Bioresource Technology 128 (2013) 423–430

Contents lists available at SciVerse ScienceDirect

Bioresource Technology

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

Batch and continuous flow studies of adsorptive removal of Cr(VI) by adapted bacterial consortia immobilized in alginate beads

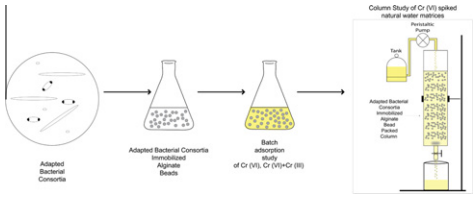
Jastin Samuel, Mrudula Pulimi, Madona L. Paul, Arun Maurya, Natarajan Chandrasekaran, Amitava Mukherjee *

Centre for Nanobiotechnology, VIT University, Vellore, Tamil Nadu, India

HIGHLIGHTS

- Biosorption of Cr(VI) using adapted bacterial consortia immobilized in alginate beads.
- Langmuir isotherm and pseudo second order rate kinetics describe batch sorption.
- Very high adsorption capacity [657 mg/g] in column reactor.
- Mechanism analyzed by Fourier-transform infrared, Energy dispersive X-ray spectroscopy.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 27 April 2012
Received in revised form 24 September 2012
Accepted 8 October 2012
Available online 2 November 2012

Keywords:
Alginate beads
Bacteria immobilization
Sorption capacity
Cr(VI) removal
Packed bed reactor

ABSTRACT

The adsorptive removal of Cr(VI) by alginate beads containing Cr(VI)-adapted *Acinetobacter junii*, *Escherichia coli* and *Bacillus subtilis* in batch and continuous packed bed column reactors was investigated. Under optimized conditions (pH 3.0; contact time, 180 min; 30 °C; initial Cr(VI) concentration of 100 mg/L), 65.86 mg/g adsorption capacity was recorded in the batch study. When an adsorbent dosage of 1 g/L, a flow rate of 5 mL/min, a bed height of 20 cm, an initial Cr(VI) concentration of 300 mg/L was employed, a capacity of 657 mg/g was noted for the continuous column assay. The batch sorption data followed the Langmuir isotherm and pseudo second order kinetics. Five sorption/desorption cycles yielded 100%, 99.63%, 95.31%, 80.7% and 74.22% regeneration, respectively. Cr(VI) adsorption studies using spiked ground water, freshwater and domestic wastewater in a packed bed reactor demonstrated Cr(VI) removals of 64.8%, 55.08%, 56.86% respectively. Cr(VI) sorption on immobilized bacteria was confirmed with Fourier-transform infrared and Energy dispersive X-ray spectroscopy.

1. Introduction

Biomass from algae, fungi, cyanobacteria and bacteria have the capability to remediate metal ions through biosorption (Paul et al., 2012), and studies on microorganisms obtained from contaminated wastewater indicate their capability to remove chromium at a high rate (Molokwane et al., 2008; Sundar et al., 2011). Chromite mine sites in the Sukinda Valley, Orissa, India contain a microbial community capable of detoxifying Cr(VI) and tolerating high chromium levels (Samuel et al., 2012). The Cr(VI) remediation potential by indigenous strains obtained from the Sukinda Valley, like *Acinetobacter* sp., has also been reported (Paul et al., 2012). Consortia of Cr(VI)-adaptated indigenous isolates like *Acinetobacter junii*, *Escherichia coli* and *Bacillus subtilis* obtained from Sukinda mine water were reported to possess an improved Cr(VI) removal rate over unadapted indigenous isolates (Samuel et al., 2012); however, separation and harvesting of metal after removal and reusability of the biosorbents are major concerns in commercializing the biosorbent system. Immobilization of microorganisms in a suitable matrix like polyvinyl alcohol, agar media and sol–gel materials has been proven to be an efficient solution to this problem (Alvarez et al., 2011; Konovalovaa et al., 2003; Raff et al., 2003; Saraj et al., 1999; Xu et al., 2011). Cr(VI) removal by *Bacillus* sp. ES 29 and *Pseudomonas aeruginosa*, immobilized in sodium alginate

* Corresponding author. Address: Centre for Nanobiotechnology, VIT University, Vellore 632014, India. Tel.: +91 416 220 2620.
E-mail address: amitav@vit.ac.in (A. Mukherjee).

0960-8524/$ - see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.biortech.2012.10.116