National Testing Laboratories, Ltd.
Quality Water Analysis

Understanding Arsenic and Its Removal Methods

On October 31, 2001 the EPA announced its decision to implement the new standard for arsenic in drinking water at a level of 10 parts per billion down from the original level of 50 parts per billion. The EPA estimates this new standard will affect about 3,000 community water supplies and about 1,100 non-transient non-community water systems.

These systems will have to install additional water treatment equipment to reduce arsenic levels. When centralized treatment is not a cost effective option, point-of-use (POU) and point-of-entry (POE) water treatment devices may be acceptable alternatives. The estimated cost of implementing this rule is about $195 million dollars annually.

In the environment

Arsenic is released into the environment from a variety of natural and industrial sources. Arsenic is the twentieth most abundant element in the Earth's crust, and is a major constituent in several igneous and sedimentary rocks. In igneous rocks, arsenic levels are highest in basalts, while in sedimentary rocks higher arsenic concentrations can be found in iron and manganese ores.

About 90 percent of arsenic used in industry comes from the treatment of lumber, but it is also used in the production of lead-acid batteries, and in the production of semi-conductor crystalline gallium arsenide, which is used in computers and various electronic applications.

The predominate forms of arsenic in water are arsenate (+5) and arsenite (+3). Arsenate is more common in surface water while arsenite is common in groundwater. Arsenate is more easily removed than arsenite due to its ionic charge. Arsenite can be converted into arsenate easily by oxidation.

The EPA has determined chlorine; potassium permanganates and ozone are effective at oxidizing arsenite into arsenate. It can be costly to perform a test that would determine species of arsenic, and with little technology available to directly treat arsenite it is best to use an oxidizing step before final treatment.

Ion Exchange

Ion Exchange can achieve acceptable arsenic removal rates by using anion resins. The resins consist of numerous porous polymer beads that contain many ion exchange sites. When the anions enter the resin bed they are drawn to the exchange sites where they are exchanged for sodium ions. Unfortunately, anion resins attract other anions such as selenium, fluoride, sulfates and nitrates.

It is important to know the levels of these other inorganics, especially sulfate (a significant competitor) because they will compete for binding sites, thus lessening the efficiency of arsenic removal and increasing costs. Additionally systems with high inorganic content may require pre-treatment.

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Alumina

Activated alumina was also evaluated as an effective water treatment for arsenic removal. Activated alumina is a granulated form of aluminum oxide, which is typically encased in a cartridge where the arsenic is absorbed by the alumina.

However, removal rates can be sensitive to varying pH levels, so additional equipment may be required to control pH levels. A higher pH level will reduce the capacity of arsenic removal (the optimum pH level is between 5.5 and 6.0).

Reverse Osmosis

Reverse osmosis seems to offer one of the best removal rates above 95 percent under optimum pressure conditions when evaluated by the EPA for arsenic reduction. While this would be an excellent option for smaller systems wishing to utilize POU or POE water treatment devices, it may not prove efficient for removal in large treatment plants due to the amount of reject water produced.

Reverse Osmosis is designed to reduce the amount of dissolve solids in water including various ions, metals and fine suspended particulates such as asbestos.

Distillation

Distillation is a good choice for removing arsenic as a POU device. In distillation the raw water is heated in the boiling chamber to form steam. This steam is then directed over cooling coils where it is condensed back into water.

Inorganics including arsenic and other impurities are left behind in the boiling chamber to be flushed into the septic or sewer systems.

What Next?

Arsenic will continue to be an important issue in the water treatment industry as new technologies are developed. There are some newer technologies utilizing adsorptive media, which have not yet been completely evaluated by the EPA for arsenic removal, but show promising data from various other sources.

It is important for water professionals to educate consumers on the significance of the new arsenic level and the importance of its removal.

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