Water Quality & Waste Management

Volatile Organic Chemicals (VOCs) in Drinking Water

Drinking water containing high concentrations of volatile organic chemicals (VOCs) may be harmful to human health. VOCs are a class of chemicals that have two important properties in common: they evaporate, or vaporize, readily (they are volatile), and they contain carbon (and are therefore called organic). Most VOCs have low solubility in water. When present in water at low concentrations, some VOCs produce a sweet, pleasant odor.

The U.S. Environmental Protection Agency (EPA) estimates that VOCs are present in one-fifth of the nation's water supplies. They can enter ground water from a variety of sources. Benzene, for example, may reach ground water from gasoline or oil that is spilled on the surface of the ground or that leaks from underground fuel storage tanks. Other examples of commonly detected VOCs are dichloromethane (methylene chloride), an industrial solvent; trichloroethylene, used in septic system cleaners; and tetrachloroethylene (perchloroethylene), used in the dry-cleaning industry. Table 1 lists possible sources and potential health effects of 12 VOCs commonly detected in water supplies.

Health Concerns

Volatile organic chemicals can have a variety of harmful health effects. At high levels of exposure, many VOCs can cause central nervous system depression (drowsiness or stupor). All can be irritating if they contact the skin, and they can irritate mucous membranes if inhaled.

The eight VOCs currently regulated by the EPA in public water supplies (systems that serve 25 or more people) are indicated in Table 1. For each chemical, the EPA has established a maximum contaminant level (MCL). Water containing less of a chemical than the maximum contaminant level is considered safe to drink. Drinking water containing one or more VOCs at levels above the maximum contaminant level should not be consumed. In addition, because little is known about the additive effects of these chemicals, special attention should be paid to determining and eliminating VOC sources if two or more of the chemicals are found in the water. In any case, sources of VOC contamination should be eliminated if possible. Primary drinking water regulations for other VOCs may be established in the future.

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Table 1. Drinking Water Standards, Potential Sources, and Human Health Risks of VOCs Found in Water Supplies

VOC[ce]	Standard (ppb)[b]	Potential Sources	Human Health Risks[c]	Cancer Group[d]
Benzene[a]	5	Naturally occurring in gasoline; formerly used as a solvent.	Associated with development of anemia and leukemia.	A
Carbon tetrachloridea[5]		Manufacture of fluorocarbon refrigerants; formerly used as a dry-cleaning solvent.	Causes liver and kidney damage.	82
1,2-dichloroethane[a]	5	Manufacture of vinyl chloride, solvents, and fluorocarbons; formerly used as a solvent.	Potent liver and kidney toxicant.	82
Para-dichlorobenzene[a]	75	Fumigant used to control insects, moths, and mildew.	Causes weakness, dizziness, liver injury.	C
1,1-dichloroethylene" (vinylidene chloride)	7	Manufacture of plastics.	Causes kidney and liver injury.	C
1,1,1-trichloroethane"	200	Solvent, degreaser, ingredient in cosmetics, hair sprays, and aerosol products.	Causes cardiovascular, nervous system, and liver damage in high doses.	D
Trichloroethylene[a]	5	Grease solvent; formerly used as anesthetic in septic cleaners and to decaffeinate coffee.	May cause liver and kidney damage.	B2
Vinyl chloride"	2	Manufacture of polyvinyl chloride (PVC); has minor uses as a solvent and chemical intermediate.	Causes brain, liver, lung, and lymphatic system damage; also bone loss from substantial hand exposure.	A
Chloroform	100	Industrial solvent, extractant, and chemical intermediate; by-product of water chlorination.	Causes liver and kidney damage.	B2
Dichloromethane (methylene chloride)	5	Widely used as a solvent, extraction medium, and paint thinner.	Converted in body to carbon monoxide; weak liver and lung toxicant.	B2
1,2-dichloropropane	5	Agricultural fumigant (discontinued), commercial solvent, and stain remover.	Ingestion and inhalation can cause severe liver damage, kidney failure, and anemia.	B2
Tetrachloroethylene (perchloroethylene)	5	Dry cleaning solvent; used in textile processing.	May cause liver and kidney damage.	B2

[a]This compound is regulated as a VOC by the USEPA in public water supplies. Primary drinking water regulations for other VOCs may be established in the future.

[b]Concentration in parts per billion (ppb) in drinking water established as safe by the USEPA as of December 1992. Drinking water standards are adjusted as new information on the toxic effects of a contaminant become available.

[c]Human health risks associated with VOC exposure occur at levels much higher than maximum contaminant standards set for drinking water. Many of these risks are known because of prolonged, high-level human exposure in industry or as a result of toxicity studies using laboratory animals.

[d]Refers to the USEPA's classification scheme for evaluating a chemical's potential to cause cancer. Group A chemicals are known human carcinogens (cancer-causing agents). Group B chemicals are probable human carcinogens, with chemicals designated B1 posing a more serious threat than those designated B2. Group C chemicals are possible human carcinogens. Group D chemicals are currently unclassified. Group E chemicals are considered to pose no human cancer risk.

Protecting Your Water Supply

The most effective method for preventing VOC contamination is to ensure that these chemicals are not used or discarded near wells or surface water supplies. Protecting your water source is the most effective method of preventing exposure to these chemicals. Be sure that your well is constructed properly and is protected to prevent surface water from moving down the well casing into your drinking water supply. See Cooperative Extension Service publication AG-469, *Your Water Supply: Well Construction and Protection,* or contact your county Cooperative Extension Center or local health department for information on proper well protection.

Public water systems are monitored routinely for contamination. For private water supplies, however, it is the owner's responsibility to have water quality evaluated regularly. If VOCs or other contaminants are found at levels near or above the levels specified in drinking water standards, the source of contamination should be eliminated. Before purchasing property, request in writing that the well water be analyzed to determine its quality. This testing is especially important if the property is a current or former agricultural or industrial site or if buried fuel tanks are located nearby. Costs of VOC testing range from less than $100 to $300 per sample. Cooperative Extension Centers and health departments can provide lists of certified private laboratories.

Treatment Options

Options for those whose water supply is contaminated are to prevent further contamination, locate an alternate water supply, or treat the water to remove contaminants. Identifying and removing the contamination source is the safest and most permanent solution. However, it is not always to possible to identify and eliminate the source.

In some cases, ground water is contaminated to the extent that cleanup may take many years and may be extremely expensive. Alternate water sources include new wells, public water systems, and bottled water. If a new well is constructed, be sure that it is not susceptible to contamination from the same source as the polluted well.

Bottled water can be used as a short-term source of drinking water. Keep in mind, however, that VOCs may also enter the body by absorption through the skin or by inhalation of water vapor. Thus water used for cleaning and bathing can still present a hazard.

Home filter systems can ensure high water quality if properly installed and maintained. Two types of filters may be purchased: those designed for point-of-use treatment, which are located at the faucet, and those for point-of-entry treatment, which are located in the water line entering the home. Point-of-entry systems are recommended to ensure that all water used for drinking, cooking, cleaning, and bathing is free of VOC contamination. A variety of filter systems are available. Before purchasing a system, consult several reputable water treatment companies to ensure that the equipment purchased will treat the specific water quality problem.

Granular activated carbon filters are typically used to reduce VOC levels in home drinking water. The effectiveness of carbon filters is related to (1) the type and amount of the contaminant, (2) the rate of water usage, and (3) the type of carbon used. High contaminant concentrations and high water use rates reduce the carbon's life. Follow the manufacturer's guidelines on how often to replace carbon filters. Water entering and leaving the filter should be tested periodically to ensure that the treatment system is working properly.

Bacteria may grow on the surface of a carbon filter. Water that passes through the filter should therefore be disinfected before it is used. Many types of disinfection systems are available. Systems using ultraviolet (UV) radiation eliminate bacteria problems effectively and efficiently.

Summary

Effective drinking water protection involves protecting the source and testing the water regularly to ensure that it is safe. Eliminating contaminants at their source and protecting wells properly are the most effective methods for maintaining the quality of ground water. If you live in an area where there is potential for organic chemicals to enter your water supply, have it tested periodically for VOCs. If testing indicates contamination, water treatment systems can be used to remove the contaminants. Be sure that any system you purchase for home treatment of VOCs is certified to remove those chemicals found in your water.

Reference: Risk Assessment, Management, and Communication of *Drinking Water Contamination.* Publication EPA/625/4-89/024. Washington, D.C.: U.S. Environmental Protection Agency, Office of Water.

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