

STUDIES ON REMOVAL OF CHROMIUM (III) USING SR1L NA RESIN

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Abstract: Effluent discharged from the tanneries contains a large amount of untreated metals like chromium salt. The removal of such salt is not only important for environmental concern but also brings in economic perks. In this paper, the efficacy of synthetic strongly cationic resin Amberlite SR1L Na was studied for the removal of trivalent chromium salts from aqueous solution. The effect of various operating parameters such as initial solution pH (2-5), resin dose (5-25 g/L), initial Cr (III) concentration (50-300 mg/L) and contact time (0-150 min.) on trivalent chromium ions removal were studied. The chromium solutions employed in the experiments were synthetic solutions.

Keywords: Ion exchange, Adsorption, Chromium (III) recovery, Amberlite SR1L Na resin.

1. Introduction

Chromium salts are largely used in various industries including tanneries, mining, electroplating etc. Chromium metal is found in two stable oxidation states, i.e., Cr (III) and Cr (VI), where Cr (VI) is a potentially carcinogen (Kimbrough et al., 1999 and Silva et al., 2006). The maximum permissible limit of Cr (III) to be disposed in surface water as set by Central Pollution Control Board, India is below 5 mg/L. It is therefore important to recover these harmful Cr(III) salts from the effluent stream before disposal.

Extensive work has been reported in literature regarding Cr extraction from aqueous streams. Many separation techniques have been proposed for the removal of chromium (III), which includes solvent extraction, ion exchange, precipitation and re-dissolution method, membrane processes and sorption by low cost materials. Among these methods, ion exchange is popular and has been widely practiced for metal ions removal (Fua et al, 2011; Bajpai et al., 2012a).

The present study reports a detailed investigation of Cr (III) removal from aqueous solutions using a macro porous strongly cationic resin, Amberlite SR1L Na under different

experimental conditions of Cr (III) concentration (50-300 mg/L), initial solution pH (2-5), resin dose (5-25 g/L), contact time (0-150 min.) at 300K

2. Materials and Methods

2.1. Ion exchange Resin

AMBERLITE SR1L Na (Rohm and Haas, S. D. Fine-Chem. Ltd. Mumbai, India) is a gel type strong acid cation exchange resin of the sulphonated (functional group) polystyrene type, used for water softening. Its key features are good ion exchange kinetics, high exchange capacity, and excellent physical, chemical and thermal stability.

All the chemicals used were of analytical grade and were obtained from S. D. Fine-Chem. Ltd. Mumbai, India.

2.3. Batch Experiments

The batch experiments were carried out in 250 mL Erlenmeyer flasks, agitated at a constant speed of 250 rpm for different time interval in an incubator cum orbital shaker at 300 K. A 100ml solution of, concentration of 50-300 mg/L, pH 2-5 and resin dose of 5-25 g/L was taken. The samples were taken from the shaker at regular time intervals to obtain the sorption data. The adsorbed amount of trivalent chromium q_t (mg/g) was calculated as follows:

$$q_t = (C_0 - C_t) * \frac{V}{m} \quad (3.1)$$

Where, C_0 was the initial metal concentration in mg/L, C_t was the metal concentration mg/L of solution after time t min, V was volume L of sample and m was the amount of resin used in g.

Percentage removal (% R) was calculated as follows:

$$(\%)R = \frac{\text{initial concentration of Cr} - \text{final concentration of Cr}}{\text{initial concentration of Cr}} * 100 \quad (3.2)$$

The concentration of chromium (III) ions in the effluent was determined using UV-visible spectrophotometer by alkaline oxidation method and absorbance of solution was recorded at 372 nm (APHA, 1992).

3. Results and Discussion

3.1. Effect of initial solution pH on removal of Cr (III)

The effect of initial solution pH on the removal of Cr (III) using Amberlite SR1L Na resin was studied by varying it in the range 2-5 (Fig. 3a). The experiment was carried out using both Na^+ and H^+ form of the resin. It was found that resin in H^+ form had better

removal efficiency to Na^+ form. However, more variation in removal efficiency was found in the Na^+ form. The study showed that the removal increased while increasing the pH from 2 to 3 before reaching maximum value and decreased further at higher pH.

The low removal at lower pH may be attributed to competition between cationic chromium species and H^+ ions of the active sites of resin. An increase in the sorption of Cr (III) with the increasing pH may be attributed to less competition between protons and metal cations (Bajpai et al., 2012b; Blázquez G. et al. 2009).

3.2. Effect of initial Cr (III) concentration on removal of Cr(III)

The effect of initial Cr (III) concentration on the sorption was studied by varying the concentration in the range 50 - 300 mg/L. Results are presented in Fig. 3b, which shows that % removal decreased from 95.24 % to 87.43 % as initial concentration of the chromium (III) increased from 50 to 300 mg/L. Decrease in % removal can be explained by the limited number of active sites available in the resin for the Cr (III) ion to capture. However, increasing Cr (III) concentration increases the ions to be accommodated and hence the % removal reduces (Kang et al., 2011; Bajpai et al., 2009).

3.3. Effect of resin dose on removal of Cr (III)

The effect of resin dose on the sorption was studied by varying it from 5 to 25 g/L. Results are presented in Fig. 3c, which shows that % removal sharply increased as resin amount increased initially from 0 to 15 g/L. Followed by a gradual increase in % removal, similar effects are reported in literature.(Huang et al., 2010; Fernandes S. et al. 2011)

3.4. Effect of contact time on removal of Cr (III)

The time-dependent behavior of sorption process was evaluated by varying the contact time in the range of 0–150 min. It was observed from Fig. 3d that more than 60% removal was achieved in first 30 minutes and about 92% removal was observed at 150 min. Further increase in contact time did not affect the removal process significantly.

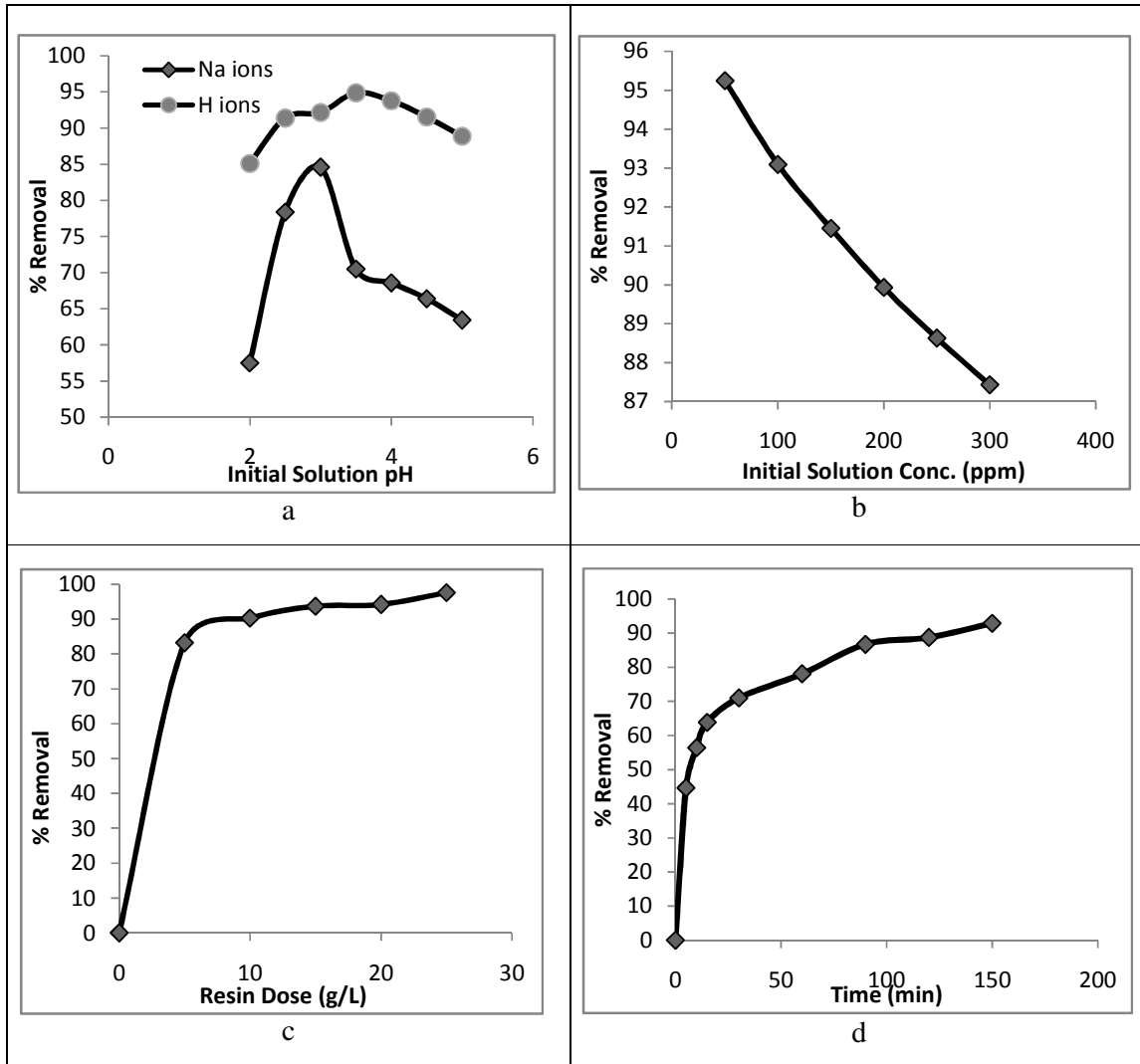


Fig. (3a) Effect of initial solution pH vs. % removal of Cr (III) on Amberlite SR1L a (resin dose 10g/L, t= 120 min and initial Cr (III) concentration 50 mg/L), Fig. (3b) Effect of initial metal concentration on adsorption of Cr (III) on Amberlite SR1L Na (initial solution pH 3, resin dose 10 g/L and t = 120 min), Fig.(3c) Effect of contact time on adsorption of Cr (III) on Amberlite SR1L Na (initial solution pH 3, resin dose 10 g/L and initial Cr (III) concentration 50 mg/L), Fig.(3d) Effect of contact time on adsorption of Cr(III) on Amberlite SR1L Na (pH 3, resin dose 10 g/L and initial Cr (III) concentration 50 mg/L).

4. CONCLUSIONS

It was found that Amberlite SR1L Na resin can effectively remove trivalent chromium from aqueous stream. More than 94% removal was obtained using SR1L resin at optimized experimental conditions. It was found that sorption was dependent on initial solution pH and was completed within 120 minutes. More removal was achieved while using H⁺ form resin

compared to Na^+ form. This study revealed the effectiveness of resin technology in the removal of trivalent Cr from the waste water.

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