International Research Journal of Environment Sciences ISSN 2319–1414
Vol. **1(5),** 81-83, December **(2012)** *Int. Res. J. Environment Sci.*

Short Communication

Chitosan for the Removal of Cadmium Rich Water

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Available online at: www.isca.in
Received 28th August 2012, revised 22nd September 2012, accepted 30th September 2012

Abstract

The sorption of cadmium (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, cadmium (II), heavy metal adsorption, chitin.

Introduction

The general methods of treating wastewater having cadmium follow precipitation and ion exchange[1]. 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[2]. The structure of chitosan is presented schematically in figure 1.

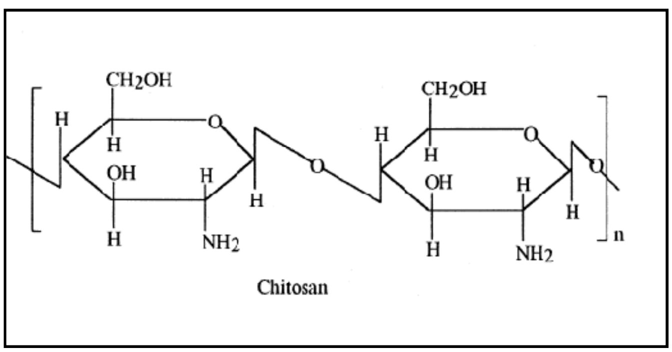

Figure-1
Structure of Chitosan

Material and Methods

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 was 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.

Results and Discussion

Effect of Contact Time and Concentration: The removal of Cd (II) by sorption on chitosan from aqueous solution increase with time (figure-2) till equilibrium is attained in 140 min. The figure show that time of saturation is independent of concentration. It is further noted that the amount of cd (II) sorbed increases from 1.913 mg.g-1 to 3.764 mg.g-1 by increasing cd (II) concentration from 100 mg/l to 250 mg/l. the time-amount sorbed curve is single, smooth and continuous indicating monolayer coverage of cd (II) on the outer surface of chitosan[3].

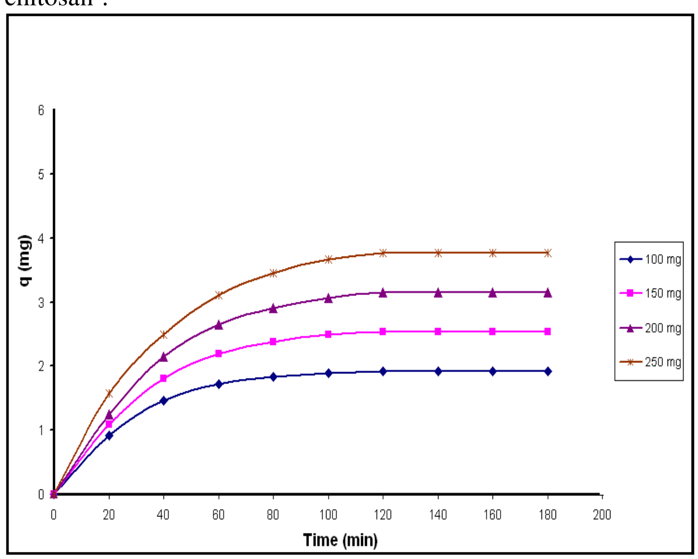

Figure-2
effect of concentration for the sorption of cadmium (II) on chitosan;
● 100 mg/L, ▪ 150 mg/ L, ◀ 200 mg/L, * 250 mg/L

Sorption Kinetics: The kinetics of sorption of cd (II) on chitosan was studied using Lagergren equation[4],
Log $(q_e - q) = \log q_e - kt / 2.3$ (1)

Where q_e and q are the amount sorbed ($mg.g^{-1}$) of cd (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' (figure-3) and different concentrations indicate that the sorption process follows first order kinetics.

Effect of temperature: The amount of cd (II) sorbed on chitosan increases from 1.913 mg.g-1 to 2.249 mg.g-1 by increasing temperature from 30°C to 40°C indicating the process to be endothermic (figure- 4).

Langmuir isotherm: The equilibrium data at the different temperatures follow Langmuir equation[5],
$C_e/q_e = 1/\varphi.b + C_e/\varphi$ (2)

Where Ce $mg.L^{-1}$ is equilibrium concentration of cd (II) and φ and b are Langmuir constants related to sorption capacity and sorption energy respectively. The value of φ and b (table 4) were determined from the slope and intercept of linear plots Fig. 5. The sorption capacity also increases with 0 temperature suggesting that the active centers available for sorption have increased with temperature.

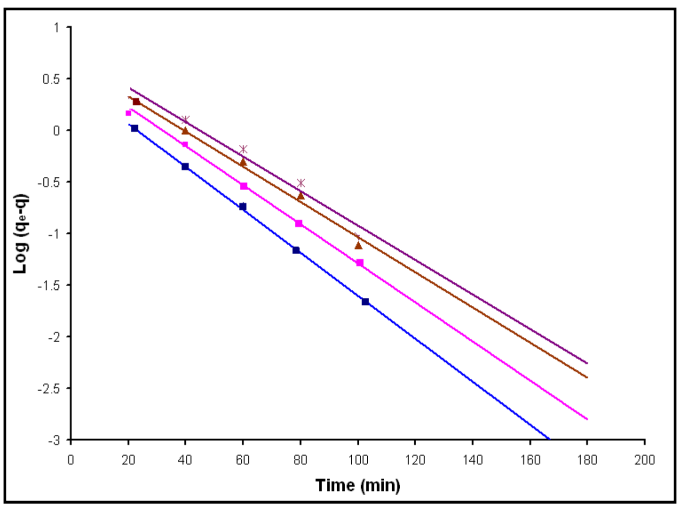

Figure-3
Lagergren plot for the sorption of Cd (II) on chitosan; ●100 mg/L, ▪ 150 mg/ L, ◄ 200 mg/L, * 250 mg/L, pH 5, temp 30°c

The change in free energy (ΔG°), enthalpy (ΔH°), and entropy (ΔS^o) of sorption have been calculated using following equations,

$\Delta G^\circ = -RT \ln K$ (3)

$\Delta H^\circ = RT_1 T_2 (T_1 - T_2) \ln k_2 / k_1$ (4)

$\Delta S^o = \Delta H^\circ - \Delta G^\circ / T_1$ (5)

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

The negative values of ΔG^o (table 2) indicate the spontaneous nature of the sorption process. The positive values of ΔH^o at different temperature support the endothermic nature of the process[6].

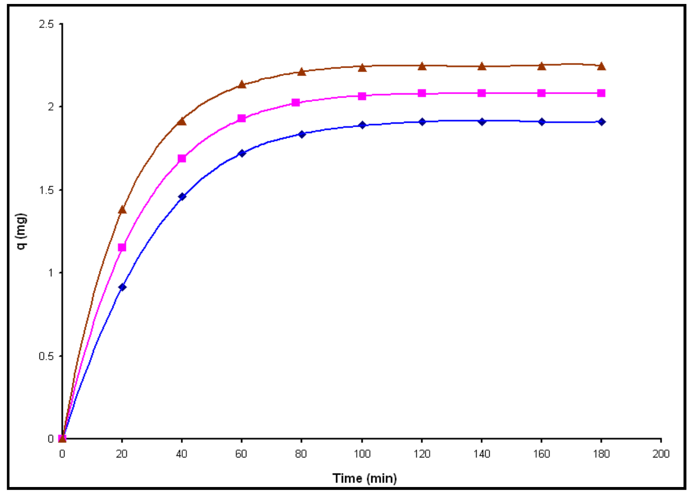

Figure-4
Effect of temperature on the sorption of Cd (II) on Chitosan
● 30°C, ▪ 40°C, ◄ 50 °C

Table-1
Ø Values at Different Temp and pH

Temperature (°C)	Ø mg.g-1	p^H	Ø mg.g-1
30	0.4353	2	0.4292
40	0.4636	4	0.4282
50	0.4941	6.5	0.4417

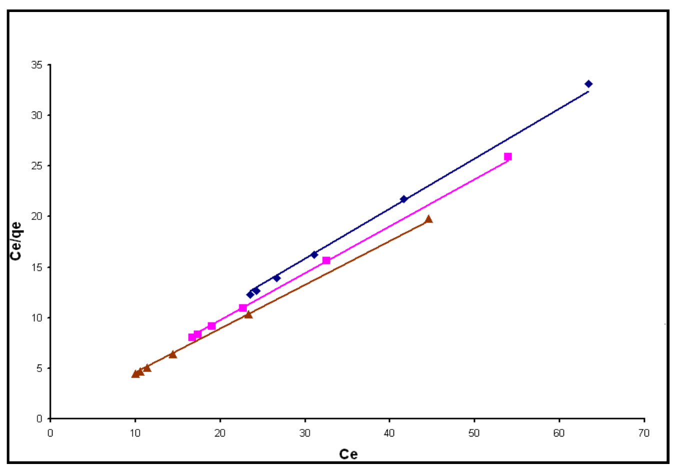

Figure-5
Langmuir isotherm for the sorption of Cd (II) on chitosan; ● 30°C, ▪ 40°C, ◄ 50 °C.

Effect of pH: The amount of Cd (II) sorbed on chitosan increases from 1.990mg.g-1 (79.6 %) to 2.330 mg.g-1 (93.2 %)

by increasing pH of the solution from 2.0 to to 6.5 (Fig.5). The Sorption capacity Φ, also increase with the increase of pH[7].

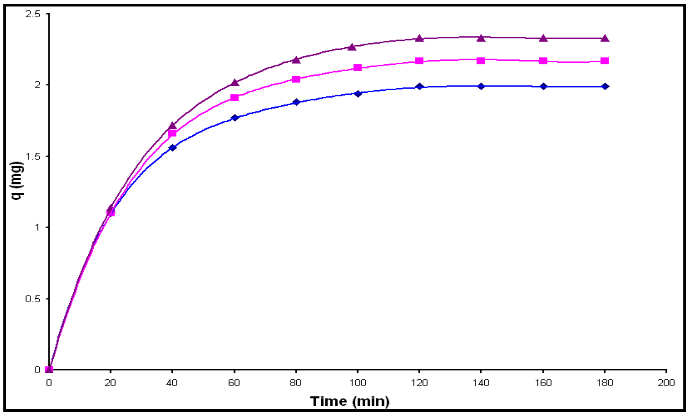

Figure-7
Effect of pH on the sorption of chitosan;
● 2.0, ▪ 4.0, ◀ 6.5; temp: 30 ^{o} C, conc. 100 mg/l

Table-2
Thermodynamic parameters at different temperatures

nperature (°C)	**ΔG° (kcal.mol^{-1})**	**ΔH° (kcal.mol^{-1})**	**ΔS° (kcal.mol^{-1})**
30	-5.18	16.13	21.32
40	-7.34	26.89	34.24
50	-9.81		

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.

Acknowledgement

The authors are thankful to Dr. Nagesh Gaveli, Director, Sudarshan College of science, management and research, Pune (Maharashtra), for providing research facilities, co- operation and constant encouragement to carry out the work.

References

1. Yadav K.P., Tyagi B.S., Pandey K.K. and Singh, Fly ash for the treatment of cd (II) rich effluents, *Env. Tech. Letter,* **(8),** 225- 234 **(1989)**
2. Singh V.N., Singh I.S. and Singh N.P., Removal of Cu (II) from aqueous solution by fly ash, *Indian Journal of Technology,* **22(2),** 22-27 **(1984)**
3. Vishwakarma P.P. and Singh V.N., Removal of Ni (II) by China Clay, *Asian Environment,* **11(3),** 49-64 **(1984)**
4. Pandey K.K., Prasad G. and Singh V.N., Fly ash China Clay for the removal of Cr (VI) from aqueous solution, *Indian Journal of Chemistry,* **23(A),** 514-515 **(1984)**
5. Namasivayam C. and Yamuna R T., *Environ Pollut.,* **9(1),** 1-4 **(1985)**
6. Sekeran G., Shanmugasundaram K.A., Mariappan M. and Raghavan K.V., *Indian J Chemical Technol.,* **2 (311),** 71-75 **(1995)**
7. Findon A., McKay G. and Blair HS., Transport studies for the sorption of copper ions by chitosan, *J. Environ. Sci. Health, A2,* **8(1),** 173-185 **(1993)**
8. Gotoh T., Matsushima K.and Kikuchi KI., Preparation of alginatechitosan hybrid gel beads and adsorption of divalent metal ions, *Chemosphere,* **5.5(1),** 135-140 **(2004)**
9. Grosse D.N., A review of alternative treatment process for metal bearing hazardous waste streams, *J. Air Pollution Contr. Assor.*, **36,** 603-614 **(1986)**
10. Ikhuoria E.U. and Omonmhenle SI., Removal of heavy metals from aqueous solution by adsorption onto chemically modified pumpkin, (Telfaira accidentalis Hook) Seed Husk, *J. Chem. Soc. Nig.,* **31(1-2),** 109-113 **(2006)**