Removal of Arsenic from Wells in Pennsylvania

Arsenic occurs in groundwater in Pennsylvania from both natural sources and manís activities. It is present naturally in certain rock types that are especially common in the western United States but also occur sporadically in parts of Pennsylvania.

Sources of Arsenic in Groundwater

Arsenic contamination of groundwater can also sometimes be traced to deep-water brines produced from gas and oil well drilling or from industrial activities like semiconductor manufacturing. Arsenic is also found in wood preservatives, animal feed additives and may be a byproduct of herbicide production. In drinking water, arsenic is odorless and tasteless.

Health Effects

Arsenic has been shown to cause skin lesions, circulatory problems, and nervous system disorders. It has also been associated with development of diabetes while prolonged exposure can cause skin, bladder, lung, and prostate cancer.

Drinking Water Standard

Arsenic has a primary drinking water standard or MCL (maximum contaminant level) because it is known to cause health effects when present in drinking water. In 1975, the U.S. Environmental Protection Agency set a MCL for arsenic of 50 micrograms per liter (µg/L). Based upon new research on the health effects of arsenic, the EPA lowered the MCL to 10 µg/L or 0.01 mg/L in January 2001. In March 2001, the 1975 MCL was reestablished by EPA until additional health and toxicity studies are completed.

How Common is Arsenic in Pennsylvania Groundwater

The U.S. Geological Survey (USGS) recently collected water samples from 578 groundwater wells in 30 counties in Pennsylvania. Their water testing was concentrated in eastern and western Pennsylvania and is not necessarily representative of the entire state. Their results are summarized in Figure 1. Half of the wells that they tested did not contain any measurable arsenic. An additional 44% of the wells contained arsenic concentrations below 5 µg/L. A total of about 6% of the wells had arsenic concentrations in excess of the new MCL of 10 µg/L. The highest arsenic concentration measured was 24 µg/L.

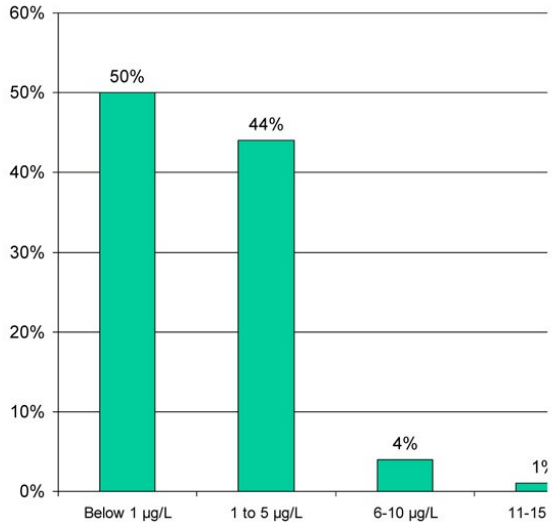

Figure 1. The frequency of occurrence of various arsenic concentrations in 578 wells in PA. Source: US Geological Survey

Testing Your Water for Arsenic

Water testing for arsenic should be done by a certified commercial water testing laboratory. You can obtain a list of certified commercial water testing laboratories from your local Cooperative Extension office. Ask for Agricultural and Biological Engineering fact sheet number F-105 entitled 'Where to Have Your Water Tested.' Arsenic is classified as a trace metal so you should look for labs that are certified to analyze for trace metals (specifically TM2 certification). The cost for an arsenic test will typically range between $15 and $50.

How to Remove Arsenic

In Pennsylvania, arsenic usually occurs in water as either arsenate (AsV) or arsenite (AsIII). The III or V superscripts indicate the electrical charge on the arsenic ion. Arsenate is more common in surface waters while arsenite occurs more frequently in groundwater. Most water test results report the total arsenic concentration including both the arsenate and arsenite concentrations. Because most private water supplies in Pennsylvania rely on groundwater, the most common form of arsenic is likely to be arsenite.

The form of the arsenic in your water can be very important. Arsenite is a greater health concern but more difficult to remove from water using treatment devices. Because arsenate is easier to remove from water, arsenic removal often starts by adding an oxidant to the water to convert all of the arsenic to the more easily removed arsenate form. Oxidation is usually accomplished using chlorine, ozone or manganese dioxide greensand filtering media. All of the treatment options discussed below are more efficient if oxidation is used to ensure that arsenic is in the arsenate (AsV) form.

Activated Alumina

Activated Alumina (AA) filtration involves the passage of water through an alumina media. Arsenate is very strongly attracted to the alumina material as the water passes through the filter. Large AA treatment devices or Point of Entry (POE) devices can be used to treat all household water or smaller Point of Use (POU) filters can be used to remove arsenic at a single tap in the home. AA is the preferred treatment method if your water has high total dissolved solids (TDS) or high sulfate concentrations. A disadvantage to AA filters is that they must be regenerated using strong acid and base solutions that are undesirable for home storage and handling. In addition to periodic regeneration, the alumina filter material must be replaced every one to two years.

Ion Exchange (IE)

Ion exchange for arsenic removal works much like a conventional water softener. In this case, arsenic in the water is removed and chloride is added to the water in its place. Sulfate, total dissolved solids, selenium, fluoride, and nitrate all compete with arsenic and can reduce the efficiency of arsenic removal. Suspended solids and precipitated iron can also clog the IE unit and may require pretreatment. IE is usually a whole house POE device that treats all of the water entering the home. IE resins can be regenerated with much less dangerous chemicals than the Activated Alumina filter but IE may increase water corrosivity by removing alkalinity. Neutralization may be required as an additional treatment to reduce corrosivity.

Reverse Osmosis (RO)

RO is usually an 'under the sink' or POU device that provides enough water for drinking and cooking. It removes arsenic by forcing the water through a special membrane that traps the arsenic. The treated water accumulates in a small, pressurized storage tank with its own faucet. RO takes out most dissolved minerals from water. Under ideal operating pressures, RO will remove more than 95% of arsenic in water. Pre-filters are often sold as standard equipment with a RO unit to remove any solids and chlorine from water to prevent damage to the RO filter. Maintenance requirements are minimal for RO units.

Iron Treatment Systems

Iron is a common pollutant in private water supplies in Pennsylvania resulting from both natural and mining sources. Iron is often removed from water using oxidation with birm or manganese greensand followed by filtration of the oxidized iron. Where iron is removed with these methods, the arsenic present would likely be removed as an added benefit. The efficiency of arsenic removal will vary considerably and water tests should be conducted to determine if there is significant arsenic removal for the particular iron oxidation/filtration treatment method used.

Other Options for Avoiding Arsenic in Water

While treatment devices are available to reduce or remove arsenic from water, other options should not be overlooked. In some cases, a municipal water supply line may be nearby. Connecting to a municipal water supply may seem expensive initially but it may be economically preferable given the long-term costs and maintenance requirements associated with purchasing and operating a water treatment device. Connecting to a municipal water supply will also usually increase the real estate value of your home.

Another option may be to develop an alternate private water supply. However, a new well may not be free of arsenic if your present well has an elevated arsenic concentration.

Other sources of water like a shallow groundwater spring or a rainwater cistern would be more likely to contain lower arsenic concentrations but they may both present other water quality and quantity problems. Since arsenic is only a health problem when the water is ingested, bottled water could be purchased for drinking and cooking purposes to avoid the problem.

Alternative sources of water should be thoroughly investigated along with treatment options when choosing a strategy to avoid arsenic in water.

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An OUTREACH program of the College of Agricultural Sciences

Penn State College of Agricultural Sciences research and extension programs are funded in part by Pennsylvania counties, the Commonwealth of Pennsylvania, and the U.S. Department of Agriculture.

Publication code: F133