124

Water Treatment

Water Treatment for Selenium

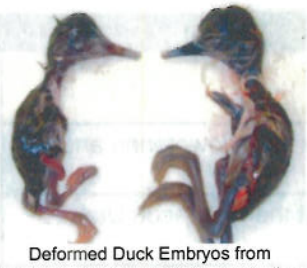
MSE is at the forefront of developing robust, cost-effective technologies to remove selenium and other contaminants from water.

● Full-Service Testing ● Onsite Sampling ● Onsite Evaluation Services ● Assessment / Resolution Services

MSE Water Treatment for Selenium - Air and Water Issues and what we can do

Selenium — Good and Bad

Selenium is a photosensitive element that occurs in both crystalline and amorphous forms, is obtained chiefly as a by-product in copper refining, and is used especially in glass, semiconductor devices, and alloys. Although selenium is an essential micronutrient for animals and humans—its prime benefit is as an antioxidant—*it is the most toxic of the essential elements when it is in excess*. The margin between healthy and toxic levels is very narrow and it bioaccumulates, so aquatic life up the food chain is most at risk. In fact, there have been occurrences of severe embryo deformities observed in aquatic life where selenium is elevated.



Deformed Duck Embryos from selenium...from the USGS site http://ww-wrcamnl.wr.usgs.gov/Selenium/Irrigation.htm

Selenium ... In the Water

The U.S. Environmental Protection Agency has established limits for selenium in water.

- Drinking water limit 50 micrograms per liter
- Chronic aquatic life limit 5 micrograms per liter

The EPA has also proposed a limit based on concentrations in fish tissue. The limit is very controversial, with no resolution in sight, and could have huge ramifications to coal mining companies. Specifically, processes related to leachate from valley fills resulting from the Mountaintop Mining/Valley Fill coal mining approach in southern West Virginia.

Selenium ... in the Air

Additional uncertainty regarding selenium issues is related to changes in air quality rules by the EPA. Selenium is frequently present in low concentrations in coal used by power plants to generate electricity. In 2005, the EPA implemented the Clean Air Interstate Rule, the Clean Air Mercury Rule, and the Clean Air Visibility Rule. These rules are intended to dramatically reduce sulfur dioxide emissions along with haze in national parks and wilderness areas. As a result, it is expected that many new, more effective flue gas desulfurization (FGD) scrubbers will be installed by coal-fired power plants. These FGD scrubbers are expected to produce wastewaters containing trace levels of selenium and require treatment prior to discharge.

Coal-Fired Power Plants must deal with emissions standards

Selenium Treatment ... Is it Working?

Selenium is generally present as selenite ($HSeO_3^-$ or SeO_3^{-2}), selenate ($SeO4^{-2}$), organic complexes, and, under strongly reducing conditions, selenide (HSe^-). It is very difficult to remove from solution, very soluble, and there are no known precipitants. An incorrect assumption frequently made is that it will behave like arsenic. Most common removal technologies are interfered with by other competing anions present (silicate, bicarbonate, sulfate). The list below shows the difficulties in standard treatments:

- Ferrihydrite adsorption. The EPA's Best Demonstrated Available Technology for selenium removal is ferrihydrite adsorption. However, this approach is only effective for selenite, not the other potential selenium forms, and even for selenite it requires fairly specific conditions, and is significantly interfered with by other anions present in solution.
- Membranes. Membrane processes such as nanofiltration and reverse osmosis, are not selective for selenium species, are energy-intensive, and are subject to scaling.
- Ion exchange. Ion exchange is generally not selective enough for selenium species in the presence of competing anions.
- Selective resins. Selenium-selective resins are being developed, but they are expensive and considered experimental. Their high selectivity can make them very difficult to strip and regenerate.
- Activated alumina adsorption. Adsorption with activated alumina can be fairly effective under proper pH conditions, but suffers from interference from competing anions, and performance is poor for selenate.
- Activated carbon adsorption. Adsorption by activated carbon is ineffective for selenium removal.
- Ferrous hydroxide reduction. The U.S. Bureau of Reclamation developed a process using ferrous hydroxide as a reductant under specific process conditions to reduce selenite and selenate to elemental selenium. While effective, this process has a high reagent requirement and produces significant sludge volumes.
- Biological reduction. Biological reduction. Using bacteria to reduce selenite and selenate to elemental selenium or selenide has been performed effectively; however, biological systems are always vulnerable to upsets in process feed conditions, nutrient delivery, temperature, etc. MSE performed a pilot-scale demonstration project focused on groundwater at a copper smelter near Salt Lake City, Utah. This process was effective, and we will monitor a full-scale system to assess the robustness of the biological treatment.

There is a way to remove Selenium--->

MSE Technology Applications Inc. U.S.A. Phone (406) 494-7100 www.mse-ta.com

MSE Selenium Removal Technology

MSE Selenium Removal Technology

Solution

MSE Solution

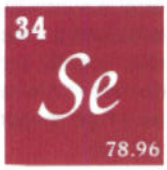
MSE's selenium removal technology involves using metallic iron as a reductant under specific process conditions to reduce all forms of selenium to the elemental state.

Originally developed by Dr. Larry Twidwell of the Metallurgical Engineering Department at Montana Tech in Butte, MT, MSE refined and demonstrated the process. MSE and Dr. Twidwell have worked together for more than a decade, developing and demonstrating technologies for arsenic, thallium, and selenium removal from water. The selenium process is very robust in that it is unaffected by the presence of high concentrations of competing anions and works well for all forms of selenium and arsenic. Specifically for selenium removal, MSE and Dr. Twidwell have completed treatability and pilot studies for customers as well as one full-scale treatment system:

MSE's Selenium Removal Technology Case Study Results

Selenium Waters	Feed Conc. (µg/L)	Treated Conc. (µg/L)
California Department of Transportation groundwater from dewatering and pump station facility. Nitrates were also an issue.	58	9.5
Selenium removal from contaminated groundwater at the Kennecott Utah copper smelter near Salt Lake City, Utah.	1062	4.0
Selenium removal from highly variable scrubber water for a confidential customer who regenerates spent catalyst for the petroleum refining industry. This water contained extremely high concentrations of sulfate and also a wide variety of metals as well as cyanide. All metals were removed to discharge requirements.	967 299 7610 903	51 26 77 <25
Selenium removal from highly variable scrubber water for a confidential customer who recycles lead from batteries. This water also contained lead and antimony, which were also successfully removed.	9830 13400	6.0 36
Selenium removal from FGD water for a confidential customer representing a number of electric utilities.	700 8320	25 5

MSE is at the forefront of developing robust, cost-effective technologies for removal of selenium and other contaminants from water.



The MSE selenium process is very robust in that it is unaffected by the presence of high concentrations of competing anions, and works well for all forms of selenium and arsenic.

For more information contact MSE

406.494.7100
www.mse-ta.com

MSE Water Treatment - Selenium
Providing engineering solutions for 30 years.
We find engineering solutions for our customers. MSE headquarters are on 45 acres in Butte, MT, with offices across the United States

Technology Applications, Inc.