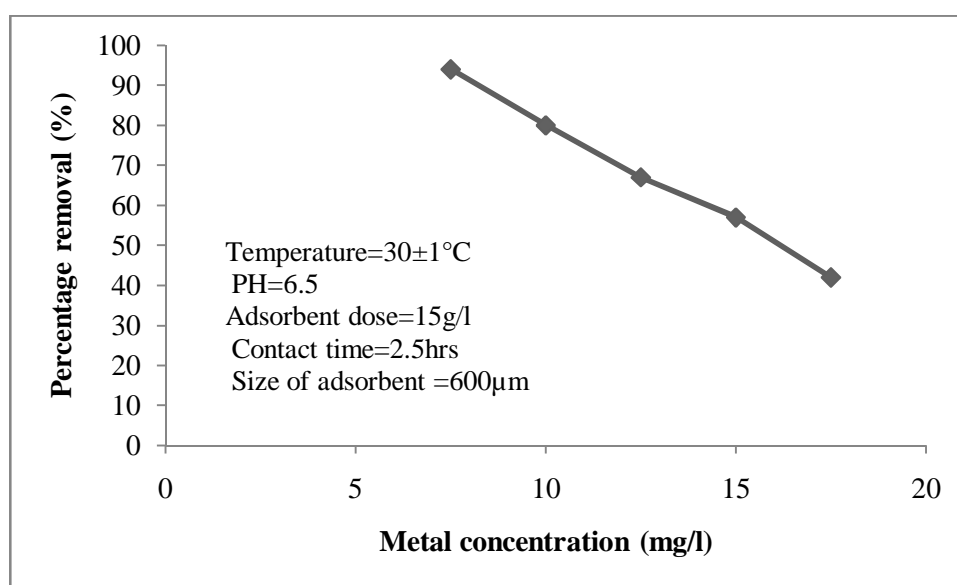


Figure 4: Effect of initial metal concentration on adsorption of Cd (II).

### 6. Adsorption Isotherm

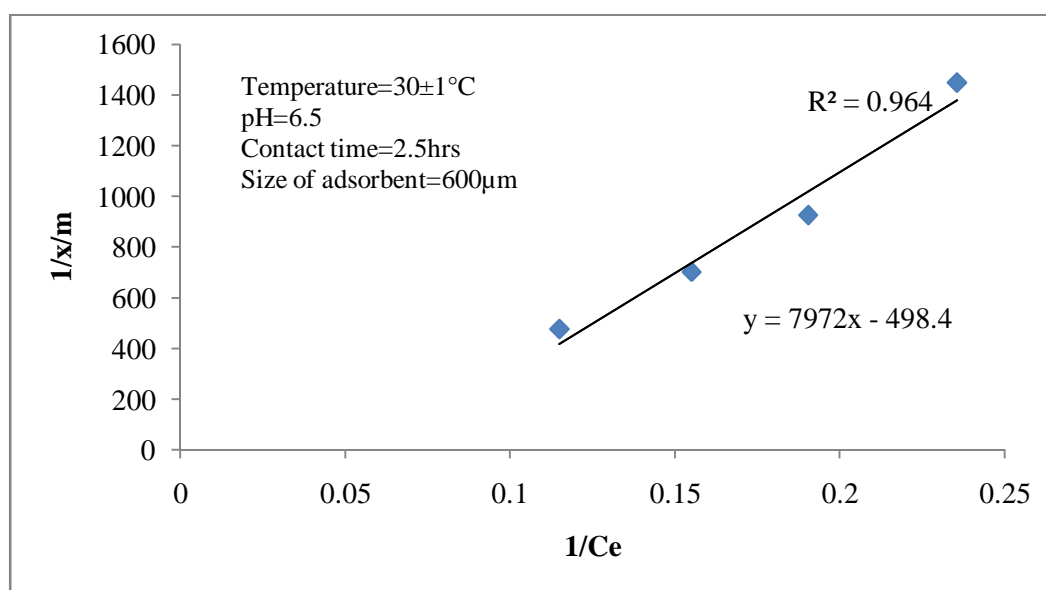
In order to model the adsorption behaviour and calculate the adsorption capacity, the adsorption data obtained during the present study is analysed by the Lanjmuir isotherm. Lanjmuir isotherm is expressed as follows:

$$\frac{1}{x/m} = \frac{1+ac}{abc} \tag{1}$$

The form of Lanjmuir model is represented by the following equation:

$$\frac{1}{x/m} = \frac{1}{b} + \frac{1}{abc} \tag{2}$$

where  $q_e$  is the mass of the adsorbate adsorbed per unit mass of adsorbent (mg adsorbate/g adsorbent), while  $C_e$  is the equilibrium concentration of the adsorbate (mg/L).  $1/b$  and  $1/ab$  are Langmuir constants related to adsorption capacity and adsorption intensity respectively. The values of constant  $1/b$  and  $1/ab$  are obtained from the plot of  $1/(x/m)$  against  $1/C_e$ , for the adsorption data of Cd (II), which is shown in Figure 5. It is evident that the data is well fitted to the Langmuir isotherm and can be represented by the following mathematical expression ( $R^2=0.964$ ).



**Figure 5:** Langmuir isotherm for adsorbent of Cd(II) by coconut shell.

## 7. Conclusion

From the present study, it can be concluded that the coconut shell has a great potential to remove cadmium (II) from wastewater. The percentage removal of Cd (II) depends on adsorbent dose, pH, contact time, and initial Cd (II) concentration. At 2.5 hours contact time and initial metal concentration of 7.5 mg/L, 94% Cd (II) removal was observed and Cr(VI) was 83%, but when the metal concentration was increased to 15 mg/L the removal efficiency dropped to 57% and 42%. Coconut shell adsorbed cadmium ions best at lower Cd (II) concentration in the range of 7.5 to 10 mg/L but the removal efficiency dropped to 42% when the metal concentration was increased to 17.5 mg/L. The adsorption data for Cd(II) fitted well to the Langmuir isotherm ( $R^2=0.964$ ). The adsorption data for Cr(VI) fitted well to the Freundlich isotherm and  $R^2$  it was 0.966.

## References

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