PROJECT SUMMARY

PROJECT ID: R/UW-REM-006

INVESTIGATOR:

PRINCIPAL INVESTIGATOR: JAE K. PARK, PROFESSOR, CEE

RESEARCH ASSISTANT: MIN JANG, PhD, CEE

PERIOD OF CONTRACT: 7/01/2002~6/30/2003

BACKGROUND/NEED:

Through our batch tests, we found that this technique will be effectively applied for arsenic removal from groundwater. However, it is needed to conduct experimental works with a real groundwater contaminated arsenic species in order to design the POU/POE application of arsenic removal.

OBJECTIVES:

The objectives of this study were as follows: (1) to develop novel adsorbents through synthesizing highly ordered mesoporous silica SBA-15 and incorporating lanthanum oxide using an incipient-wetness impregnation technique; (2) to characterize the physicochemical properties of these media using several fine characterization techniques such as; XRD, N_2 gas *isotherm* analysis, and FTIR; (3) to evaluate the adsorption capacities through performing adsorption *kinetics* and *isotherms* of arsenate; and finally (4) to try to elucidate the adsorption behavior of the media in connection with the physicochemical characterization discovered by above fine tools.

METHODS:

Preparations of experimental procedure: Environmental Program Lab. (July/02~June/03)

Kinetics and isotherms: Environmental Program Lab. (Sep/02~May/03)

Analysis of physicochemical properties of media (Sep/02~June/03)

XRD: Materials Science and Engineering

N_2 gas isotherms: Water Chemistry

FTIR: Forest Product Lab.

HRTEM: Materials Science and Engineering

XPS: Materials Science and Engineering

Surface complexation modeling: Environmental Program Lab. (Jan/03~March/03)

RESULTS AND DISCUSSION:

XRD and N_2 *isotherm* results showed that an immoderate substitution of lanthanum into silica networks was occurred at 80 percent of lanthanum impregnation even though lanthanum was highly dispersed into the mesopore structures of SBA-15 without a formation of lanthanum oxide particles.

FTIR results showed that there was no structural collapse of silica frameworks at 80 percent lanthanum impregnation. This can be explained as a result of a partial substitution of lanthanum precursors with silicon, which could play an important role in structural stabilization as has been shown by other studies.

Although the arsenate adsorption densities increased with lanthanum impregnation up to 50% (the most efficient percentage of lanthanum impregnation), it abruptly decreased at 80% due to the substitution of lanthanum with silicon, leading to the overall reduction of arsenate adsorption capacity.

At the arsenate concentration of 0.667 $mmol_{As}/L$ in this study, the adsorption capacity of 50% lanthanum-impregnated SBA-15 (designated to La_{50}SBA-15) was 1.651 $mmol_{As}/g$, (123.7 mg_{As}/g) which was about 10 or 14 times higher than the other referenced values of La(III) impregnated alumina (0.172 $mmol_{As}/g$) or La(III) impregnated silica gel (0.118 $mmol_{As}/g$).

CONCLUSIONS/IMPLICATIONS/RECOMMENDATIONS:

Nano-scale impregnation of lanthanum onto SBA-15 has a lot of advantages in terms of not only adsorption velocity and capacity but also cost benefits for small scale of POU/POE application of arsenate removal since a small amount of lanthanum precursor is needed for impregnation and the regeneration of the lanthanum-impregnated mesoporous media will be applicable due to excellent structural stability of lanthanum-impregnated SBA-15.

RELATED PUBLICATION:

SCI Paper

(1) Min Jang, Eun Woo Shin, Jae K. Park, and Sang I. Choi, Mechanisms of Arsenate Adsorption by Highly-Ordered Nano-Structured Silicate Media Impregnated with Metal Oxides, Accepted in *Environmental Science and Technology* (August 28, 2003).

(2) Min Jang, Park, Jae K., Eun Woo Shin, Lanthanum Functionalized Highly Ordered Mesoporous Media for Arsenic Removal, Submitted to *Environmental Science and Technology*.

US Patent

Jae K. Park and Min Jang, "Removal of Arsenic and Other Anions Using Novel Adsorbents," Patent (U.S. Patent) proceeding.

Presentation

Min Jang, Eun Woo Shin, and Jae K. Park, Removal of Arsenic Using Mesoporous Silicate Media Impregnated Metal Oxides Nano-Particles, WEFTEC, Research Section 41, Chicago.

KEY WORDS: arsenic, mesoporous, SBA-15, lanthanum, adsorption

FUNDINGS: the State of Wisconsin Groundwater Research Program through the University of Wisconsin Water Resources Institute (WRI)