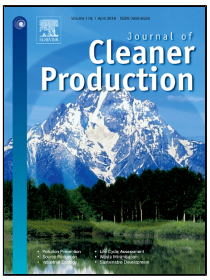
Accepted Manuscript



Heavy metal removal from aqueous solutions by calcium silicate powder from waste coal fly-ash

Jing Ma, Guotong Qin, Yupei Zhang, Junmin Sun, Shuli Wang, Lei Jiang

PII:	S0959-6526(18)30427-X
DOI:	10.1016/j.jclepro.2018.02.115
Reference:	JCLP 12062
To appear in:	*Journal of Cleaner Production*
Received Date:	29 April 2017
Revised Date:	03 December 2017
Accepted Date:	11 February 2018

Please cite this article as: Jing Ma, Guotong Qin, Yupei Zhang, Junmin Sun, Shuli Wang, Lei Jiang, Heavy metal removal from aqueous solutions by calcium silicate powder from waste coal fly-ash, *Journal of Cleaner Production* (2018), doi: 10.1016/j.jclepro.2018.02.115

Heavy metal removal from aqueous solutions by calcium silicate powder from waste coal fly-ash

Jing Ma[a], Guotong Qin[a, *], Yupei Zhang[a], Junmin Sun[b, *], Shuli Wang[a], Lei Jiang[c]
[a] School of Space and Environment, Beihang University, 37 Xueyuan Road, Beijing 100191, China; [b] National Energy Key Laboratory on Development and Utilization of High Alumina Coal Resources, Hohhot 010050, China; [c]School of Chemistry, Key Laboratory of Bio-Inspired Smart Interfacial Science and Technology of Ministry of Education, Beihang University, 37 Xueyuan Road, Beijing, 100191)

Abstract: The removal of Ni (II), Cu (II), Zn (II), and Co (II) ions from simulated aqueous solutions using calcium silicate powder (CSP), a new by-product derived from the production of alumina from coal ash, has been studied.CSP showed high efficiency for the removal of these metal ions. The maximum adsorptions were 420.17, 680.93, 251.89, and 235.29 mg/g for Ni (II), Cu (II), Zn (II), and Co (II), respectively. Total (100%) removal of Ni (II) was obtained when the initial concentration was 100 mg/L, indicating that CSP was highly effective even at an extremely low concentration. Adsorption isotherms and kinetics have been studied using different models. It has been found that the adsorption isotherms can best be described on the basis of the Langmuir model, with the kinetics of adsorption following a pseudo-second-order reaction process. The calcium ion concentration was examined before and after adsorption to investigate the mechanism of removal of the heavy metal ions. It was found that the removal of heavy metal ions is mainly achieved through ion-exchange, combined with some adsorption.

Keywords: calcium silicate powder; adsorption; heavy metal; mechanism

1. Introduction

Heavy metal pollution has become an increasingly serious environmental problem in recent decades, causing numerous diseases and disorders. An action plan for tackling soil pollution in China was released on 28th May 2017. The Action Plan for Soil Pollution Prevention and Control aims to improve soil quality, ensure safe agricultural products and a healthy living environment for people, according to the State Council, China's cabinet. To control soil pollution by heavy metals, China has vowed to cut the discharge of major heavy metal pollutants in key industries by 10% by 2020. Finding a highly efficient remediation technology remains a bottleneck. Various processes exist for removing dissolved heavy metals from aqueous solutions, including ion-exchange, precipitation, phytoextraction, ultrafiltration, reverse osmosis, electro coagulation, electro dialysis, and adsorption. Adsorption, particularly using low-cost absorbents, has attracted a great deal of attention from the research community and industry due to its high efficiency and simplicity of operation.

Numerous studies have been reported regarding the adsorption of heavy metals by both natural and artificial adsorbents. Natural zeolites, which are abundant, low-cost adsorbents, show high adsorption capacity for heavy metal ions in water (Erdem et al., 2004). The kinetics (Kocaoba et al., 2007; Motsi et al., 2011; Panayotova and Velikov, 2002), equilibrium (Kocaoba et al., 2007), and influence of temperature and pH (Jimenez et al., 2004) have been investigated in relation to these materials. Activated carbon adsorbents

*To whom correspondence should be addressed. Tel. & fax: +86 10 61716768; Email: qingt@buaa.edu.cn (G. Qin); sunjmdt@163.com (J. Sun)