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Carboxymethyl chitosan with cross-linker urea glutaric acid as adsorbent in water treatment containing Cr(VI)

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Abstract

Adsorption of Cr(VI) was performed using chitosan derivative, carboxymethyl chitosan-urea-glutaric acid (CMC-UGLU) with adsorption-fluidization method. CMC-UGLU synthesized from chitosan was reacted with chloroacetic acid, the productt obtained, carboxymethyl chitosan (CMC), was then characterized by FTIR spectroscopy. Adsorption of Cr(VI) was carried out with the variation of time, temperature and pH onto the fluidization bed with 200 mL solution of Cr(VI) with levels of 100 mg/L and 0.5 g CMC-UGLU by air blowing air from the bottom of the column. The results reveal that the adsorption capacity of CMC-UGLU was 93.36% at the operating conditions which compares to the adsorption capacity of 92.89% of the adsorbent silica gel-CMC-UGLU at the same conditions.

Keyword: Adsorption-fluidization, Carboxymethylchitosan-urea glutaric acid, Cr(VI), Water treatment

Introduction

Human health, among other factorss, depends on the availability of clean water, especially water for drinking, cooking, washing, sanitation, industrial processes, agriculture and fisheries. Heavy metals in water at contents that exceed the threshold can be harmful to human health, such as toxic chromium (Cr) causes dermatitis, bronchial cancer, gastroenteritis and hepatocelullar deficiency; chromate and dichromate ions are exposed for a long time to get into the liver, kidney and nerve tissues.[1,3-4] Reverse osmosis, chemical reactions such as precipitation, reduction and adsorption with activated carbon are used to treat water containing Cr. The weaknesses of this method are high cost, inefficiency in the discharge, and are not effective for concentration less than 100 mg/l.[1,2,4-7] Heavy metal ions such as Cr can be absorbed by chitosan.[8-15,20] In a neutral solution reactivity of the hydroxyl and amine groups on chitosan causes absorption of metal ions. Absorption can be enhanced by chemical modification with aim to increase the adsorption sites by means of grafting of new function groups[16], whereas cross-linking is used to improve stability in the acidic solution.[17-19] Efficacy and selectivity of chitosan to metal ions in solution can be improved by modifying the polymer surface, thus forming a new group that can form a chelate complex with the metal ions.[8,17,21-34] Hydroxyl, carboxyl and amine groups at carboxymethyl cellulose (CMC) causes the formation of chelate, so the adsorption power toward metal ions is increased.[4,8,22,32-35] To improve the chitosan properties including stability in the acidic solution chitosan and for the prolonged use it has to be cross-linked by using a cross-linking agent such as glutaraldehyde, ephichlorohydrin and ethyleneglycoldiglycidyl ether.[17,28-31,36-38]

To extend the life cycle of chitosan, in the present work efforts have been made by synthesizing a chitosan derivative, that is, carboxymethyl chitosan-urea-glutaric acid (CMC-UGLU) for use to remove Cr(VI) from aqueous solution by the fluidization process. Fluidization is a process or operation, where fine particles are converted to behave like a fluid in a way contacting the fine particles with a liquid or gas.[39,40] Fluidization is done by using solid particles, while liquid or gas flows from the bottom of the fluidized bed. In the solid-liquid-gas fluidization system, with a certain rate of gas, so each individual particle apart from the others, and experience the circulation from the bottom bed toward the top, then back to the bottom bed, so that the contact between each individual solid particle and solution is perfect, thus increasing the adsorption power to the metal ions. Synthesis of CMC was conducted using an earlier reported method[8,41], whereas CMC-UGLU was synthesized by modified method of Zhu *et al*[28] and Wang *et al*.[42]

Experimental

Material and methods

Chitosan used in this experiment is a commercial chitosan with deacetylation degree 79.56%, with a relative mass 5.52599×10^5 g /mole, while the reagent

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