Optimization of process parameters for Cr(VI) removal by seed powder of prickly pear (Opuntia ficus-indica L.) fruits using Taguchi method

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Abstract

Hexavalent chromium is one of the most toxic and carcinogenic heavy metals in aqueous solutions. It is widely used for industrial purposes and released into the environment in large quantities. In this study, Taguchi experimental method was applied to optimize the process parameters for the removal of hexavalent chromium ions from aqueous solutions. Adsorption experiments using seed powder of prickly pear (Opuntia ficus-indica L.) fruits as a new low-cost adsorbent were performed in batch reactor. The five selected controllable parameters, each at three levels, were initial pH of solution (pH), adsorbent dose (m), initial concentration of metal (C₀), time of contact (t), and temperature (T). The L₁₈ orthogonal array experimental design and “the higher-is-better” criterion were selected to determine optimum removal conditions. The data from all experiments were analyzed using signal-to-noise (S/N) ratio and analysis of variance. The obtained results revealed that the initial pH of the solution was the most important parameter contributing to the removal efficiency (82.48%) followed by adsorbent dose (10.21%), and contact time (5.56%). The optimal conditions for chromium(VI) removal were determined at initial pH of 1, adsorbent dose of 6.0 g/L, initial concentration of metal of 30 mg/L, temperature of 55°C, and time of contact of 80 min, and the Cr(VI) removal percentage was 98.24%. A multiple linear regression equation was developed for estimating predicted values.

Keywords: Chromium(VI); Adsorption; Prickly pear seeds; Optimization; Taguchi method