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CASE STUDY

CO-OCCURRING CONTAMINANTS: ARSENIC and URANIUM IN DRINKING WATER

A significant number of small drinking water systems across the United States rely on groundwater. In recent years, changes to the drinking water quality regulations established by the EPA and administered by most States have created challenges for many of these small systems. In particular, two primary drinking water contaminants that have generated considerable regulatory and industry activity are Arsenic and Uranium. In 2003, the standard for safe drinking water for uranium became effective, establishing a maximum contaminant level (MCL) of 0.03 milligrams per liter (mg/l). In January, 2006, an MCL of 0.01 mg/l of Arsenic became effective, reducing the level from the previously established 0.05 mg/l.

OCCURRENCE:

Ongoing water quality compliance testing has confirmed the presence of either Arsenic or Uranium and in many cases both contaminants, in water systems across the country. In New England, regulators have identified the co-occurrence of Arsenic and Uranium, and with the support of the U.S. Geological Survey (USGS), are extending the water quality evaluations to include private residential wells. Kansas similarly maintains aquifers impacted with naturally occurring arsenic and uranium. In the West and Southwest, where the arsenic problem is most pronounced, co-occurrence with Uranium is not uncommon. Sourcing treatment to effectively address both Arsenic removal and Uranium removal can represent additional challenges for small community water systems.

TREATMENT OPTIONS:

The treatment options for the removal of both arsenic and uranium have been identified by the U.S. EPA. They include the categories:

1. Adsorption
2. Lime-softening
3. Ion exchange
4. Reverse osmosis
5. Coagulation/filtration

METSORB™ HMRG is a highly effective granular adsorbent that removes Arsenic III & V, and a wide variety of heavy metals including Lead, Chromium⁺⁶, Selenium, Uranium and Vanadium from aqueous sources. For more information on MetSorb® arsenic adsorbent media contact James Knoll at 410 596-9434, or by email at jknoll@gravertech.com.



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Adsorption technologies have been extensively evaluated and are being recognized as the most feasible treatment processes for small water systems. Independent evaluations are concluding that Adsorption technologies often present a series of benefits:

1. Lower Capital Costs
 - a. Equipment and Installation
 - b. Packaged Units – Small Footprint
2. Reduced Operational and Maintenance Activities
 - a. Less Operational Oversight
 - b. Less Mechanical/Electrical Sophistication
3. Reduced Waste Generation
 - a. Minimal Backwash
 - b. No waste sludge generation

When evaluating treatment options for both Arsenic and Uranium it is often the case that minimal waste generation, and waste handling significantly influence the selection criteria.

EXPERIMENTAL METHOD AND RESULTS:

To define the treatment effectiveness of an adsorbent technology in source water containing co-occurring contaminants of Arsenic and Uranium, a small water system in northern Arizona was chosen to conduct on-site small-scale testing. The water quality at the site was typical of water quality characteristics found in the Southwestern States, including concentrations of arsenic and uranium exceeding the MCL as well as elevated concentrations of Vanadium, in an elevated pH environment with very low Calcium and Magnesium (Total Hardness) concentrations. The source water quality data is presented in Table 1.

TABLE 1:

	pH	Total Hardness	Silica	Arsenic	Uranium	Vanadium
Units	units	mg/l	mg/l	µg/l	µg/l	µg/l
Value	8.9	28.0	47.0	21.0	38.8	322.0

The treatment design consisted of a single 12"x54" pressure vessel charged with 1 ft³ (40 lbs) of adsorbent media. The adsorbent media chosen for the testing program was the **Nano-Titanium Oxide (MetSorb® brand, by Graver Technologies)**, based upon results realized in previous arsenic and uranium testing experiments. The well known

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effects of pH > 8.5 on the adsorption capacity of metal oxide/hydroxide adsorbent media were avoided through pre-treatment with a common mineral acid to a pH of 7.3. Following pH adjustment, the vessel was fed at a controlled flow-rate of 2.5 gallons per minute (GPM) providing a total empty bed contact time (EBCT) of 3.0 minutes and allowed to operate 24 hours per day, 7 days per week. The raw, untreated water and the treated water were tested routinely over the course of nearly 3 months to evaluate the removal efficiency of the adsorbent media for Arsenic, Uranium and Vanadium. The testing was concluded at roughly 500,000 gallons of flow through the test unit and the data gathered for evaluation and interpretation.

CONCLUSIONS:

The data concluded that the nano-titanium oxide adsorbent media (MetSorb®) effectively removed both Arsenic and Uranium to below the safe drinking water MCL for each primary contaminant. A graph of the data is presented in Graph 1. The data also suggests a high level of selectivity of the nano-titanium oxide to both Arsenic and Uranium, given the operation of the test unit at 3.5 minutes of EBCT. An increase in EBCT to 4 or 5 minutes would be expected to provide further removal efficiency for Arsenic, Uranium and Vanadium. The continued application of Adsorbent Technologies as cost-effective treatment solutions for Arsenic removal should be expanded to included co-occurring contaminant challenges such as Arsenic and Uranium. This becomes even more applicable for small water systems where financial and human resources are limited and cost effective, easy-to-operate treatment solutions are needed.

It is recommended that a characterization of the saturated media be conducted for proper disposal consideration under the Federal Resource Conservation and Recovery (RCRA) as well as State and local disposal restrictions.

GRAPH 1

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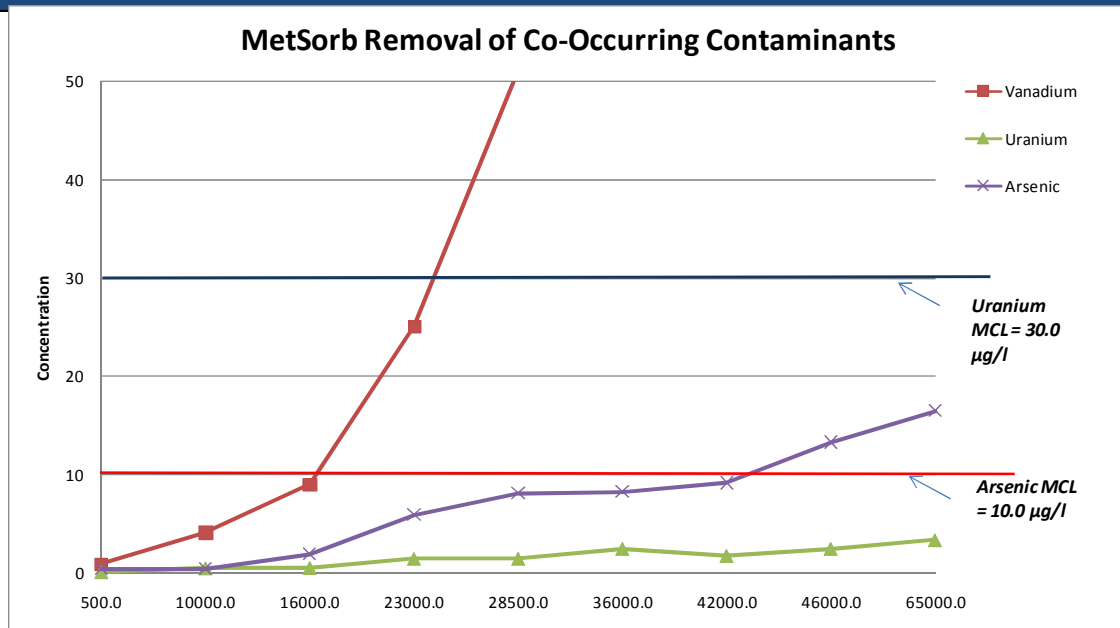


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REFERENCE:

“Removal of heavy metals, arsenic and uranium from model solutions and mine drainage waters” Gunnar Horak, Christian Lorenz, Karsten Steudel, Sabine Willscher, Wolfgang Pompe, Peter Werner. 2004

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