Chemical Engineering Journal 210 (2012) 280–288

Contents lists available at SciVerse ScienceDirect

Chemical Engineering Journal

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

Column study of Cr (VI) adsorption onto modified silica–polyacrylamide microspheres composite

Mehdi Karimi [a], Akbar Shojaei [a,*], Ali Nematollahzadeh [b], Mohammad J. Abdekhodaie [a]

[a] Department of Chemical and Petroleum Engineering, Sharif University of Technology, P.O. Box 11155-9465, Tehran, Iran
[b] Department of Chemical Engineering, University of Mohaghegh Ardabili, Ardabil, Iran

HIGHLIGHTS

- We have introduced a procedure for synthesis of silica–polyacrylamide composite.
- The capability of produced composite was investigated in removal of Cr (VI).
- The results showed a good capability for removal of Cr (VI) using the composite.
- Regeneration of composite after adsorption was done with 0.02 M NaOH successfully.

ARTICLE INFO

Article history:
Received 29 May 2012
Received in revised form 12 August 2012
Accepted 13 August 2012
Available online 23 August 2012

Keywords:
Silica
Polyacrylamide
Chromium
Adsorption
Column study

ABSTRACT

Adsorption of Cr (VI) from aqueous solution was studied using a continuous fixed bed column which is packed with a new micro-porous composite particle developed in this study. This composite particle is composed of silica porous particle in which acrylamide is polymerized within the pore regions of the silica particles. The composite particle was supposed to maintain the mechanical properties of polyacrylamide as efficient absorbent to serve appropriately in the continuous processes. In order to enhance the adsorption capacity of the composite particle, it was modified with ethylenediamine. Scanning electron microscopy (SEM), Fourier transforms infrared spectroscopy (FT-IR) and thermogravimetry analysis (TGA) was applied to characterize the adsorbent. It was shown that polyacrylamide itself within the pore region of silica particle is also porous possibly because of the evaporation of solvent during the drying process. The effect of various parameters such as feed concentration (50–200 mg/L), feed flow rate (3–10 mL/min) and sorbent amount (250–750 mg) on the breakthrough characteristics of the adsorption system was investigated appropriately. Two well-known column adsorption models, Thomas and Adams–Bohart models were applied to fitting the experimental data. The results showed that the Thomas model was suitable for the description of breakthrough curve at all experimental conditions, while Adams–Bohart model was suitable for an initial part of dynamic behavior of column.

1. Introduction

Releasing of pollutant materials such as heavy metal ions from industrial effluents threats the environment and public health. Among heavy metals, chromium is a toxic pollutant that is being introduced into natural water and human environment by a variety of industrial waste waters including paint and pigment manufacturing companies, corrosion control, stainless steel production, fertilizers, leather tanning, chrome plating, wood preservation, and textiles [1]. When chromium concentration in body reaches 0.1 mg/g body weight, it can cause damage and create various problem such as liver damage and pulmonary congestion [2,3]. Chromium predominantly exists in two oxidation states, hexavalent (Cr (VI)) and trivalent (Cr (III)). Cr (VI) has a high mobility in soil and aquatic system and is more toxic than the trivalent one [4]. In the recent decades, researchers have concentrated on developing various methods that can effectively remove heavy metal ions from water and environments. General methods for removing heavy metal ions include filtration, chemical precipitation, chemical oxidation and reduction, ion exchange, and electrochemical treatment [5]. In comparison with other conventional methods for removing heavy metals from the waste water, adsorption has various advantages like economic viability, availability, profitability, ease of operation, high efficiency and friendly to environment [6]. Adsorption process can perform in batch and continuous mode. Batch mode experiments are usually done to measure the capability and effectiveness of adsorption process using specific adsorbent

* Corresponding author. Tel./fax: +98 21 66166432.
E-mail address: akbar.shojaei@sharif.edu (A. Shojaei).

1385-8947/$ - see front matter
http://dx.doi.org/10.1016/j.cej.2012.08.046