Chemical Engineering Journal 219 (2013) 411–418

Contents lists available at SciVerse ScienceDirect

Chemical Engineering Journal

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

Naphthalimide-functionalized $Fe_3O_4@SiO_2$ core/shell nanoparticles for selective and sensitive adsorption and detection of Hg^{2+}

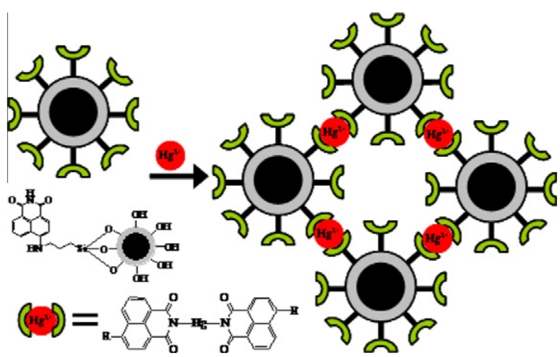
Baocun Zhu [a,*], Jie Zhao [a], Haiqin Yu [b], Liangguo Yan [a], Qin Wei [b], Bin Du [a,*]

[a] School of Resources and Environment, University of Jinan, Jinan 250022, China
[b] Key Laboratory of Chemical Sensing & Analysis in Universities of Shandong, School of Chemistry and Chemical Engineering, University of Jinan, Jinan 250022, China

HIGHLIGHTS

- Naphthalimide-functionalized **MFNPs** was designed and synthesized.
- **MFNPs** exhibits the high selectivity and sensitivity toward Hg^{2+}.
- **MFNPs** possesses good reusability and high adsorption capacity.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 31 October 2012
Received in revised form 23 December 2012
Accepted 26 December 2012
Available online 11 January 2013

Keywords:
Magnetic fluorescent nanoparticles
Naphthalimide
Hg^{2+}
Removal
Detection

ABSTRACT

A novel 1,8-naphthalimide-functionalized $Fe_3O_4@SiO_2$ core/shell magnetic fluorescent nanoparticles (**MFNPs**) for simultaneous detection and adsorption of Hg^{2+} was designed and synthesized. A series of adsorption studies were carried out with various Hg^{2+} concentrations, temperature, time and pH. The maximum adsorption capacity is higher than 30 mg/g over a broad temperature (0 °C, 25 °C, and 50 °C) and pH (4–10). The results showed that **MFNPs** possesses an excellent reusability and the high adsorption specificity toward Hg^{2+}. The detection limit for Hg^{2+} is 3.4 nM. In addition, owing to the aggregation of **MFNPs** occurring in the Hg^{2+} aqueous solution, the adsorbent was separated easily by the settlement or the external magnetic field, which facilitated the removal of Hg^{2+}.

1. Introduction

Mercury (Hg) is highly toxic at low concentrations and can accumulate in the environment and biota, which would lead to a series of adverse effects, particularly in the human health [1–5]. Currently, the principal methods that have been used to remove Hg^{2+} from various industrial effluents or water resources include chemical precipitation, sedimentation, ion exchange, membrane filtration and adsorption [6–9]. Although these methods have been proved to be practically feasible in some degree, they also expose several non-ignorable restrictions such as high operational cost and/or low removal efficiency, mainly at trace level concentrations. Therefore, it should be desirable to develop new and more accurate, efficient, precise and selective techniques for Hg^{2+} extraction from natural water samples.

It is worth noting that solid-phase extraction (SPE) technique exhibits numerous advantages such as flexibility, high preconcentration factors, high capture capacity, speed and simplicity, possibilities for field sampling, ease of automation [10,11]. The SPE is realized by immobilizing trapping agents to the surface of kinds of solid supports, which mainly include polyvinylchloride [12,13],

* Corresponding authors. Tel.: +86 531 82765730; fax: +86 531 82765969.
E-mail addresses: lcyzbc@163.com (B. Zhu), dubin61@gmail.com (B. Du).

1385-8947/$ - see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.cej.2012.12.068