Desalination and Water Treatment
www.deswater.com

doi:10.5004/dwt.2018.21742

103 (2018) 221–231
January

Hybrid nano-adsorbent supported carbon dots for removal of chromium from aqueous solution

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Received 26 July 2017; Accepted 24 November 2017

ABSTRACT

In this study, hybrid nano adsorbent supported carbon dots was prepared and used for removing Cr(VI) from aqueous solution. Carbon dots were synthesized from sugarcane molasses under microwave irradiation. Hybrid nano adsorbent was prepared by impregnating carbon dot with H_3PO_4 in a ratio of 2:1 and introducing 0.01 M $FeCl_3$ into the slurry. The carbon dot hybrid was activated via a conventional thermal method under N_2 flow. The physico-chemical properties of the synthesized material were investigated using X–ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), N_2 adsorption/desorption, and field emission scanning electron microscopy (FESEM). Chromium adsorption was studied in a synthesized aqueous solution using hybrid Fe–carbon dots as the adsorbent under various adsorption conditions like solution pH, adsorbent dosage, various initial chromium concentrations, and contact time. Adsorption isotherms were conducted and it was indicated that the adsorption equilibrium data was well fitted for both the Langmuir ($R^2 > 0.99$) and Freundlich ($R^2 > 0.97$) models. The maximum adsorption capacity of Cr(VI) onto Fe–CDs was obtained at 81.97 mg g^{-1}. Adsorption kinetics for Cr(VI) was followed. The pseudo-second-order model indicated very well that the rate-controlling step in the adsorption is mainly chemisorption. The saturated hybrid nano adsorbent could be easily regenerated using dilute 1 N NaOH and 1 N HCl aqueous solutions and high desorption efficiency (up to 74%) of Cr(VI) was achieved for various initial chromium concentrations after 5 adsorption-desorption cycles. The obtained results proved that the hybrid Fe–CDs is a low–cost and effective adsorbent for Cr(VI) ions removal.

Keywords: Carbon dots; Hybrid Fe–carbon dots; Nano adsorbent; Hexavalent chromium; Aqueous solution

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