All about arsenic in drinking water

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I recently attended an Inorganic Contaminants Workshop, held in Albuquerque and sponsored by the American Water Works Association. Both in terms of the number of papers presented and participant attendance at talks, arsenic removal was the topic of highest interest. One presenter, who works for the U.S. Environmental Protection Agency (EPA), was so committed to presenting his work (which detailed the health effects of the exposure to high levels upon Native American communities, and which was also the thesis for his master's degree in public health) that he paid his own way from Washington, D.C., to Albuquerque. His work was based on measured arsenic concentrations in communal water supplies, water intake diaries and analyses of urine samples from volunteer subjects.

The EPA's maximum contamination level (MCL) for arsenic was reduced from 50 to 10ppb (parts per billion or micrograms per liter), effective April 2003. Efforts to tighten the federal requirement gained momentum after a National Academy of Sciences report in 1999 found that arsenic in drinking water causes bladder, lung, and skin cancer, and might cause kidney and liver cancer. This legislation also put the United States drinking water standard for arsenic in line with recommendations from the World Health Organization (WHO).

Health-risk information about arsenic is available on the Web sites of the EPA, National Academy of Sciences, WHO, National Sanitation Foundation International (NSF), and the New Mexico Environment Department.

Concern about arsenic primarily relates to chronic, long-term exposure to arsenic from regulated (public) drinking-water supplies. The original 2003 deadline for compliance with the new standard was extended to the end of 2007 in many Western states in order for the public systems to develop plans to reduce arsenic levels. Eight public systems in New Mexico, including Santa Fe's, were given extensions through the end of 2008.

One way that public systems achieve compliance with the new standard is through blending water from wells with low arsenic levels. This technique is effectively used by the City of Santa Fe's Sangre de Cristo Water Division at the Buckman Tank, at which the compliance level of 6 ppb was achieved between 2005 and 2007. In addition, the Buckman Direct Diversion Project is anticipated to provide treated surface water lower in arsenic to supplement or replace current groundwater wells. The Canyon Road Plant, which supplies surface water that is much lower in arsenic levels (not detected during 2005), is also being upgraded.

Arsenic occurs naturally in rocks and soil, water, air, and plants and animals. It can be further released into the environment through natural activities such as volcanic action, erosion of rocks, and through industrial applications. Agricultural activities, mining, and smelting also contribute to arsenic releases in the environment. But in the western United States, arsenic enrichment is typically associated with the natural weathering, erosion, and transportation of materials from arsenic-bearing, silicic volcanic rocks.

Arsenic may be preferentially mobilized by ground waters under specific geochemical conditions. For example, arsenic levels in the Rio Grande are markedly higher below the entry point of the Jemez River, which drains the relatively young Jemez volcanic fields. Weathering of volcanic tuff exposed in outcrops contributes to the high arsenic content of some private wells in northern Santa Fe County.

Arsenic in groundwater commonly occurs in one of two major forms (valences or oxidation states): pentavalent arsenic (AsV or arsenate) and trivalent arsenic (AsIII or arsenite). In natural groundwater, arsenic may exist as trivalent arsenic, pentavalent arsenic, or a combination of both with variance of the relative proportions of each through time. The form in which the arsenic is present is highly dependent upon water chemistry, with pentavalent arsenic predominating in oxygen-rich waters and trivalent arsenic predominating under oxygen-deficient conditions. Although both forms are potentially harmful to human health, trivalent arsenic is the more toxic and more difficult to treat because it cannot be removed by all arsenic-removal technologies.

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Arsenic can be removed by anion exchange, using an arsenic-specific anion resin in a system requiring regeneration with brine. Anion exchange removes pentavalent arsenic but not trivalent arsenic, and oxidation pre-treatment is required. Another option for removing arsenic is a self-contained, arsenic-removal system using a certified (NSF/ANSI Standard 61) hydrous oxide resin. This system safely removes arsenic and does not require backwashing. Testing kits are sent to you at regular intervals based on your water chemistry. When testing indicates that the resin is depleted in one of the two tanks (you continue to be protected by the second tank), the water treatment company will replace the spent media and tank and handle disposal.

Because the health risk of arsenic consumption is related to ingestion, arsenic is commonly treated with point-of-use reverse osmosis. It is a common misconception that reverse osmosis (RO) removes all arsenic. The National Sanitation Foundation Intl. , which is the gold standard for certification of water-treatment equipment, certifies reverse-osmosis drinking water treatment systems (under Standard 58) to reduce only pentavalent arsenic contamination, and by as much as 99 percent; but RO systems are not certified for trivalent arsenic reduction. In order to reduce the latter using reverse-osmosis technology, oxidation must also be used. Oxidation is commonly achieved using household chlorine bleach and then removing the chlorine by carbon filtration. New D.O.G. (dissolved oxygen generation) technology offers promise for oxidizing arsenic (as well as iron and manganese) and eliminating the need to use chlorine bleach.

Trivalent arsenic can be converted to pentavalent arsenic in the presence of an effective oxidant such as free chlorine, so water treated in some chlorinated municipal systems is more likely to contain the more easily removed pentavalent arsenic. The arsenic in water containing detectable free chlorine, or water that has been treated with another effective oxidant, will be in the pentavalent arsenic form; whereas well water commonly contains higher percentages of the more harmful (and difficult to treat), trivalent arsenic.

As with most contaminants, the health risks associated with arsenic are greater in unregulated, private water wells, and high arsenic levels are commonly tested in private wells in Santa Fe County and in northern New Mexico. Arsenic does not generally impart color, taste, or smell to water; therefore it can only be reliably detected in sample analysis by a testing laboratory. Most arsenic test results are reported as undifferentiated "total arsenic" and are less than ideal for use in selecting methods for arsenic reduction.

Arsenic "speciation" is available, but it is very expensive. And there exist abundant undocumented and uncertified claims for arsenic reduction without regard to arsenic species. The most effective methods for removing high levels of arsenic are through using systems with media which removes both valances of arsenic, and which can be replaced or exchanged after processing a metered volume of water, or by putting an oxidation system ahead of an anion exchange or reverse osmosis drinking water system.

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