Removal Of Copper From Waste Water Using Low Cost Adsorbent

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Abstract: The sorption of copper (II) on chitosan has been found to be dependent on contact time, concentration, temperature, and pH of the solution. The process of removal follows first order kinetics and absorption of heat.

Keywords: chitosan, bioabsorbent, copper (II), heavy metal adsorption, Chitin.

I. Introduction

The general methods of treating wastewater having cadmium follow precipitation and ion exchange. Recently, much interest has been exhibited in the use of sorption technique for the removal of cadmium from wastewater using chitosan. The present investigation aims at using chitosan, a low cost and highly effective sorbent for the removal of cadmium from waste water. Chitosan is a biopolymer, which is extracted from crustacean shells or from fungal biomass. The structure of chitosan is presented schematically in Figure 1.

II. Experimental Procedure

Chitosan was obtained from India sea foods, cochi (India)

Batch sorption experiments were carried out in temperature controlled shaking machine by agitating 25ml aqueous solutions of sorbates with 1.0 g sorbent in different glass bottles at different conditions of concentrations, temperatures and pH. The pH of different solutions were adjusted with 0.05 M NaOH or HCl by pH meter, systronic 335. The speed of agitation was maintained at 1000 rpm to ensure equal mixing. The progress of sorption was noted after each 20 min. till saturation. At the end of predetermined time interval each 20 min, the sorbate and sorbent were separated by centrifugation at 16,000 rpm and the supernatant liquid analyzed by atomic absorption spectrophotometer.
III. Result And Discussion:

Effect Of Contact Time And Concentration
The removal of Cd (II) by sorption on chitosan from aqueous solution increase with time (fig. 2) till equilibrium is attained in 140 min. The fig. shows that time of saturation is independent of concentration. It is further noted that the amount of Cd (II) sorbed increases from 1.926 mg.g-1 to 3.814 mg.g-1 by increasing Cu (II) concentration from 100 mg/l to 250 mg/l. The time-amount sorbed curve is single, smooth and continuous indicating monolayer coverage of Cu (II) on the outer surface of chitosan.

Sorption Kinetics
The kinetics of sorption of Cu (II) on chitosan was studied using Lagergren equation (Yadav et. al. 1987)

\[
\log (q_e - q) = \log q_e - \frac{kt}{2.3} \quad \text{.......................... (1)}
\]

Where \(q_e\) and \(q\) are the amount sorbed (mg.g\(^{-1}\)) of Cu (II) at equilibrium and at time\(t'\) respectively and \(k\) is sorption constant. The straight lines obtained from the plots of \(\log (q_e - q)\) against\(t'\) (fig. 4) and different concentrations indicate that the sorption process follows first order kinetics.

Effect of temperature
The amount of Cu (II) sorbed on chitosan increases from 1.927 mg.g-1 to 2.228 mg.g-1 by increasing temperature from 30°C to 40°C indicating the process to be endothermic (fig. 5).
Langmuir isotherm

The equilibrium data at the different temperatures follow Langmuir equation.

\[ \frac{C_e}{q_e} = \frac{1}{\varphi b} + \frac{C_e}{\varphi} \]  
(2)

Where \( C_e \) mg.L\(^{-1}\) is equilibrium concentration of cd (II) and \( \varphi \) and \( b \) are Langmuir constants related to sorption capacity and sorption energy respectively. The value of \( \varphi \) and \( b \) (table 4) were determined from the slope and intercept of linear plots Fig. 6. The sorption capacity also increases with o temperature suggesting that the active centers available for sorption have increased with temperature.

\[ \Delta G^o = -RT \ln K \]  
(3)

\[ \Delta H^o = RT \frac{1}{T_2} \left( \frac{1}{T_1} - \frac{1}{T_2} \right) \ln k_2/k_1 \]  
(4)

\[ \Delta S^o = \Delta H^o - \Delta G^o / T_1 \]  
(5)

Where \( K_1 \) and \( K_2 \) are equilibrium constants at temperature \( T_1 \) and \( T_2 \) respectively.

The negative values of \( \Delta G^o \) (Table 2) indicate the spontaneous nature of the sorption process. The positive values of \( \Delta H^o \) at different temperature support the endothermic nature of the process.
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Effect of pH

The amount of Cu (II) sorbed on chitosan increases from 1.989 mg·g⁻¹ (78.6 %) to 2.349 mg·g⁻¹ (94.2 %) by increasing pH of the solution from 2.0 to 6.5 (Fig.5). The Sorption capacity Φ, also increase with the increase of pH.

### Table 1: Φ values at different temp. and pH

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Φ mg·g⁻¹</th>
<th>pH</th>
<th>Φ mg·g⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>0.4351</td>
<td>2</td>
<td>0.4312</td>
</tr>
<tr>
<td>40</td>
<td>0.4783</td>
<td>4</td>
<td>0.4315</td>
</tr>
<tr>
<td>50</td>
<td>0.5001</td>
<td>6.5</td>
<td>0.4568</td>
</tr>
</tbody>
</table>

**Fig 6**: Langmuir isotherm for the sorption of Cu (II) on chitosan; ● 30°C, ▷ 40°C, ◄ 50°C.

**Fig 7**: Effect of pH on the sorption of Cu(II) on chitosan; ● 2.0, ▷ 4.0, ◄ 6.5; temp: 30 °C, conc. 100 mg/l.

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>ΔG° (kcal mol⁻¹)</th>
<th>ΔH° (kcal mol⁻¹)</th>
<th>ΔS° (kcal mol⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>-5.29</td>
<td>15.18</td>
<td>23.41</td>
</tr>
<tr>
<td>40</td>
<td>-7.60</td>
<td>25.92</td>
<td>36.28</td>
</tr>
<tr>
<td>50</td>
<td>-9.88</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Table 2**: Thermodynamic parameters at different temperatures

IV. **Conclusion**

From the above discussion it is clear that due to chemical composition, structure, more adsorption sites, cheap, availability in plenty etc. this substance will provide to be efficient adsorbent.
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References: