Desalination and Water Treatment
www.deswater.com

doi: 10.5004/dwt.2020.25126

181 (2020) 289–299
March

Dynamic sorption of hexavalent chromium using sustainable low-cost eggshell membrane

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Received 29 May 2019; Accepted 4 November 2019

ABSTRACT

The valorization of agricultural and industrial wastes for water remediation is a great environmental and economic gain. The purpose of this work was the preparation and application of the eggshell membrane (ESM) for the recovery of hexavalent chromium from water in the dynamic adsorption system. To understand the adsorptive behavior of ESM and its surface characteristics, the powder was fully characterized using several techniques such as scanning electron microscopy, Brunauer–Emmett–Teller, Fourier transform infrared spectroscopy, X-ray diffraction, Zeta potential, thermogravimetric analysis, and differential scanning calorimetry. It was found that the ESM is rich with amides, amines, and carboxylic groups and exhibits a porous and interlaced fibrous morphology which is suitable for the fixation of metal ions. The specific surface area was 13.38 $m^2\ g^{-1}$ while the pH_{pzc} of ESM is 7.51. Several operating parameters were investigated such as the bed height, Cr(VI) concentration, pH, ionic strength and temperature. Overall, the best adsorption capacity was found to be 41.49 mg g^{-1} under the following conditions: flow rate of 2 mL min^{-1}, Cr(VI) concentration of 5 mg L^{-1}, bed height of 20 mm, pH 3 and a temperature of 298 K. The regeneration of ESM was studied, wherein, the results showed that the ESM can be reused much time for Cr(VI) removal. The adsorption rate decreased from 57.70% to 44.24% after the tenth adsorption for the removal of Cr(VI) at 10 ppm. Five models were applied including Thomas, Yoon–Nelson, Bohart–Adams, Wolborska, and BDST to model the experimental dynamic adsorption of Cr(VI) on ESM.

Keywords: Egg-shell membrane; Hexavalent chromium; Dynamic adsorption; Regression; Modeling

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