Desalination and Water Treatment
www.deswater.com
20 (2010) 123–132
August
1944-3994 / 1944-3986 © 2010 Desalination Publications. All rights reserved.
doi: 10.5004/dwt.2010.1228

Utilization of shells of hazelnut modified with Reactive Orange 122 as adsorbent for the removal of Cu(II)

Haluk Aydın[a]*, Çiğdem Yerlikaya[b]

[a]*University of Dicle, Faculty of Arts and of Sciences, Department of Chemistry 21280 Diyarbakır, Turkey*
Tel. +90 4122488412; Fax +90 4122488300; email: halukaydin@dicle.edu.tr
[b]*University of Dicle, Graduate School of Sciences 21280 Diyarbakır, Turkey*

Received 9 June 2009; Acepted in revised form 4 January 2010

ABSTRACT

The influence of reactive dye modification on the efficiency of adsorption capacities of hazelnut shells was investigated. To that end, natural adsorbents such as shells of unmodified hazelnut (RH), and modified hazelnut (MH) were used. The removal of Cu(II) by these adsorbents from aqueous solution was investigated by using several parameters such as modification, contact time, temperature and pH. The adsorption process attained equilibrium within 60 min. The extent of Cu(II) removal increased with increasing the contact time, temperature and pH and also with modification by Reactive Orange 122 as the adsorbent. Optimum pH value for Cu(II) adsorption was determined between 4–5. The experimental data were analysed by the Langmuir and Freundlich models of adsorption. It was found that the Langmuir equation fited better than the Freundlich equation. The maximum adsorption capacities for Cu(II) onto RH and MH at 298, 308 and 318 K were found to be 3.95, 4.65, and 4.74, 7.00, 8.12 and 8.61 mg/g, respectively. In addition, the adsorption data obtained at different temperatures of Cu(II) by adsorbents were applied to the pseudo first-order, pseudo second-order and Weber–Morris equations, and the rate constants of the first-order adsorption (k_1), the rate constants of the second-order adsorption (k_2) and intraparticle diffusion rate constants (k_3) at these temperatures were calculated, respectively. The rates of adsorption were found to conform the pseudo second-order kinetics with good correlation ($R^2 \geq 0.991$). The data obtained from the adsorption isotherms at different temperatures were used to calculate some thermodynamic quantities such as free energy of adsorption (ΔG^o), enthalpy (ΔH^o) and entropy (ΔS^o). It is expected that ΔG^o is negative, indicating that the nature of the adsorption process for Cu(II) is spontaneous. The positive value of ΔH^o indicates that the adsorption of Cu(II) onto adsorbents is an endothermic process. The positive value of ΔSo reflects the affinity of the adsorbent for Cu(II). As a result, the hazelnut shells (both modified and unmodified), inexpensive and easily available material, can be an alternative for more costly adsorbents used for Cu((II) removal from wastewater.

Keywords: Adsorption; Adsorbents; Hazelnut shell; Kinetics; Thermodynamics; Modification; Isotherm

* Corresponding author.