

Drinking Water Problems: Benzene

Monty Dozier and Bruce Lesikar*

Benzene is a clear, colorless, aromatic, highly flammable liquid with a distinctive, sweet smell. Benzene occurs naturally and evaporates easily. Small amounts are released by volcano eruptions, forest fires, and underground oil and gas reservoirs; however, larger amounts are released by human activities.

Benzene is a component of crude oil and petroleum-based chemicals that can be released into the environment through motor vehicle exhaust, leaking underground storage tanks and gasoline spills. Benzene is also present in petroleum products used to manufacture such common products as plastics, nylon, Styrofoam, rubber, dry cleaning solvents, dyes, lubricants, printing fluids and pesticides. Benzene may escape into the environment through industrial discharges, improper waste management and faulty product handling and storage. Tobacco smoke also releases benzene into the air.

Occurrence of Benzene in Texas

According to the U.S. Environmental Protection Agency, 2 million pounds of benzene were released into the environment between 1987 and 1992; in Texas the amount was 1,436 pounds, released mostly through petroleum refining and related activities. Areas of the state with the highest concentrations of petroleum refining industries, such as the Gulf Coast, are at the greatest risk of benzene contamination.

Benzene released into soil will volatilize quickly or leach into groundwater. A report from the Texas Commission on Environmental Quality identifies locations having benzene contamination of groundwater (Fig. 1). In addition, 37 groundwater contamination cases involving benzene are under the jurisdiction of the Railroad Commission of Texas. Microbes in soil can break down benzene. Benzene released into surface water evaporates in a few hours.

Texas Commission on Environmental Quality Benzene Contamination Cases*

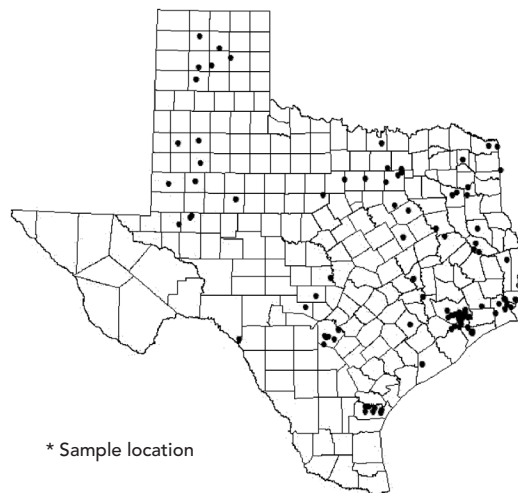


Figure 1: Occurrence of benzene in Texas groundwater. (Source: Joint Groundwater Monitoring and Contamination Report, 2006); Naturally occurring benzene or contamination cases under the jurisdiction of other regulatory agencies not shown.

*Associate Professor and Extension Regional Program Director-Agriculture and Natural Resources; Professor, Associate Department Head and Extension Program Leader for Biological and Agricultural Engineering; The Texas A&M System

What are the Potential Health Effects of Benzene?

Everyone is exposed to a small amount of benzene every day, most often through breathing automobile exhaust and gasoline vapors, tobacco smoke and industrial emissions. Workers involved in benzene-producing industries may inhale it in airborne vapor. Though not as common, exposure also can occur through consumption of benzene-contaminated drinking water.

Large concentrations of benzene in groundwater can be a health risk because benzene is known to cause cancer. The maximum contaminant level goal set by the EPA is zero (0) micrograms per liter ($\mu\text{g/L}$). Based on this number, the maximum contaminant level for benzene is 5 $\mu\text{g/L}$. This is the level of benzene that public water suppliers must meet in order to comply with national standards. The maximum contaminant level is usually slightly higher than the goal due to the limitations of present technology and the resources available to remove benzene from drinking water.

Private water wells are not regulated. Private water well owners or users who store gasoline on their property, live within a half-mile of a gasoline station or petroleum storage or refining facility, or notice a sweet, chemical smell in their water should have their water wells tested for benzene.

Benzene attacks the central nervous system; acute exposure to high levels can be fatal. Breathing benzene can cause drowsiness, dizziness, rapid heart rate, headaches, tremors, confusion and unconsciousness. Consumption of high levels of benzene can lead to vomiting, stomach irritation, dizziness, sleepiness, convulsion, rapid heart rate and death.

Benzene also is known to cause cancer. Long-term or chronic exposure to benzene can damage bone marrow and decrease red blood cell counts, which leads to aplastic anemia with its abnormally low counts of red and white blood cells and platelets. Breathing high levels of benzene for a long time can cause leukemia and/or disruptions of the bone marrow. Long-term exposures also can damage chromosomes, depress the immune system, reduce the size of women's ovaries and disrupt the menstrual cycle.

How Can Benzene be Removed from Well Water?

Benzene requires a specific treatment process for removal from water. Well owners can use granular activated carbon or charcoal to remove benzene from their water. Activated charcoal or granular activated carbon

filters used to improve the taste or remove odor of the water also can remove some contaminants in water supplies. These filters are effective in removing volatile organic compounds which easily vaporize into the atmosphere under normal conditions, as well as benzene, pesticides, chlorine, radon and some metals. A typical water softener will not remove benzene from water.

Home granular activated carbon systems are usually simple. The activated charcoal is packaged in filter cartridges that are inserted into a purification device (Fig. 2). Drinking water passes through the cartridge and the activated charcoal where benzene is removed from the water before it reaches the faucet. When the filters

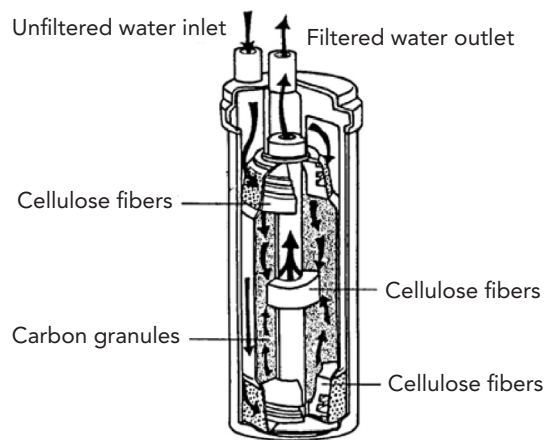


Figure 2: Granular activated carbon (GAC) filter (adapted from Parrott et al).

lose their ability to adsorb contaminants, they must be replaced according to manufacturer's guidelines.

In the home, granular activated carbon filtering systems are usually installed where the treated water will be used for drinking or cooking. Treatment systems can be placed directly on the faucet, on the countertop or under the sink (Fig. 3). Most systems contain a bypass so water used for purposes other than drinking and cooking may be dispensed without being treated, thus extending the life of the filters.

Filters for home water treatment contain either granular activated charcoal or powdered block charcoal. The amount of material in a filter affects the amount and rate of contaminant it removes. More granular activated carbon in a filter means more contaminant removal, longer filter life, fewer filter cartridge changes and less chance of drinking contaminated water.

Particle size may also affect contaminant removal rate, with smaller activated charcoal particles having higher adsorption rates. Rust, scale, sand and other sediments can clog filters and reduce removal capacity and treatment

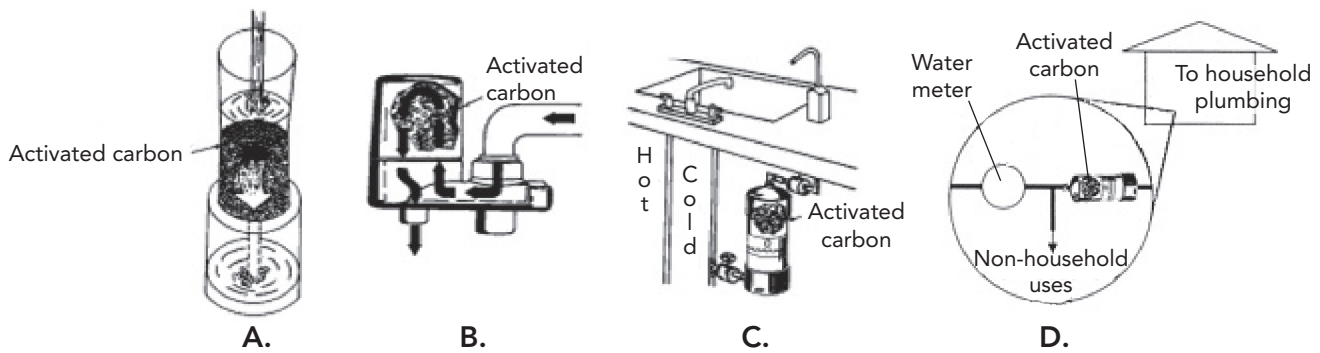


Figure 3. Four types of activated carbon filtration units are, from left: A) pour-through; B) faucet-mounted; C) high-volume and D) point-of-entry. (adapted from Dvorak, 2003).

life. Foam or cotton fiber pretreatment filters can be used to remove such particulates. However, filters will become clogged over time and will require replacement.

How Should a Water Well Owner Select a Treatment Unit?

No single technology will treat all water contaminants. Before a treatment option is selected, have the water tested by a qualified laboratory. A list of labs certified by the Texas Commission on Environmental Quality can be found at http://www.tceq.state.tx.us/assets/public/compliance/compliance_support/qa/sdwa_lab_list.pdf.

After the water has been tested to determine what contaminants it contains, research different products to find one suitable for treating your water supply. Take note of the system's co-treatment compatibility if more than one contaminant is to be treated. Compare different systems' costs and requirements, as well as contaminant removal efficiency, warranties, life expectancy of the system and the reputation of the company. Also consider the wastewater or solid waste that the system will generate.

Home treatment systems are not regulated by federal or state laws. However, some national organizations offer certification of products. The Water Quality Association (www.wqa.org) offers a validation program and advertising guidelines. Products that receive the association's Gold Seal Product Validation are certified in mechanical performance but not in their ability to remove harmful contaminants.

The NSF International (www.nsf.org) certifies a product's ability to remove contaminants that affect health. A list of drinking water treatment units that have the certification can be found at: <http://www.nsf.org/Certified/DWTU/>. To ask about certification of a particular product contact the Consumer Hotline at 800-NSF-MARK (800-673-6275) or e-mail to info@nsf.org, or

write to NSF International, P.O. Box 130140, 789 North Dixboro Road, Ann Arbor, MI 48113-0140. An EPA registration number indicates that the unit is registered with the EPA but does not imply the agency's approval or certification.

How Can Water Well Owners Keep Their Systems Working?

No matter what treatment technology is being used, maintenance will be required to keep the system operating properly. The first step is proper installation. Qualified installers:

- Carry liability insurance for property damage during installation
- Are accessible for service calls
- Accept responsibility for minor adjustments after installation
- Give a valid estimate of the cost of installation

After system installation, the treatment unit will need to be maintained properly. Refer to the system's manual for maintenance details.

All systems should be operated according to the manufacturer's specifications. Treating more water than the system is designed for may lower the effectiveness of the treatment and reduce the quality of water. Water from the treatment units should be tested regularly to ensure proper operation of the system.

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