Sources of Arsenic

Arsenic is a naturally occurring element present in rocks and soil. Arsenic is the 20th most abundant element in the earth's crust and often forms inorganic compounds by combining with oxygen, chlorine and sulfur. As water passes through and over soil and rock formations, it dissolves many compounds and minerals including arsenic. The result is that varying amounts of soluble arsenic are present in some water sources.

Arsenic chemistry is complex, because it has many forms. The most common are As(III) (arsenite) and As(V) (arsenate) in anaerobic waters. As(III) exists in most natural water as arsenous acid (As(OH)3). AS(III) is more mobile in underground environments than As(V), which is negatively charged. This characteristic of arsenic compounds is important for understanding treatment options. Removal efficiencies for As(III) are poor compared to removal of As(V). Treatment takes advantage of the charge to extract As(V). For this reason, some techniques convert As(III) to As(V) before treatment, to take advantage of the effects of negative charge

Arsenic in Drinking Water

Arsenic contamination of a drinking water source most often results from natural sources; however, it can result from human activities. Arsenic solutions were used to treat a variety of health disorders in the past. While the medical use of arsenic has declined, an arsenic solution received Food and Drug Administration approval for leukemia treatment in 2000. Arsenic has been used in mining and manufacturing and was a component of some pesticides used in the past. Chromated copper arsenate was used to pressure-treat wood for preservation and to prevent insect damage; this wood commonly was known as CCA-treated lumber.

Indications of Arsenic

Arsenic in drinking water cannot be detected by taste, sight, or smell. The only way to know the concentration of arsenic in water is through sampling and testing. Appropriate

Potential Health Effects

Arsenic exposure can cause a variety of adverse health effects. The severity of the effect depends on how much arsenic is in the water, how much water is consumed, how long a person has been drinking the water, and a person's general health. Arsenic poisoning can be acute or chronic. Acute poisoning can occur when a high concentration (over 60 mg/L) of arsenic is ingested over a short time. This is more likely to occur where arsenic has been concentrated by industrial processes or at unregulated waste disposal sites. Chronic poisoning can occur when moderate or small amounts of arsenic are ingested over long periods (usually five years or longer), such as where groundwater containing arsenic is consumed daily for extended periods.

Uncertainty exists in arsenic risk assessment, and more research must be done to determine the connections between level of arsenic, duration of exposure, and health effects. However, studies summarized in a recent report by the National Research Council point to a preponderance of evidence that long-term ingestion of arsenic can increase the risk of skin, bladder, lung, kidney, liver, and prostate cancer. Non-cancer effects of ingesting arsenic may include cardiovascular, pulmonary, immunological, neurological effects, and endocrine problems such as diabetes.

Symptoms of chronic arsenic poisoning are usually delayed, with years of exposure required to initiate the disease process. Factors such as genetics, age, metabolism, diet and overall health may also impact health risks associated with arsenic exposure, because they potentially affect one's ability to clear arsenic from the system. Individuals with chronic Hepatitis B infection, protein deficiency or malnutrition may be more sensitive to the effects of arsenic. Children and older adults may be other groups at special risk.

Testing

Public water supplies classified as either community or non-transient non-community are required to test for arsenic concentration. If your water comes from a public water supply, contact the water utility for the arsenic level in your water.

Water quality in private wells is not currently regulated; thus, the regular testing of a private water supply is not required under state or federal law. If users want to know the concentration of arsenic in a private water supply, they will need to have the water tested at their own expense. Tests to determine the presence of arsenic in drinking water should be done by a laboratory approved for arsenic testing.

Interpreting Test Results

Public drinking water standards established by EPA fall into two categories -- Secondary Standards and Primary Standards. Secondary Standards are based on aesthetic factors such as taste, odor, color, corrosivity, foaming, and staining properties of water that may affect the suitability of a water supply for drinking and other domestic uses. Primary Standards are based on health considerations and are designed to protect human health. The EPA has established an enforceable Primary Standard for arsenic in public drinking water supplies.

The Maximum Contaminant Level (MCL) for arsenic had been 50 parts per billion since 1942. Three expert panel reports on the science, cost of compliance, and benefits analyses on arsenic in drinking water were released in October 2001. They were: The National Academy of Sciences National Research Council's Report, The National Drinking Water Advisory Council Report, and The Science Advisory Board Report. Reports indicated the EPA had underestimated the cancer risks of arsenic in drinking water. With this new information, EPA issued regulations revising the arsenic drinking water standard. EPA established an enforceable MCL for arsenic of 0.010 milligrams per liter (mg/L) which can also be expressed as 0.010 parts per million (ppm). This amount is equivalent to 10 micrograms per liter (ug/L) which can also be expressed as 10 parts per billion (ppb). The new regulation applies to all community water systems (CWS) and non-transient non-community water systems (NTNCWS). A CWS is a public water system that serves at least 15 locations or 25 residents regularly year round (e.g., most cities and towns, apartments, and mobile home parks with their own water supplies). An NTNCWS is a public water system that is not a CWS and serves at least 25 of the same people more than 6 months of the year (e.g., schools, churches, nursing homes, or businesses with their own water supplies).

Options

Of all the public water systems affected by the arsenic rule, some communities may be able to meet the new MCL by shutting down or replacing one or two wells. Other communities will need to find other alternatives for lowering the arsenic concentration in the drinking water. These alternatives may range from finding new wells that contain water with a lower arsenic concentration, treating the water, or becoming part of a larger rural or community water district (which benefits from economies of scale in treating water or obtaining water from a high quality source). Management and disposal of the waste stream generated (arsenic removed) also must be considered. EPA has provided millions of dollars for research and development of more cost-effective technologies to help public water systems meet the more protective 10 ppb standard. Some of this research is not yet complete. Research results will be available to help communities select the best alternative for their situation.

In cases where an individual household obtains its drinking water from a private well, a private residential drinking water treatment device may be an option for reducing arsenic concentrations in drinking water. Residential treatment devices are affordable and can remove arsenic from drinking water to concentrations below 0.010 mg/L. Periodic testing by an accredited laboratory should be conducted on both the water entering a treatment device and the water it produces to verify that the device is effective.

The most common types of treatment devices available for the removal of arsenic from drinking water in residential systems are reverse osmosis and steam distillation. Other types of systems based on technologies such as adsorption and ion exchange are also becoming common. Filtration systems may be installed at the faucet (point of use) or where water enters the home(point of entry).

Residential reverse osmosis systems have been shown to effectively remove total arsenic from drinking water. The amount of arsenic removed depends on the type of membrane filter employed in the system. Reverse osmosis requires larger quantities of influent (incoming) water to obtain the required volume of drinking water, as reverse osmosis systems reject (waste) part of the influent water. A consumer may need to pretreat the influent water to reduce fouling and extend the service life of the membrane. The major advantage of using reverse osmosis systems is that they are widely available, affordable, and easy to service and can remove up to 98% of other dissolved minerals as well as fine colloidal and coarse suspended matter.

Distillation systems can remove virtually all arsenic in drinking water. These systems are more complex than reverse osmosis systems. Although distillation systems are usually installed in commercial applications, more systems are becoming available for residential applications.

Adsorption/filtration is a promising technology that is applicable to residential-scale treatment. Adsorption using media such as iron, aluminum, and titanium oxide is effective at removing arsenic. Fixed-bed treatment systems, such as adsorption and ion exchange, are becoming increasingly popular for arsenic removal in small water treatment systems because of their simplicity, ease of operation and handling, and regeneration capacity.

Summary

Arsenic is a naturally occurring element present in rocks and soil. As water passes through and over geologic formations it can dissolve arsenic. The result is that arsenic can be present in some water sources. Ingestion of drinking water containing arsenic can cause adverse health effects. Most notably, arsenic is a known carcinogen, and long-term ingestion may increase the risk of cancer. Public water supplies must comply with the revised EPA standard of 10 ppb which became effective in January, 2006 or obtain an extension in time. Management of a private drinking water well for arsenic is a decision made by the well owner and/or water user. Research is being conducted to identify effective, economical methods for arsenic removal. The treatment system or combination of systems that will be best for a given situation will depend on several factors.

How to remove arsenic from drinking water

Arsenic can be removed from water, but we need to take a closer look at the element itself.

Arsenic can come in two forms, or valences. One, is inorganic, the other organic. The EPA MCL of 10 ppb is based on total combined arsenic. One form, trivalent**(combine power of three hydrogen atoms)** or AsIII is also known as arsenite.

The other form, pentavalent, **(combine power of five hydrogen atoms)** or AsV is also known as arsenate. Most manufacturers produce filters that will remove pentavalent arsenic as long as the starting level is less than 300 ppb. Speciation can be performed to determine which forms you have and in what proportions, but as you read further, it is not really necessary to speciate.

Typically, the trivalent form is converted to pentavalent form using free chlorine or other similar oxidation chemical because AsV is easier to remove. As previously mentioned, have a certified lab give you the total arsenic number, then let a qualified and experienced treatment professional take care of the filtration.

In the past years many experiments have done worldwide, there is only technology which can remove arsenic from drinking water that is reverse osmosis technology.

for the treatment of organic and inorganic contamination from the water the reverse osmosis technology is most feasible and reliable in the world.