Project Summary

Title: **Photocatalytic Adsorption Media and Processes for Enhanced Removal of Arsenic from Groundwaters**

Project I.D.: **R/UW-WSP-001**

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Period of Contract: July 2002 – June 2003

Publications

1. E. Lee, M.A. Anderson, W.A. Zeltner, Arsenic Removal Strategies Using Novel Adsorbent Material, American Water Works Association 2003 Annual Conference, Proceeding Paper, Anaheim, Ca., 6/15 – 6/19/2003.

2. E. Lee, M.A. Anderson, W.A. Zeltner, Photoactive Removal of As (III) From Water Using Novel Active Material, American Water Works Association 2003 Annual Conference, Proceeding Paper, Anaheim, Ca., 6/15 – 6/19/2003.

Objectives:

The main objective of this study is to validate the new technologies we have developed in our laboratory for arsenic removal and to develop parameters for scaling these techniques to use in the field.

Methods:

Aluminum oxide (Al_2O_3), spinel ($MgAl_2O_4$), titanium dioxide (TiO_2) and mixed sols were synthesized by sol-gel technology and coated on glass beads. The synthesized media were tested in batch, column, and differential column batch reactors using synthetic solutions and groundwater samples from Danvers, Ill.

Results and Discussions:

Many arsenic removal processes have been found to be ineffective for arsenite, As(III), which is uncharged at the pH of drinking water. Removal of As(III) is generally accomplished by oxidizing it to arsenate, As(V), which can be removed by adsorption or ion-exchange mechanisms.

Previous researchers have found that the TiO_2/ultraviolet photocatalytic process effectively converts As(III) to As(V). However, most of these studies were performed with TiO_2 nano-particle suspensions. Removal of these particles later in the treatment process could be problematic. During the authors' testing, a heterogeneous photocatalytic adsorbent (Al_2O_3/TiO_2) was synthesized by sol-gel techniques and shown to effectively remove As(III) without requiring a separate oxidation process. This composite acts as a photocatalyst that can oxidize As(III) to As(V), with the latter species being adsorbed by the adsorbent. The materials (Al_2O_3/TiO_2) were mixed as a stable suspension (sol) that was used to coat glass beads. After the coated beads were fired, the resulting thin films served as both a photocatalyst and an adsorbent. It was found that the TiO_2 photocatalyst oxidizes As(III) at the same rate at a lower dissolved oxygen DO level (~ 1 mg/L) as at a higher DO level (7 mg/L).

Conclusions/ Implications/ Recommendations:

This study indicates that photocatalytic adsorption may prove to be an effective single-step method for removing arsenite without requiring separate oxidation and adsorption processes. Mixed coated media have been shown to remove arsenite more effectively than either pure Al_2O_3 or TiO_2. Photocatalytic oxidation of arsenite was found to be effective for both synthetic solutions and groundwater samples from Danvers, Ill. The photooxidation rate was not changed at a lower dissolved oxygen level, and the rate of arsenite oxidation in synthetic solutions and in groundwater samples was comparable. The photooxidation rate was not changed even after 6000 hours operation without regeneration. Arsenic adsorption on the surface of the photocatalyst did not interfere with the arsenite oxidation rate, therefore, this device is possible to use as a photocatalytic adsorption process. This test shows the potential for this combined oxidation-adsorption process, although further development and optimization is required.

Related Publications: None at present.

Key Words: Arsenite, Arsenate, Adsorption, Surface Charge, Photooxidation, Arsenic Remediation

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