Novel Photo-catalysis Hybrid System for Arsenic Removal

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1. Introduction

The predominant arsenic species in groundwater are arsenite (AsO\textsuperscript{3−}) and arsenate (AsO\textsuperscript{5−}). Concentrations of arsenite are particularly significant from a human health perspective, although arsenic levels are typically reported as total arsenic. The World Health Organization and the United States Environmental Protection Agency have both set arsenic limits at 10 µg/L (Agency, 2001). TiO\textsubscript{2} is an attractive water treatment material because it is inexpensive, no-toxic and widely available because of its inclusion in a variety of consumer products. Unlike other materials TiO\textsubscript{2} is an effective sorbent of both As(III) and As(V), as well as a photo-oxidant with demonstrated ability to oxidize As(III) to As(V) in the presence of UV light. Herein a novel arsenic sorbent, Alumina:Boehmite:TiO\textsubscript{2} beads, which has been synthesized and successfully tested, is reported.

2. Materials Methods

Experiments were conducted with either trivalent As(III). Aluminum oxide prepared by calcinating aluminum hydroxide wastes generated from a stone manufacturing company in Korea. Various combinations of Alumina:Boehmite:TiO\textsubscript{2} beads by varying compositions as 3:2, 3:2:1, 3:2:2 and 3:2:3 were used in batch experiment.

3. Results and Discussion

TiO\textsubscript{2} binds both arsenite and arsenate via an inner-sphere, binuclear, bidentate complex, where by the tetrahedral geometry of the arsenic oxyanion is maintained. This is analogous to arsenic binding complexes formed with other metal oxide sorbents, such as activated alumina, where arsenate in solution is exchanged for hydroxide groups on the surface of the hydroxylated metal oxide. It is well established that pH is a critical parameter in sorption of arsenic by TiO\textsubscript{2}. The experiments were carried at three different pH’s and found pH 6.5 was suitable, the results were shown in Fig. 1. By keeping the pH constant at various time intervals kinetic data for arsenic sorption by hybrid media (3:2, 3:2:1 and 3:2:2) beads in the presence of UV light is presented in Fig. 1, indicating that equilibrium is reached after 180 min for arsenite. The hybrid media 3:2:2 was found to be effective in removal of As(III) compared with the materials 3:2 and 3:2:1.

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4. Conclusions
1) Photo-oxidation experiments with titanium dioxide (TiO$_2$) as photo-catalyst showed that photo-oxidation of As(III) to As(V) is possible.
2) Also the hybrid media adsorb both As(III) and As(V) on its surface, and the hybrid media 3:2:2 was found to be effective.

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References