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Entrapment of Mg-Al layered double hydroxide in calcium alginate beads for phosphate removal from aqueous solution

Yong-Un Han[a], Won-Suk Lee[b], Chang-Gu Lee[a], Seong-Jik Park[c], Ki-Woo Kim[d], Song-Bae Kim[a]*

[a]*Department of Rural Systems Engineering and Research Institute for Agriculture and Life Sciences, Seoul National University, Seoul 151-921, Korea*
Tel.: +8228804587; Fax: +8228732087; email: songbkim@snu.ac.kr
[b]*Department of Agricultural and Biological Engineering, University of Florida, Gainesville 32611, Florida, USA*
[c]*Korea Advanced Institute of Science and Technology, Daejeon 305-701, Korea*
[d]*School of Ecological and Environmental System, Kyungpook National University, Sangju 742-711, Korea*

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ABSTRACT

Mg-Al layered double hydroxide was entrapped in calcium alginate beads (LDH-alginate beads) for phosphate removal. A field emission scanning electron microscope (FESEM), combined with an energy dispersive X-ray spectrometer and an X-ray diffractometer, were used to analyze the properties of LDH-alginate beads. Batch and flow-through column experiments were performed to examine phosphate removal in LDH-alginate beads. FESEM images show that the cross-sectional surface of LDH-alginate beads was heterogeneous in surface topography, and LDH powders were intermingled with alginate polymers. Experimental results indicate that Mg-Al LDH-alginate beads are effective in the removal of phosphate. Batch experiments indicate that phosphate removal in 8% LDH-alginate beads was not sensitive to initial solution pHs between 4.9 and 8.9. Kinetic experiments demonstrate that phosphate removal reached equilibrium around 12 h of reaction time. Column experiments show that the removal capacity of 8% LDH-alginate beads was two orders of magnitude greater than that of pure alginate beads.

Keywords: Layered double hydroxides; Calcium alginate beads; Phosphate removal; Sorption; Batch experiment; Column experiment

1. Introduction

Layered double hydroxides (LDHs) are a class of nanostructured anionic clays. They have a general formula of $[M1-x^{2+}Mx^{3+}(OH)2]^{x+}(A^{n-})x/n{\cdot}mH2O$, where M^{2+} is the divalent cation, M^{3+} is the trivalent cation, x is the molar ratio of $M^{3+}/(M^{2+}+M^{3+})$, and A is the interlayer anion of valence n. LDHs consist of positively charged brucite-like sheets which are balanced by the intercalation of anions in the hydrated interlayer regions [1–4]. Because of the high surface area, large anion exchange capacity, and good thermal stability [5–7], LDHs have been studied for their potential application to the removal of oxyanions, such as arsenate/arsenite, chromate, selenate/selenite, borate, and nitrate from contaminated waters [7–19]. The removal of oxyanions by LDHs can be ascribed to three different mechanisms,

*Corresponding author