Tonka Technical Bulletin

Arsenic Removal from Potable Water
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Introduction

The USEPA Final Arsenic Rule became effective on February 22, 2002, with compliance required by January 23, 2006. The rule effectively reduces the maximum contaminant level (MCL) from arsenic in drinking water from 50 parts per billion (ppb) to 10 ppb.[1]

Of the 74,000 systems regulated by this MCL, approximately 4,000 systems will have to install treatment equipment or take other steps to comply with this MCL.[1]

The EPA reports that this reduction in the arsenic MCL will reduce the incidence of bladder and lung cancer, resulting in fewer deaths each year from these cancers in the United States. It is also expected that "numerous cases of other non-cancerous diseases such as diabetes and heart disease" can be prevented.[1]

Background

Arsenic is naturally occurring in many parts of the United States and is found in high concentrations in the West, parts of New England and Michigan. Arsenic commonly occurs in two forms in water, arsenite (III) and arsenate (V). Arsenite (III) is neutral in charge whereas arsenate (V) is negatively charged.

Generally, arsenite (III) must be oxidized to arsenate (V) prior to treatment. Effective pre-oxidants include chlorine, potassium permanganate, ozone, hydrogen peroxide or ultraviolet light.

There are several identified methods for removing arsenic from water. Tonka has experience in the use of all relevant arsenic removal technologies and is capable of manufacturing equipment for these processes. A brief description of each technology follows.

Tonka Manganese Greensand Filtration

The most plausible mechanism for the removal of arsenic is the complexing of arsenic with ferric hydroxide or the adsorption of arsenic onto manganese greensand.[2] Iron co-precipitation technologies using manganese greensand media can provide arsenic removal efficiencies above 92%.[2] Manganese greensand is effective at both oxidation and adsorption of arsenic.[2] In addition, iron and manganese hydroxides can remove arsenic through adsorption co-precipitation.[2, 5]

As (III) is readily oxidized by manganese oxide surfaces, and therefore the use of manganese greensand can facilitate the oxidation of As (III) and enhance removal efficiencies.[2, 5]

Tonka has experience with two full-scale plants using different types of filtration media for arsenic removal.[4] Actual removal efficiencies for these plants are shown in Table 1.

Table 1.
Arsenic Removal Efficiency at Two full-scale Municipal Water Treatment Plants

Plant	[Fe] initial	[As] initial	[As] final	Removal
Plant A	0.96 mg/l	19.8 ppb	4.9 ppb	75%
Plant B	1.2 mg/l	24 ppb	4 ppb	83%

Tonka Equipment understands the arsenic removal technologies for municipal drinking water.[4] Each plant has different design parameters involving various chemical feed systems with variations in detention times and filtration media.[4]

Although these plants have different operating parameters, the arsenic removal efficiencies are very similar. It is worth noting that the chemical feeds, iron co-precipitation, and pH levels have not been optimized to provide for maximum arsenic removal in these plants.

A full-scale plant study at Kelliher, Saskatchewan, Canada, concluded that arsenic removal rates up to 95% were possible using manganese greensand filters.[3]

The principal advantage of manganese greensand filtration is low cost. In addition, filter backwash flows to municipal sewer systems generally are exempt from regulation under the Clean Water Act.

Tonka Ion Exchange Systems

Anion exchange can effectively remove arsenic As (V) at greater than 95% efficiency. Strong base anion exchange resins, commonly used for nitrate removal, are the only effective resins for arsenic removal. In considering the behavior of arsenic in solution, it is important to recognize that the As (V) molecule is chemically similar to that of sulfate.

Anion exchange is not effective if high levels of competing anions such as sulfates (>120 mg/l), nitrates, fluorides or TDS are present in the water. In such cases, pretreatment is necessary. The EPA recognizes anion exchange as a Best Available Treatment technology (BAT) for removing arsenic from water. One significant drawback to anion exchange processes is the waste regenerate solution, which, due to its high arsenic concentration and corrosive nature, is subject to stringent disposal requirements.

Tonka Membrane Filtration Systems

Reverse osmosis (RO) and nanofiltration (NF) can provide arsenic removal efficiencies of 95% and 90% respectively. Membranes are not affected by changes in pH or the presence of other inorganic constituents. The principal disadvantages of RO and NF are high cost and water recoveries as low as 60%. The large percentage of wasted water associated with membrane technology makes the use of these systems impractical in the Western United States where water supply is limited, unless additional equipment is installed to recover the reject water.

Tonka has experience-based knowledge of arsenic removal processes and can engineer and build cost effective solutions to meet any arsenic treatment challenge. Because each arsenic situation is unique, Tonka offers pilot testing to optimize an existing plant or to assist in the design of a new plant.

Call your Tonka representative for more information on arsenic removal or any other water treatment challenge.

References:

1. http://www.epa.gov/safewater/ars/ars-oct-factsheet.html EPA 815-F-01-010 fact sheet.

2. Edwards, M., Chemistry of Arsenic Removal During Coagulation and Fe-Mn Oxidation, Journal of the AWWA, Vol.86, No. 9, September, 1994.

3. Reporter Newsletter. Sask. Environment and Public Safety, Vol. 16, No. 4, December, 1992.

4. Internal Tonka database of independent lab testing from water treatment plants.

5. Arsenic Removal from Water using Manganese Greensand: Laboratory scale batch and column studies, New Mexico State University, Bureau of Reclamation report #41, June 1999.