Penn State Extension

Water Facts #30

Reducing Radon in Drinking Water

You can't see, smell or taste radon. It could, however, be a problem in your home. According to the United State's Environmental Protection Agency (EPA) and the Surgeon General, radon is the second leading cause of lung cancer in the United States today. Only smoking causes more lung cancer deaths. And if you smoke and your home has high radon levels your risk of lung cancer is much higher.

Most common radon concerns have focused primarily on airborne radon (radon that comes from soil and rocks surrounding the building foundation); radon in drinking water is not something that is often considered. However, water tests reveal its presence and many homeowners ask, "How can I reduce radon in my water supply?" This fact sheet provides information about radon in drinking water and methods to reduce that source radon in your home.

Sources of Radon

Radon is a naturally occurring, colorless, tasteless, odorless, radioactive gas. It is formed from the decay of radium in soil, rock and water and can be found all over the United States and the world.

The radon in the air in your home generally comes from two sources: the soil or the water supply. From the soil it escapes from the earth's crust through cracks and crevices in bedrock, and either seeps through foundation cracks or poorly sealed areas into basements and homes, or it dissolves in the groundwater that you may use as your water supply. The radon becomes trapped in your home where it can increase to dangerous levels. Radon entering your home's air supply through the soil is typically a much larger risk than the amount of radon entering through a water supply.

Health Effects

Radon can be inhaled from the air or ingested from water. Inhalation of radon increases the chances of lung cancer and this risk is much larger than the risk of stomach cancer from swallowing water with a high radon concentration. Generally, ingested waterborne radon is not a major cause for concern. The extent of the effects and the risk estimates involved are difficult to determine. According to the EPA's 2003 Assessment of Risks from Radon in Homes (EPA 402-R-03-003), radon is estimated to cause about 21,000 lung cancer deaths per year. The National Research Council's report, *Risk Assessment of Radon in Drinking* Water, estimates that radon in drinking water causes about 160 cancer deaths per year due to inhalation and 20 stomach cancer deaths per year due to ingestion.

For more information about removing radon from indoor air, consult the EPA publication *Consumers Guide to Radon Reduction* available online at: *www.epa.gov/radon/pubs/consguid.html*

Radon in Water

Radon in water usually originates in water wells that are drilled into bedrock containing radon gas. These wells could be private water wells or wells that are utilized by a public water supply system. If you have public water and have a concern about radon, contact your water supplier. Radon usually does not occur in significant concentrations in surface waters.

Dissolved radon in groundwater will escape into indoor air during showering, laundering, and dishwashing. Estimates are that indoor air concentrations increase by approximately 1 pCi/L for every 10,000 pCi/L in water. For example, a water well containing 2,000 pCi/L of radon would be expected to contribute 0.2 pCi/L to the indoor air radon concentration. Based on the potential for cancer, the EPA suggests that indoor air should not exceed 4 picocuries per liter (pCi/L).

EPA and various states have recommended drinking water standards for radon in water ranging from 300 to 10,000 pCi/L but no standard currently exists. One study of radon in over 900 Pennsylvania water wells found that 78% exceeded 300 pCi/L, 52% exceeded 1,000 pCi/L and 10% exceeded 5,000 pCi/L.

Detection and Testing

Since most exposure to radon is from air, testing of indoor air is the simplest method to determine the overall risk of radon in your home. Test kits for indoor air radon are inexpensive and readily available at most home supply stores.

Testing for radon in water is also inexpensive (generally $25 to $50) but requires special sampling and laboratory analysis techniques that measure its presence before it escapes from the sample. Test kits are available from various private testing labs. Contact the Pennsylvania Department of Environmental Protection (PA DEP), Radon Division at 800-237-2366 for a list of labs. Carefully follow the lab instructions when collecting your water sample to ensure accurate results.

Radon Treatment

Keep in mind that the presence of waterborne radon indicates that radon is probably also entering the house through the soil into the basement which is generally the predominant source. Therefore, treating the water without reducing other sources of incoming airborne radon probably will not eliminate the radon threat. Therefore, you should also test the air in your home for radon.

Radon must be removed from water before the radon can become airborne. Devices broadly termed “point-of-entry” treatment are installed in order to treat the water as it enters the home. Treatment equipment can be purchased through water treatment dealers or a select few radon mitigation companies. Be sure to thoroughly investigate and check references for the company you choose.

Granular Activated Carbon (GAC)

One method for removing radon from water is a granular activated carbon (GAC) unit. Although these units come in a variety of models, types and sizes, they all follow the same principle for removal (Figure 1). For radon removal, GAC units are constructed of a fiberglass tank containing granular activated carbon—a fine material that traps and holds the radon. Because of the carbon’s fine particle size, it may easily clog with sediments or other contaminants present in the water. Some GAC units come with a special backwashing feature for removing sediment. The backwash feature, however, may eventually reduce the effectiveness of the carbon to remove radon. Elimination of the sediment source or a sediment filter placed ahead of the GAC tank is the best protection against clogging.

Various estimates suggest that GAC should only be used on water supplies with a maximum radon concentration of less than 30,000 pCi/L. After having your water tested, investigate GAC filters that have high removal efficiency rates at the level found in your water. If you do decide to purchase a unit, select a filter size that matches your water use and conditions. According to EPA, a three-cubic-foot unit can handle as much as 250 gallons of water per day and effectively reduce radon levels. Typical water use in the home ranges from 50 to 100 gallons per person per day. Standard GAC treatment systems typically cost about $2,000 including professional installation.

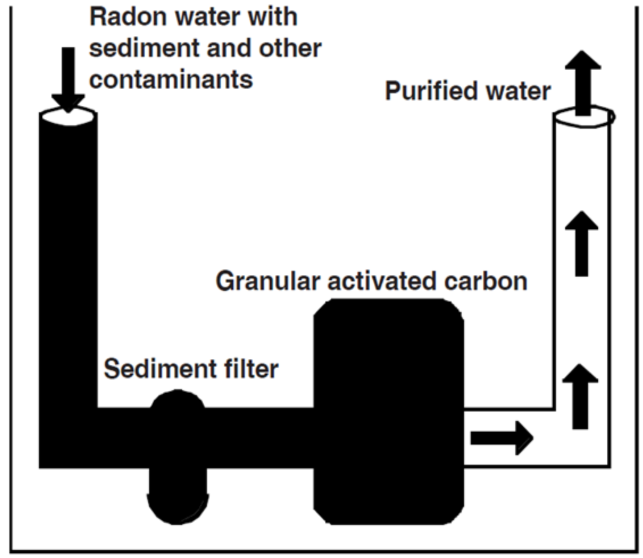

Figure 1: Treatment by activated carbon

A major drawback to the use of GAC filters for radon removal is the eventual buildup of radioactivity within the filter. For this reason, the GAC unit should be placed in an isolated part of the basement to minimize exposure. The carbon may also need to be replaced annually to reduce the hazard of accumulated radioactivity. Spent GAC filters used for radon removal may need special disposal. Contact your local PA DEP office or solid waste authority regarding proper disposal of spent GAC filters.

GAC treatment units are frequently also installed to remove chlorine, pesticides, petroleum products, and various odors in water. In these cases, the GAC filter may unknowingly be accumulating radioactivity as it removes radon from the water. Radon should always be tested for and considered as a potential hazard with the use of GAC filters.

Home Aeration Units

EPA has listed aeration as the best available technology for removing radon from water. Home aeration units physically agitate the water to allow the dissolved radon gas to be collected and vented to the outside. With new technological advancements in home aeration, these units can have radon removal efficiencies of up to 99.9%. Standard aeration treatment units typically cost $3,000 to $5,000 including installation.

When considering installation of aeration units, other water quality issues *must* be taken into account, such as levels of iron, manganese and other contaminants. Water with high levels of these types of contaminants may need to be pre-treated in order to prevent clogging the aeration unit. Disinfection equipment may also be recommended since some aeration units can allow bacterial contamination into the water system.

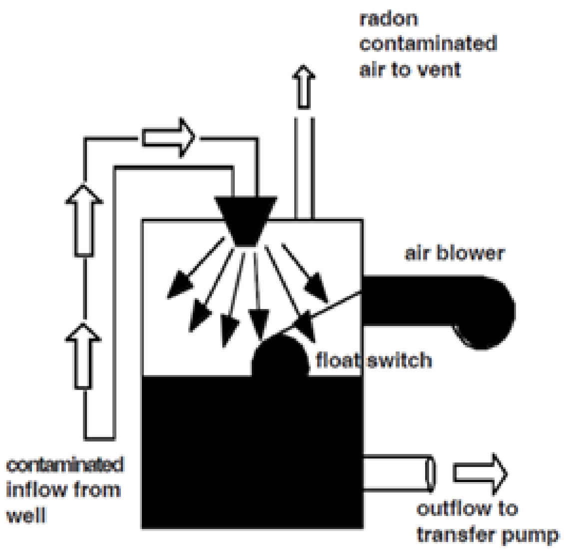

Figure 2: Radon Removal with a home spray aeration system.

There are several styles of aeration treatment units but all work on the same principle of aerating or agitating the water to allow the radon gas to escape so it can be captured and vented. Each type of unit has advantages and disadvantages. One of the more common styles is a spray aeration unit shown in Figure 2. In this case, water containing radon is sprayed into a tank using a nozzle. The increased surface area of the sprayed water droplets causes the radon to come out of the water as a gas while the air blower carries the radon gas to a vent outside the home. About 50% of the radon will be removed in the initial spraying so the water must be sprayed several times to increase removal efficiencies. To keep a supply of treated water, a 100-gallon or larger holding tank must be used.

Another common aeration unit is the packed column where water moves through a thin film of inert packing material in a column. The air blower forces radon contaminated air back through the column to an outdoor vent. If the column is high enough, removal efficiencies can reach 95%.
A final aeration system uses a shallow tray to contact air and water. Water is sprayed into the tray, and then flows over the tray as air is sprayed up through tiny holes in the tray bottom. The system removes more than 99.9% of the radon and vents it outside the home.

Other Radon Resources

United States Environmental Protection Agency (USEPA) web site. 2012. *Proposed Radon in Drinking Water Regulation.* http://water.epa.gov/lawsregs/rulesregs/sdwa/radon/regulations.cfm

United States Environmental Protection Agency (USEPA): Indoor Environments Division. 2012. *A Citizen's Guide to Radon: The Guide to Protecting Yourself and Your Family From Radon.* 16 pp. www.epa.gov/radon/pubs/citguide.html

Pennsylvania Department of Environmental Protection, Bureau of Radiation Protection, Pennsylvania Radon Information Center. 2012. *Pennsylvania Citizen's Guide to Radon: The Guide to Protecting Yourself and Your Family from Radon.* 24 pp. http://www.dep.state.pa.us/brp/Radon_Division/Radon_Publications.htm

National Research Council. 1999. *Risk Assessment of Radon in Drinking Water*. Washington, DC: The National Academies Press. 296 pp. http://books.nap.edu/catalog.php?record_id=6287

More Information

For additional information on all aspects of managing a private water system, contact your local Penn State Extension office or consult the Water Resources Extension web site at *http://extension.psu.edu/water.*

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