Colloids and Surfaces A: Physicochem. Eng. Aspects 419 (2013) 69–79

Contents lists available at SciVerse ScienceDirect

Colloids and Surfaces A: Physicochemical and Engineering Aspects

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

Coating carbon nanotubes with crystalline manganese dioxide nanoparticles and their application for lead ions removal from model and real water

Mohamed Abdel Salam*

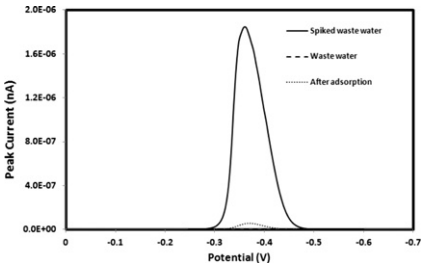
Chemistry Department, Faculty of Science, King Abdulaziz University, P.O Box 80200-Jeddah 21589, Saudi Arabia

HIGHLIGHTS

- The MWCNTs/MnO_2 nanocomposite were synthesized and characterized.
- The results showed that MWCNTs were coated with 10.2% of the crystalline α-MnO_2.
- The MWCNTs/MnO_2 used for the removal of lead ions from model and real water sample.
- The adsorption was studied kinetically and thermodynamically.
- The adsorption was spontaneous, endothermic, and chemical in nature.

GRAPHICAL ABSTRACT

This graph shows the differential pulse anodic stripping voltammetry measurements for the removal of lead ions from spiked waste water sample by MWCNTs/MnO_2 nanocomposite.



ARTICLE INFO

Article history:
Received 16 September 2012
Received in revised form 8 November 2012
Accepted 25 November 2012
Available online 4 December 2012

Keywords:
Carbon nanotubes
MnO_2
Lead ions
Kinetic
Thermodynamic
Real water

ABSTRACT

Multi-walled carbon nanotubes/manganese oxide (MWCNTs/MnO_2) nanocomposite was synthesized, characterized, and used successfully for the removal of lead ions from an aqueous solution and waste water sample. The characterization techniques showed that MWCNTs were coated with 10.2% of the crystalline α-MnO_2 (w/w percent). The adsorption process was optimized, and the results showed that most of the lead could be removed from a solution with 10 mg MWCNTs/MnO_2 nanocomposite, at a pH between 7.0 and 9.0, and within a few min. The adsorption was studied kinetically, and the results revealed that the adsorption of lead ions by a MWCNTs/MnO_2 nanocomposite from an aqueous solution could be described well by a pseudo-second-order model and the Elovich model. The mechanism of adsorption showed that the adsorption process was complex and involves a different step, but it was mainly controlled by a liquid film diffusion mechanism. The thermodynamic parameters were calculated, and the adsorption was found to be chemical, spontaneous, and endothermic in nature with positive entropy. The MWCNTs/MnO_2 nanocomposite was used for the removal of lead ions from a spiked waste water sample, and the results showed that all the lead ions were removed.

1. Introduction

Environmental pollution as a result of rapid technological development is a serious concern for ecology. Heavy metals are major pollutants of some ground and surface waters and are often present in industrial or urban waste waters. These metals are harmful to humans, animals, and other living creatures. Lead, for example, is the second most hazardous substance according to the Agency of Toxic Substances & Disease Registry (ATSDR, 2007) [1]. Lead in the environment arises from both natural and anthropogenic sources. Exposure can occur through drinking water, food, air, soil, and dust from old paint containing lead. It is a very toxic element and human exposure can result in a wide range of biological effects, depending on the level and duration of exposure. High levels of exposure to lead may result in toxicity in humans, which causes problems in the synthesis of hemoglobin; has an effect on the kidneys,

* Tel.: +966 541886660; fax: +966 2 6952292.
E-mail address: masalam16@hotmail.com

0927-7757/$ – see front matter © 2012 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.colsurfa.2012.11.064