SPECIAL FEATURE

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Volatile Organic Chemicals in Drinking Water

When addressing water treatment needs, the average person usually wants to remedy his water of items that cause laundry stains, unpleasant "egg-like" or musty odors and buildup on pipes and fixtures. While the contaminants that cause these problems certainly present legitimate reasons for treatment, it is the "silent" contaminants in our drinking water that cause the most problems with everyday health.

Although great efforts currently are exercised on a daily basis to clean our environment, past carelessness and naivete have created environmental chaos in some areas of the country. In order to determine the areas of most concern regarding hazardous waste, the U.S. Environmental Protection Agency (EPA) has developed a scoring system known as the Hazard Ranking System. Under this scoring system, sites are judged on the likelihood of a substance leaching from the area, toxicity and amount of the substance and the population in the surrounding area that potentially could be affected. If a site ranks a high enough score, the site then is placed on the National Priorities List (NPL), making it eligible for cleanup with the use of federal funds. According to data from the EPA, as of March 2000, there are 1,485 such sites nationwide. New Jersey has the most sites with 130 and Nevada has the least with only one. Although these sites are of the most serious long-term concern, there also are 41,442 sites listed in the Superfund inventory as non-NPL sites as well as sites that have no further remedial action planned (NFRAP sites). Non-NPL sites still may pose environmental and health risks. However, it is believed that they may be addressed with shorter-term cleanups.

A majority of the compounds that are a result of contaminated sites and leaking underground storage tanks are chemicals that are considered volatile organic chemicals (VOCs). Chemicals are called volatile because they rapidly vaporize when they come into contact with air. Many of these items, although they are not highly soluble, still may be transported from a site by water with little effort if they are not stored properly and come into contact with the groundwater. These chemicals typically are generated from petroleum and gasoline products, plastics, paints, solvents, degreasers and other types of industrial chemicals.
Volatile chemicals also may come from the components of a home's distribution system when conditions are aggressive. Sources may include leaching of the plastic piping used in plumbing or from adhesives used in the original construction of the system. Another source of volatile compounds that will not be discussed in detail is from the municipal systems. In the disinfection process utilized by the municipalities, compounds called trihalomethanes are generated when chlorination agents come into contact with naturally occurring organic materials in the source water. The chemicals that are formed are those such as bromoform, chloroform and dibromochloromethane, to name a few.

A volatile compound that recently has been highly publicized and is of growing concern in the environment is methyl-tertiary-butyl-ether (MtBE). The recent publicity, although the chemical is not new, is due to the result of various amounts of the chemical discovered in wells and municipal water sources nationwide. The chemical is so readily dissolved in water that it takes less than a teaspoonful of MtBE to contaminate an Olympic-sized swimming pool. (MtBE is used as an oxygenate in gasoline to reduce air pollution.) Until either another acceptable oxygenate is put into use or until requirements of the Clean Air Act are changed or amended, MtBE will continue to be a problem.

Testing

Some VOCs, because of their nature, will make themselves known by an unpleasant odor at high concentrations in the water. Unfortunately, they do not necessarily have to be present at a high concentration to be considered a health concern. Many VOCs are considered possible carcinogens. Therefore, it is important to determine their existence in the water (even if only in minute quantities) in order to verify the appropriate treatment.

The EPA has established many different methods of analysis for volatiles in drinking water and wastewater. The methods primarily used for the analysis of drinking water and those that will be discussed are known as EPA Method 502.2 and EPA Method 524.2. Generally speaking, 502.2 is performed by the use of gas chromatography and 524.2 is performed by the use of gas chromatography in combination with mass spectrometry. 524.2 is the more advanced and preferred method because of its ability to determine a greater scope of compounds that may be identified. 502.2 does not allow for the differentiation between the ions in the compound. Until recently, many states allowed for the use of either method in the analysis of VOCs. However, many now require that they be run according to 524.2.

The EPA has established Maximum Contaminant Levels (MCLs) or safety levels for approximately 25 VOCs and requires that other unregulated VOCs also be tested for by municipalities on a regular basis. (The MCL is the maximum allowable level for a contaminant in drinking water.) All compounds that are required can be detected using the 524.2 method. Another advantage to this method is the ability to identify "unidentified compounds" that are detected in the scan. In the process of the test, different "peaks" are generated based on the unique mass spectra of each analyte. The location of where the peak is produced can help determine what the compound is with an assuredness that is simply not available by other techniques.

With this superior technology available through certified and accredited laboratories throughout the country, it simply behooves individuals in a known contamination zone to have their household water tested.

Health Issues

Contaminants in drinking water can cause either acute or chronic health effects. Acute effects usually occur immediately after ingestion of a large dose. Common acute affects include nausea, lung irritation, skin rash, vomiting, dizziness and, in extreme cases, death. Normally the levels of contaminants in water are not high enough to cause acute health effects. Typically, the amount of contaminants in water is more likely to cause chronic health effects. Chronic effects occur after exposure to small amounts over long periods of time. Chronic health effects can include cancer, birth defects, organ damage, nervous system disorders and immune system deficiencies.

It is difficult to determine what health effects will be a result of ingesting contaminates in varying amounts. Humans are introducing new chemicals into the environment at such an alarming rate that we are not fully able to evaluate the risks and benefits of each. In many cases, we have come to understand the health effects of some toxic substances the hard way. The effects of mercury became apparent in the 1950s in Japan, when thousands became crippled and some even died from eating mercury-tainted fish. The effects of ingesting lead have become better understood after hundreds of health studies on children exposed to lead. More recently, we are observing the effects of arsenic poisoning in Bangladesh where thousands are consuming arsenic-tainted water. The effects of VOCs are not thoroughly understood at this time because of the lack of information available.

Chemicals that are tested for toxicity require testing on laboratory animals. These tests may not accurately predict how that chemical will affect humans. Periodically, human data from clinical reports and epidemiological studies are available. The relatively short time frames of these studies make it difficult to use the information generated in predicting the health effects related to ingesting small amounts of a chemical over a long period of time. It also must be considered that VOCs can affect health through skin absorption and inhalation of water vapor. When treating water VOCs, it is important to remember to address the water utilized by the entire home.

Carcinogens

Many VOCs are viewed as cancer-causing agents. The EPA has established Agency Guidelines for Carcinogen Risk Assessment that include five classes of carcinogenicity. The first is referred to as Group A, which is considered a human carcinogen, based on sufficient evidence from epidemiological studies. Group B is labeled as a probable carcinogen and is divided into Group B1 and B2. Group B1 is based on limited evidence of carcinogenicity in humans

while Group B2 is based on a combination of sufficient evidence on animals and inadequate data for humans. Group C is listed as a possible human carcinogen with limited data in animal studies and no human data available. Group D is not classifiable based on a lack of animal and human studies. Finally, Group E is designated for evidence of non-carcinogenicity for humans. No evidence of carcinogenicity in at least two adequate animal tests in different species or a combination of both epidemiological and animal studies determines non-carcinogenicity.

Establishing Guidelines

The EPA is responsible for establishing MCLs for potential contaminants in drinking water. Public water suppliers are required to monitor their water quality to ensure they are meeting these safety guidelines. Standards are divided into two categories; primary and secondary. Primary contaminants are known to cause adverse health effects, while secondary contaminants cause aesthetic effects such as odor, taste and staining. The regulated volatiles are considered primary contaminants. Many volatiles do not have MCLs established. However, a presence of an unregulated volatile still is cause for concern and treatment should be considered. A variety of factors are considered when developing primary standards. The contaminant must be known to cause adverse health effects and known to occur in drinking water. Other important factors include the availability of instruments, technological ability to detect the contaminant in the water at an acceptable level and the cost of treatment.

Treatment

When choosing a water treatment system VOC removal, it is important to select a system that has been certified specifically to reduce VOCs. It is recommended to install a "point-of-entry" treatment system to ensure all water used for drinking, cooking, cleaning and bathing is free of volatile contamination. Systems that are certified to remove VOCs are put through a strict set of testing protocols to determine that the unit actually removes volatiles and to what capacity it is capable of removal. Typically, the testing is done according to protocols specified in the ANSI/NSF Standard 53. The National Sanitation Foundation (NSF), Water Quality Association (WQA), Underwriters Laboratories (UL) or any other independent certified laboratory can perform the testing. The manufacturer is able to make claims for removing an extensive list of volatiles by testing using chloroform as a surrogate. Chloroform is used because it is representative of how typical VOCs are removed. However, chloroform is not a surrogate for all volatiles. For example, a claim for MtBE removal must be tested using MtBE. The surrogate testing involves continually spiking the influent water with a known amount of chloroform and then checking the effluent to ensure the filter is effectively removing chloroform. This protocol remains the same for other volatile organic claims. The manufacturers are required to test their units to 200 percent of the capacity they will be claiming to ensure adequate protection for end-users.

Some manufacturers have developed units with performance indicator devices, which will indicate to the users that the unit is not functioning properly. Devices may include a termination of discharge water, sounding alarm or flashing light. If such a device is included in the unit, the manufacturer is required only to test to 120 percent of the claimed capacity provided the performance indication device works properly. Unfortunately, of the hundreds of systems being sold, only a few have been tested for the efficiency of VOC removal by an independent laboratory. Without some type of independent testing, consumers have no way of knowing whether or not the unit is capable of removing volatile compounds and to what capacity.

It is important to maintain a regular maintenance and monitoring schedule for systems that remove VOCs. Regular maintenance usually will include changing a carbon cartridge based on how many gallons are being treated. This is extremely important because once carbon is exhausted it can start to add the volatiles it was removing. Periodically testing the water before and after the filter to ensure proper filter function also is very important.

Some additional useful resources regarding this topic may include the following.

- EPA website: www.epa.gov
- EPA Drinking Water Hotline: 1-800-426-4791
- Environmental Working Group: www.ewg.org

- NSF Website: www.nsf.org
- WQA Website: www.wqa.org

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Marianne R. Metzger and Tami E. Castelli, technical support and account managers with National Testing Laboratories, Ltd. since 1997, service companies such as water treatment equipment manufacturers and dealers, well drillers, contractors, engineers and consultants in the water industry. Metzger has degrees in both environmental geology and political science and Castelli has degrees in both biology and general science studies. Both serve on Water Quality Association committees and have authored numerous articles for industry publications.

For more information on this subject, write in 1014 on the reader service card.