Chitosan-Al_2O_3 green hydrogel composites: a sustainable approach for Cr(VI) removal from simulated solution

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Abstract

Extensive industrial activities discharge huge amounts of different pollutants into water bodies. Among these pollutants, heavy metals stand as the most poisonous species due to their resistance to biodegradation and their short- and long-term exposure effects. More specific, Cr(VI) is one of the top-five toxic elements that pose potent toxicity to the entire environmental system. In this study, six modified chitosan hydrogel composites (Categorized in two groups and comprised of chitosan or carboxymethyl chitosan crosslinked with acrylamide and incorporating aluminum oxide as an inorganic core) were prepared under the influence of gamma irradiation at an optimized dose (30 kGy) as a facile, environmentally friendly technique. These hydrogels were employed for the removal of Cr(VI) from aqueous solution considering various variables that influencing removal performance, taking structural variation into consideration. The removal process was followed by the AFM to compare between the chromium free and chromium-loaded surfaces. According to the experimental findings, the following circumstances were ideal for maximizing dye uptake by the optimized samples: pH 2, 120-min contact duration, 0.1 g of sorbent, and a metal concentration of 50 ppm. The maximum metal uptake was achieved by the prepared green sorbents was found competitive (ranging from 48.9 to 51.5 mg/g). Moreover, all the investigated sorbents showed strong removal efficiency and adsorption

capability after four cycles of sorption/desorption. However, it was found that the adsorption capacities of the second group's elements was higher than that of the first group. Additionally, the data demonstrated that the adsorption process conformed the pseudo-first order kinetic isotherm and best fit the Freundlich model imposing multilayer adsorption of Cr(VI) onto the sorbent matrix via several mechanisms which is consistent with variable functionalities in the hydrogel matrix. Highlights • Six crosslinked chitosan composites were produced using gamma irradiation at a dosage of 30 kGy. • To remove Cr(VI) from aquatic settings, green sorbents were used. • It was confirmed that the structural variation and metal removal performance were correlated. • The AFM was used to track the removal procedure. Keywords Chitosan, Carboxymethyl chitosan, Cr(VI), Kinetic models, Kinetic isotherms, AFM