ADDRESSING PRIMARY CONTAMINATION

Arsenic is a well-documented toxin and human carcinogen. Arsenic trioxide (As_2O_3) has been used with deadly effect throughout history as a poison because it is tasteless, colorless and odorless. A small pea-sized piece (<150 mg) can be fatal.

By Paul Sylvester & Dan Shepard

An under the sink, cold-water tap, point-of-use arsenic removal system.

Because the symptoms of acute arsenic poisoning—headache, diarrhea, vomiting—are similar to cholera or food poisoning, the fact that a person had been poisoned often went undetected. This aspect, coupled with the wide availability of the compound, made arsenic trioxide very popular for discrete poisonings from the Middle Ages until the end of the 1800s. Long-term exposure of consumers to even low levels of arsenic via drinking water consumption has more recently been linked to an increased risk of skin, prostate, lung and bladder cancers, as well as diabetes, circulatory disorders and tremors.

Arsenic naturally occurs in groundwater throughout the world due to the presence of arsenic-bearing minerals in the aquifers. Although pure arsenic minerals, such as orpiment (As_2S_3), are not particularly abundant, arsenic is found as a trace component in many common primary sulfide minerals, such as iron pyrite, and is often associated with iron oxides and hydroxides. As a consequence, groundwater contains dissolved arsenic, usually at parts per billion or micrograms per liter (mg/L) levels.

Protecting Consumers

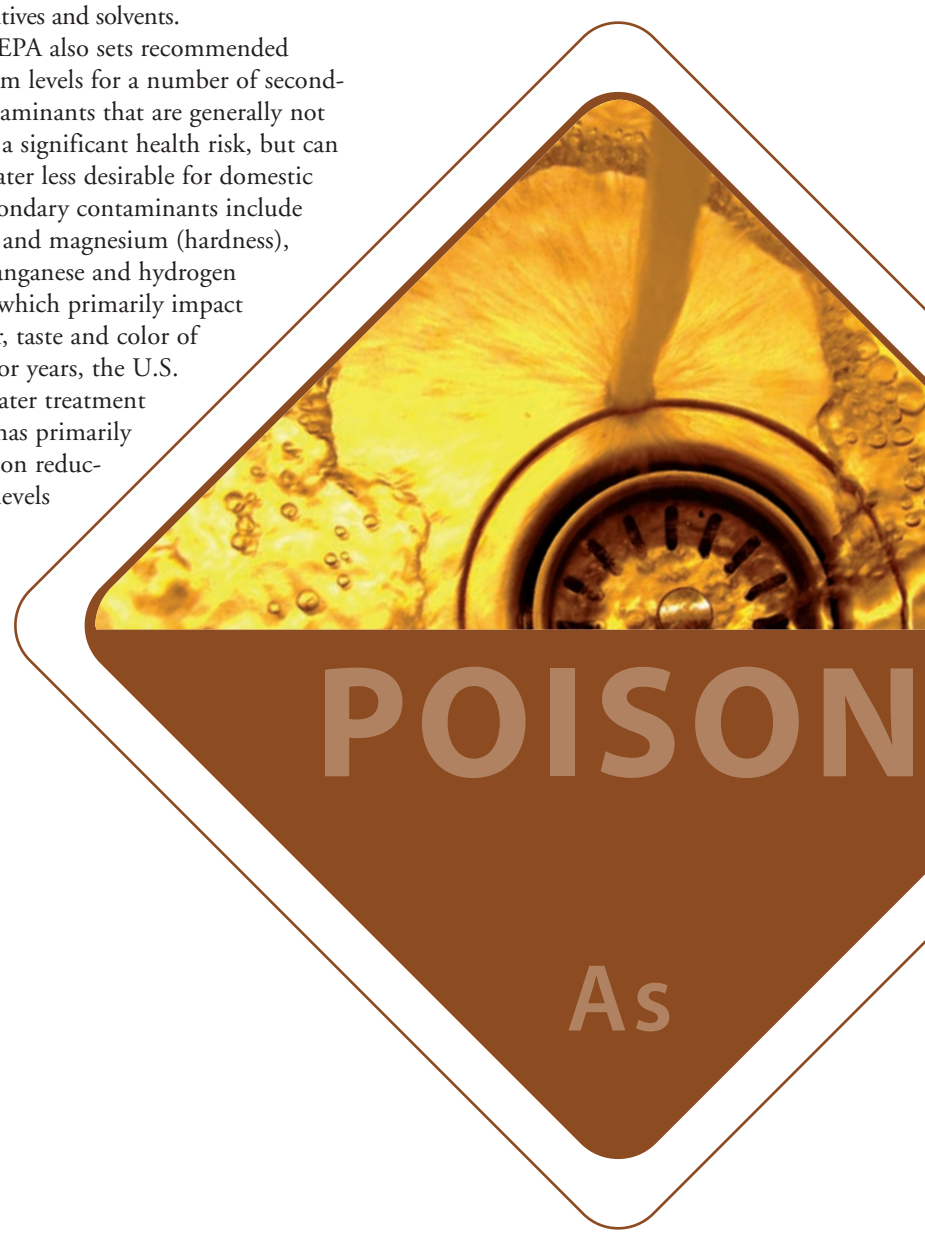
Federal and state agencies do not monitor water quality in private wells. This means that private well owners are responsible for the quality and safety of their well water. All groundwater and surface water contain dissolved compounds, some of which are more hazardous than others. The U.S. Environmental Protection Agency (EPA) regulates the concentrations of a number of contaminants in drinking water, both natural and anthropogenic, to protect human health. These primary contaminants can be biological, such as bacteria or viruses; inorganic chemicals, such as arsenic, lead and nitrate; and organic chemicals, such as insecticides, herbicides, fuel additives and solvents.

The EPA also sets recommended maximum levels for a number of secondary contaminants that are generally not deemed a significant health risk, but can make water less desirable for domestic use. Secondary contaminants include calcium and magnesium (hardness), iron, manganese and hydrogen sulfide, which primarily impact the odor, taste and color of water. For years, the U.S. home water treatment market has primarily focused on reducing the levels of secondary contaminants, making water aesthetically pleasing but not addressing the adverse health risks that can be caused by primary contaminants.

Between one and two million private wells in the U.S. are out of compliance for arsenic, which presents a significant health risk to consumers. Only recently, in January 2006, the EPA reduced the maximum allowable concentration of arsenic in drinking water to 10 mg/L from the existing 50 mg/L.

Treating Private Wells

Arsenic exists in water in two major chemical forms: arsenate (As(V)) and arsenite (As(III)). The form in which the arsenic is present is dependent on the water chemistry, with arsenate predominating in oxygen-rich waters and arsenite



Considering a POU system as an alternative for treating water for arsenic

predominating under oxygen-deficient conditions. It is not uncommon to find both species existing simultaneously in specific water. Of the two species, arsenite is more toxic and also more difficult to treat because it is usually present as an uncharged species and cannot be removed by many arsenic removal technologies, including ion exchange and reverse osmosis. Fixed bed adsorption systems are a favored treatment method, as many adsorption media will remove both arsenite and arsenate.

Generally, point-of-entry (POE) and point-of-use (POU) systems are based on adsorption technology. For arsenic treatment, whole-house POE systems are preferred over POU devices designed for individual faucet treatment, because POE guarantees arsenic-free water for the entire household. POE systems can be relatively expensive, however, and a POU system may be a cost-effective alternative for some homeowners. There are a number of POU technologies available for arsenic removal. Water passes through the arsenic-selective sorbent bed where arsenic is bound to the solid media to provide arsenic-free drinking water. Device life is highly dependent on the volume of media contained in the device and the quantity and quality of water being treated. Some POU devices operate with a separate low-flow faucet, which reduces the volume of water treated and can increase the possibility of consumption of untreated water from the free flowing tap.

Ensuring Compliance

Because arsenic is a primary contaminant, regular testing of the treated water is essential to ensure the device is operating as designed. Municipalities are required to regularly test their finished water to ensure compliance with the new arsenic limit and other standards. There are no regulations affecting individual households, so the effectiveness of home treatment technologies is often not known. The accurate detection of arsenic levels in drinking water requires highly specialized instrumentation and it is recommended to have a sample analyzed by a professional laboratory. A testing program adjacent to a POU device would include an initial test of the raw water to determine the base water chemistry and appropriate follow-up testing to catch arsenic breakthrough in the device before the arsenic level reaches the maximum contaminant level (MCL).

Protecting Your Home

Arsenic is a common contaminant in groundwater worldwide, and the consumption of even trace levels of this potent toxin and human carcinogen is becoming an increasing concern. Cost-effective, cold water-flow POU systems are readily available in the marketplace and are highly effective at maintaining arsenic concentrations below the MCL. Regular water testing is recommended to ensure continued protection for homeowners where health contaminants are concerned. *wqp*

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