Colloids and Surfaces A: Physicochem. Eng. Aspects 417 (2013) 26–31

Contents lists available at SciVerse ScienceDirect

Colloids and Surfaces A: Physicochemical and Engineering Aspects

journal homepage: www.elsevier.com/locate/colsurfa

Adsorptive characteristics of perchlorate from aqueous solutions by MIEX resin

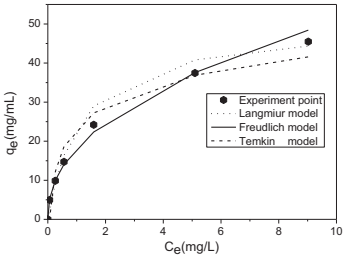
Yulin Tang*, Song Liang, Haicheng Guo, Haorong You, Naiyun Gao, Shuili Yu*

State Key Laboratory of Pollution Control and Resource Reuse, College of Environmental Science & Engineering, Tongji University, Shanghai 200092, PR China

HIGHLIGHTS

- Perchlorate concentration, agitation speed, pH and coexisting anions affected significantly perchlorate removal.
- The equilibrium data could be well fitted by the Freundlich isotherm model.
- The adsorption kinetics agreed with the pseudo second-order model.
- The adsorption was an exothermic and thermodynamically spontaneous process.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 4 July 2012
Received in revised form 18 October 2012
Accepted 24 October 2012
Available online 30 October 2012

Keywords:
Perchlorate
MIEX resin
Adsorption
Kinetics
Thermodynamics

ABSTRACT

The adsorption characteristics of perchlorate on MIEX resin were investigated using batch experiments. Effects of contact time, agitation speed, pH, coexisting anions and organic matter were determined. The kinetics data indicated that the perchlorate adsorption process reached equilibrium within 30 min. In an experimental pH of 4.0 to 9.0, perchlorate removal was above 98%. Major anions reduced perchlorate adsorption in the order of $SO_4^{2-} > PO_4^{3-} > CO_3^{2-} > NO_3^-$. However, humic acid had not obvious effect on perchlorate removal. Langmuir, Freundlich, and Temkin isotherms were used to fit the perchlorate adsorption equilibrium at 298 K. The results were shown that the adsorption equilibrium could be well fitted by Freundlich isotherm. The pseudo first-order and second-order kinetics models were used to fit the kinetics process of perchlorate adsorption on MIEX resin. The results demonstrated the adsorption kinetics agreed with the pseudo second-order model, indicating that the adsorption of perchlorate on MIEX was chemical sorption. The negative ΔG^0 values indicated that the adsorption of perchlorate on MIEX resin was thermodynamically feasible and was a spontaneous process. The values of ΔH^0 and ΔS^0 showed that the adsorption was an exothermic process in nature and the randomness degree at the solid/liquid interface increases after adsorption.

1. Introduction

Perchlorate is both a naturally occurring and man-made anion, which is tetrahedrally coordinated with four oxygen atoms bonded to a central chlorine atom (ClO_4^-). It has commercially been made in the form of perchloric acid and salts such as ammonium, potassium or sodium perchlorate. Perchlorate is used in the production of matches, fireworks and explosives as well as rocket propellants and missile motors because of its high oxidizing power [1,2]. The perchlorate anion is produced when the salts or acid of perchlorate are dissolved in water. Some of this perchlorate has leached into groundwater sources, particularly in Chinese regions [3].

Perchlorate is very stable and difficult to be degraded in environment conditions. ClO_4^- has been shown to inhibit perchlorate uptake by the thyroid gland [4]. The presence of perchlorate in drinking water can cause thyroid ailments as well as other medical problems [5]. Therefore, perchlorate removal from drinking water sources is critically important to the public health. Several perchlorate treatment technologies have been developed including activated carbon adsorption [6,7], biological/chemical reduction

* Corresponding authors. Tel.: +86 21 65982708; fax: +86 21 65982708.
E-mail address: tangyulin@tongji.edu.cn (Y. Tang).

0927-7757/$ – see front matter © 2012 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.colsurfa.2012.10.040