



SORPTION OF Ni (II) FROM AQUEOUS SOLUTION USING CHITOSAN

Dhanesh Singh¹, Anjali Singh², Saroj Kumar³.

¹Deptt. of Chemistry, K.G. Arts & Science College, Raigarh (C.G)- INDIA

²Deptt. of Applied Sciences, Singhania University, Jhunjhunu (Rajasthan)- INDIA

³Deptt. of Chemistry, K.G. Arts & Science College, Raigarh (C.G)- INDIA

Abstract: The sorption of nickel (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, nickel (II), heavy metal adsorption, Chitin.

I. INTRODUCTION

The general methods of treating wastewater having Nickel follow precipitation and ion exchange. Recently, much interest has been exhibited in the use of sorption technique for the removal of nickel from wastewater using chitosan^[1]. The present investigation aims at using chitosan, a low cost and highly effective sorbent for the removal of nickel 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.

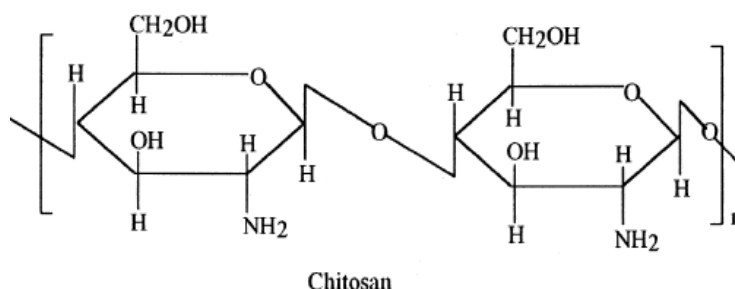


Fig. 1: Structure of chitosan

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.^[2]

III. RESULT AND DISCUSSION

EFFECT OF CONTACT TIME AND CONCENTRATION

The removal of Ni (II) by sorption on chitosan from aqueous solution increase with time (fig. 2) till equilibrium is attained in 140 min. The fig. show that time of saturation is independent of concentration. It is further noted that the amount of Ni (II) sorbed increases from 2.190 mg.g-1(87.60%) to 5.680 mg.g-1(89.54%) by increasing Ni (II) concentration from 100 mg/l to 250 mg/l. the time-amount sorbed curve is single, smooth and continuous indicating monolayer coverage of Ni (II) on the outer surface of chitosan.^[3]

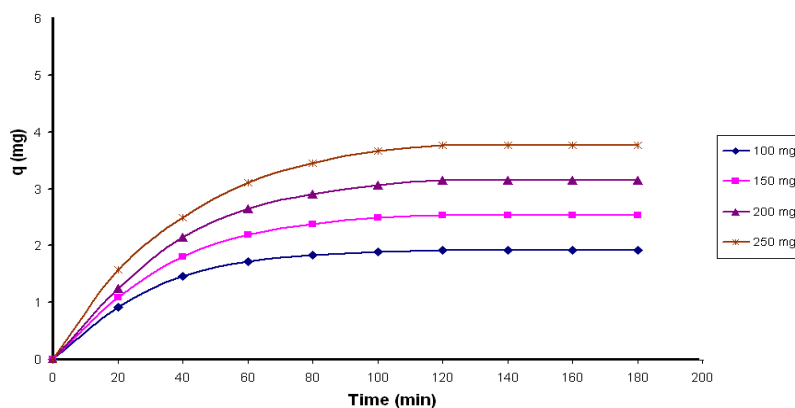


Fig. 2: effect of concentration for the sorption of nickel (II) on chitosan;
 ● 100 mg/L, ■ 150 mg/ L, ▲ 200 mg/L, * 250 mg/L

SORPTION KINETICS

The kinetics of sorption of Ni (II) on chitosan was studied using Lagergren equation (yadav *et. al.* 1987)^[4]

$$\log (q_e - q) = \log q_e - kt / 2.3 \quad \dots\dots\dots (1)$$

Where q_e and q are the amount sorbed (mg.g⁻¹) of Ni (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.^[5]

Effect of temperature

The amount of Ni (II) sorbed on chitosan increases from 2.190 mg.g⁻¹ (87.60%) to 2.3336 mg.g⁻¹ (96.13%) by increasing temperature from 30°C to 40°C indicating the process to be endothermic (fig. 5).^[6]

Langmuir isotherm

The equilibrium data at the different temperatures follow Langmuir equation.

$$C_e/q_e = 1/\phi \cdot b + C_e/\phi \quad \dots\dots\dots (2)$$

Where C_e mg.L⁻¹ is equilibrium concentration of Ni (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. 6. The sorption capacity also increases with temperature suggesting that the active centers available for sorption have increased with temperature.^[7]

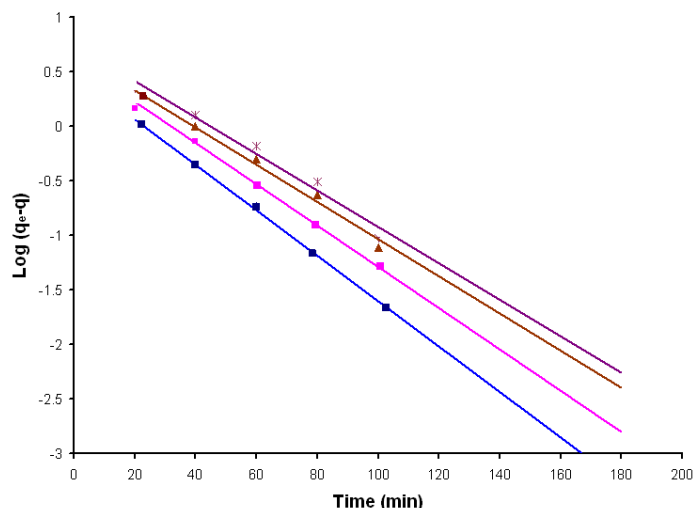


Fig. 3: Lagergren plot for the sorption of Ni (II) on chitosan;
 ● 100 mg/L, ■ 150 mg/ L, ▲ 200 mg/L, * 250 mg/L, pH 5, temp 30°C

The change in free energy (ΔG°), enthalpy (ΔH°), and entropy (ΔS°) of sorption have been calculated using following equations.^[8]

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

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

$$\Delta S^{\circ} = \Delta H^{\circ} - \Delta G^{\circ} / T_1 \quad (5)$$

Where K₁ and K₂ are equilibrium constants at temperature T₁ and T₂ respectively.

The negative values of ΔG° (Table 2) indicate the spontaneous nature of the sorption process. The positive values of ΔH° at different temperature support the endothermic nature of the process.^[9]

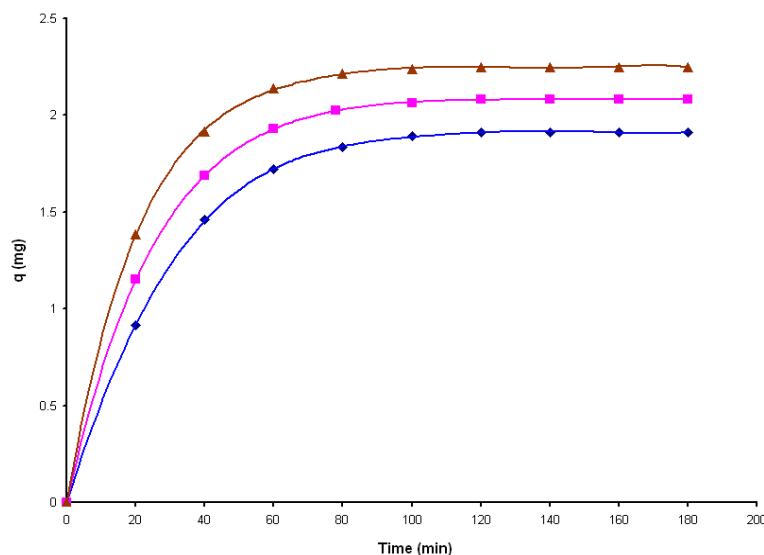


Fig. 4: Effect of temperature on the sorption of Ni (II) on Chitosan ● 30°C, ■ 40°C, ▲ 50 °c

Temperature (°C)	Ø mg.g ⁻¹	p ^H	Ø mg.g ⁻¹
30	0.7543	2	0.3891
40	1.1865	4	0.6880
50	1.3656	6.5	0.7543

TABLE 1: Ø values at different temp. and p^H

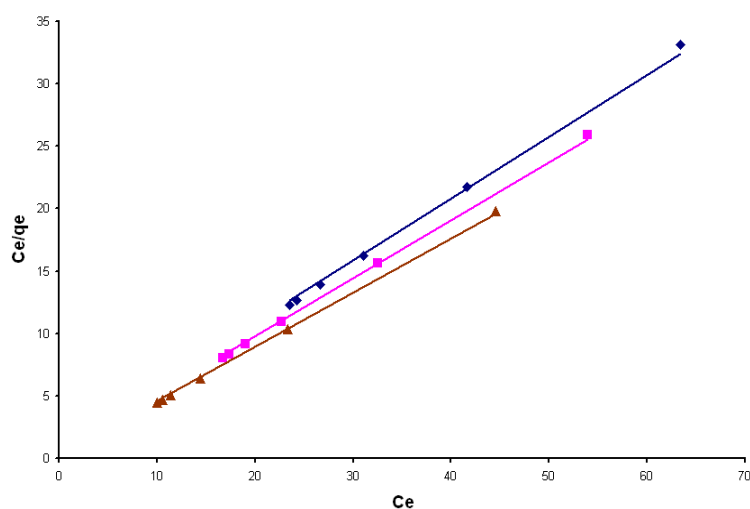


Fig. 5: Langmuir isotherm for the sorption of Ni (II) on chitosan; ● 30°C, ■ 40°C, ▲ 50 °c.

Effect of pH

The amount of Ni (II) sorbed on chitosan increases from 1.640mg.g⁻¹ (65.60 %) to 2.190 mg.g⁻¹ (87.60 %) by increasing pH of the solution from 2.0 to 6.5 (Fig.6). The Sorption capacity Φ , also increase with the increase of pH.^[10]

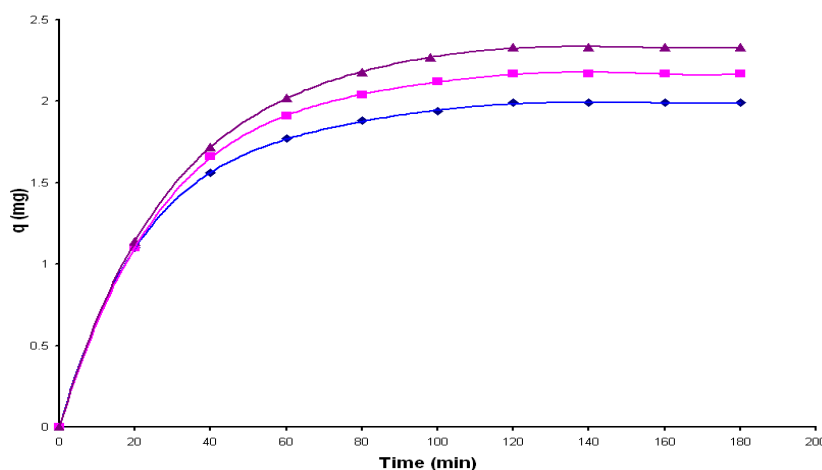


Fig. 6: Effect of pH on the sorption of Ni (II) on chitosan; ● 2.0, ■ 4.0, ▲ 6.5; temp: 30 ° c, conc. 100 mg/l.

Temperature (°C)	ΔG° (kcal.mol ⁻¹)	ΔH° (kcal.mol ⁻¹)	ΔS° (kcal.mol ⁻¹)
30	-5.40	12.41	20.02
40	-6.85	24.86	35.16
50	-8.24		

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.^[11]

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