Desalination and Water Treatment
www.deswater.com

doi: 10.1080/19443994.2014.922498

55 (2015) 978–985
July

Taylor & Francis
Taylor & Francis Group

Ammonium removal from water by natural and modified zeolite: kinetic, equilibrium, and thermodynamic studies

Zhihua Cheng, Wenming Ding*

School of Chemical Engineering of Beijing University of Chemical Technology, Beijing, China, Tel. 0086+10 58462939; email: dingwm@mail.buct.edu.cn (W. Ding), Tel: 0086+18810701483; email: chengzhihua1988@126.com (Z. Cheng)

Received 28 October 2013; Accepted 30 April 2014

ABSTRACT

Zeolite is commonly used to remove ammonium from water. To improve its adsorption performance, natural zeolite (N-Z) was modified by NaCl immersion and calcination. Batch experiments were used to investigate the adsorption performance of N-Z, immersion zeolite (M-Z-1), and immersion-calcination zeolite (M-Z-2). Kinetic studies showed that the adsorption rate followed the sequence M-Z-2 > M-Z-1 >> N-Z. The pseudo-second-order model fitted the N-Z, M-Z-1, and M-Z-2 data well. The k_s values of the two types of modified zeolite were considerably larger than that of N-Z; the k_s of M-Z-2 was slightly larger than that of M-Z-1. These results indicate that the adsorption rate of M-Z-2 is only slightly faster than that of M-Z-1, which agrees with the experimental results. Equilibrium studies showed that the adsorption capacities of M-Z-1 and M-Z-2 were 1.4–1.5 times higher than that of N-Z. Adsorption isotherms fitted the Freundlich model well. The k_F and $1/n$ values of the modified zeolites were similar, which indicates that M-Z-2 does not exhibit significant improvements compared with M-Z-1. Thermodynamic studies showed that the ΔG°, ΔH°, and ΔS° of all zeolite samples were negative, which indicates that adsorption was spontaneous, exothermic, and orderly. The ΔG° values of both types of modified zeolites were similar and more negative than that of N-Z. This similarity suggests that NaCl modification effectively improves the adsorption potential of zeolite.

Keywords: Ammonium removal; Zeolite; Modification; Adsorption

*Corresponding author.