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ADSORPTIVE REMOVAL OF HEXAVALENT CHROMIUM USING RESPONSE SURFACE METHODOLOGY AND ARTIFICIAL NEURAL NETWORK

P. Roy✉
Department of Chemistry, B.N Mahavidyalaya, Itachuna, Hooghly–712147 (West Bengal) India.
✉Corresponding Author: palaschem@gmail.com

ABSTRACT

Fe–SCC adsorbent was used in a batch procedure to remove Cr(VI) from an aqueous solution. An RSM and an ANN model were developed using data gathered from 30 batch trials, which were then utilized to optimize and accelerate the absorption processes. As a result of a three-level, four-factors central composite design (CCD) in RSM, the impacts of operational factors such as Cr(VI) concentration, contact duration, the dosage of adsorbent, and pH of solution were evaluated. The suggested quadratic model had a coefficient of determination (R^2) value of 0.996 and a Fisher *F*-value of 264.18, which indicated an excellent match of the experimental data. When it came to figuring out how important the various variables were in determining the best process conditions, response surface plots came in handy. Assuming ideal operating circumstances, the maximum removal of Cr(VI) was determined to be 98.3% when the test variables stayed unchanged at a maximum desirable value of 0.978: 20 mg/L initial Cr(VI) concentration plus 0.1 g Fe–SCC dosage, pH 8, and 13 min of contact time. The same architecture was used to construct an ANN model that predicted Cr(VI) adsorption with acceptable accuracy (R^2 = 0.962). The R^2 coefficient of determination and the order of relevance of the operational parameters were used to compare the two models. The experimental datasets were well–suited to both models, as seen by the overall findings.

Keywords: Chromium, Adsorption, Removal, RSM, ANN.
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INTRODUCTION

The significant toxicity and harmful influence on human health that heavy metals have on the environment make it a critical concern. The mutagenic and carcinogenic consequences of chromium (Cr) in its hexavalent form have drawn attention to this heavy metal.[1–4] Metal finishing, iron and steel industries, and the manufacture of inorganic compounds all lead to the emission of Cr(VI) into the environment. Compared to the WHO acceptable limit of 0.05 mg/L in wastewater systems, industrial effluents have substantially higher concentrations. Large amounts of Cr(VI) effluent from these businesses end up in the soils and waterways, where they build up in the food chain and pose serious health risks to humans.[5–8] Chromium–containing industrial effluents must be treated to decrease Cr(VI) to permissible limits before they are discharged into the environment to comply with these regulatory requirements.[1,9]

Adsorption technology is the most used removal method since it is both simple and affordable.[10,11] Commercially available activated carbon is the most widely used adsorbent for the removal of Cr (VI) because of its vast surface area, micro/mesoporous structure, and significant adsorption capabilities.[12,13] Activated carbon is expensive and difficult to get, so researchers are focusing on generating less expensive but similarly efficient adsorbents produced from agricultural and industrial waste sources.[14–16] Char carbon from various agricultural and industrial waste sources is anticipated to be a useful substitute for activated carbon because of its physical activity.[16–19] Carbonized sugarcane bagasse, known as sugarcane carbon (SCC), is an alternate adsorbent for this application. In addition, iron implanted into char carbon increases the adsorption capacity of Cr(VI) by providing more reactive sites.[20] There are a number of potential applications for Fe–SCC, such as the removal of Cr(VI) from water, that might be explored. The current research focuses on batch studies to determine if Fe–SCC can eliminate Cr(VI) from polluted water and see if it is effective. RSM and ANN were used in conjunction to improve the

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