Virginia Cooperative Extension
Knowledge for the CommonWealth

Nitrates in Household Water

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Introduction

Nitrate (NO3) is the primary source of nitrogen (N) for plants; it is a nutrient they cannot live without. Nitrate contamination of a water supply occurs when there is more nitrate in the soil than plants can use and when water can move easily through the soil and underlying rock. The excess nitrate is carried through the soil into groundwater supplies by irrigation water, rainwater, and snowmelt. This is most likely to occur when the soil is sandy, or gravelly and/or shallow water tables exist. Excess nitrate can accumulate in the soil from several sources, including fertilizer, manure, and sewage.

Why are nitrates a problem?

High levels of nitrate in household water supplies can be of grave concern, especially to families with infants. Human babies are extremely susceptible to acute nitrate poisoning because of certain bacteria that may live in their digestive system during the first few months of life. These bacteria change nitrate into toxic nitrite (NO2). The nitrite reacts with hemoglobin (which carries oxygen to all parts of the body) to form methemoglobin, which does not carry oxygen. The level of oxygen being carried throughout the body decreases in proportion to the amount of hemoglobin converted to methemoglobin. As the oxygen level decreases, the baby is gradually suffocated. This condition is called methemoglobinemia commonly referred to as "blue baby" disease.

Around the age of three months, as the baby's digestive system develops, stomach acid kills most of the bacteria that convert nitrate to toxic nitrite. By the time a baby is about six months old, its digestive system is fully developed, and none of the nitrate-converting bacteria remain. In older children and adults, nitrate is absorbed and excreted, and methemoglobinemia is no longer a concern.

How much nitrate is dangerous?

Drinking water quality standards have been set by the Federal government to offer the greatest protection to infants. The standard of ten milligrams per liter (mg/1) nitrate-nitrogen (NO3-N) or 45 milligrams nitrate (NO3) has a small margin of safety built into it. Because of this safety factor, some individuals can drink water exceeding the standard and show no adverse effects. However, levels above this standard are considered to be potentially hazardous.

Because nitrate is tasteless and odorless, water must be chemically tested to determine if it is contaminated. If you are on a municipal or public water system, it is the responsibility of the water authority to test and treat the water supply to prevent nitrate contamination. If nitrate contamination occurs in a public water supply, customers may be warned not to feed the water to infants until the problem is corrected. However, if you are on a private or individual water system, it is your responsibility to monitor for nitrate.

How do you test for nitrates?

Water testing for nitrate needs to be done at an independent, certified laboratory. For more information about the location of these laboratories, contact the local Cooperative

Extension office or county or city health department. Contact the laboratory for specific instructions required for collecting a water sample.

Accurately determining the nitrate level in a well can be difficult since nitrate levels vary according to the time of year. For this reason, spring is the best time to test, since snowmelt and rains will leach any excess nitrate into the groundwater. Also, commercial fertilizer usage is generally greatest at this time of year.

When your report comes back from the lab after the water test, the nitrate concentrations can be reported either as nitrate (NO3) or as nitrate-nitrogen (NO3-N). Be sure to know which reporting system is being used since the acceptable concentrations of each are considerably different. If the lab reports its results as nitrate-nitrogen (NO3-N), the drinking water quality standard is 10 milligrams per liter. The standard is 45 milligrams per liter if the results are reported as nitrate (NO3). A milligram per liter (mg/l) is also equal to a part per million (ppm). If you are unsure of how to interpret the report, contact the lab, the local Extension office, or health department. It is important to check the lab report carefully because the two systems of reporting are frequently interchanged.

If your water supply has been tested and the report shows that the water has a high nitrate level, you must immediately stop feeding it to infants. As alternatives to contaminated water, you can plan to breast feed, feed formula prepared with bottled distilled water, or feed premixed infant formula.

How do you prevent nitrate contamination?

Prevention of nitrate contamination of the water supply is critical. Wells need to be isolated from possible sources of contamination and to be protected from surface damage. Abandoned wells need to be sealed to prevent contamination. Sinkholes are direct routes to groundwater and should never be used as garbage dumps. Good nitrogen management is needed when applying fertilizers, both on the farm and in the home yard and garden.

The surest way to deal with a contaminated water supply is to find a new, clean water supply. If you do not have access to a new water supply, the contaminated water can be treated to remove the nitrate.

How can nitrate be reduced or removed from water?

Nitrate is a very soluble substance, easily dissolved in water and extremely hard to remove. Treatment for nitrate is, therefore, very complicated and expensive. However, only water used for drinking and cooking needs to be treated. The three methods of reducing or removing nitrate are: 1) demineralization by distillation or reverse osmosis; 2) ion exchange; and 3) blending.

Demineralization Demineralization removes nitrate and all other minerals from the water. Distillation is one of the most effective types of demineralization. The distilling process has only three steps: 1) the water is boiled; 2) the resulting steam is caught; and 3) the steam is condensed on a cold surface, turning the water back into liquid form. The nitrate and other minerals remain concentrated in the boiling tank.

Reverse osmosis is another way to demineralize water. In a reverse osmosis system, the water is put under pressure and forced through a membrane that filters out minerals and nitrate. Both of these demineralization systems require a lot of energy to operate efficiently. They are also low-yield systems, and storage space for treated water is required.

Ion Exchange The second type of water treatment for nitrate contamination is ion exchange, the same process used for water softening. Most often chloride is exchanged for nitrate. The ion-exchange unit is a tank filled with special resin beads that are charged with chloride. As water containing nitrate flows through the tank, the resin takes up the nitrate and replaces it with chloride. In time, all the chloride will be exchanged for nitrate. The resin can then be recharged by backwashing with a brine solution (sodium chloride) and reused.

Ion-exchange systems can treat large volumes of water. However, in addition to exchanging nitrate, the resin beads will also take up sulfate in exchange for chloride. Therefore, if sulfates are present in the water supply, the capacity of the resin to take up nitrate is reduced. Second, the exchange process may also make the water corrosive. For this reason, the water must go through a neutralizing system after going through the ion-exchange unit. Finally, the backwash brines, which are high in nitrate, must be disposed of properly so they do not recontaminate the groundwater supply.

Blending The third and most common way to reduce nitrates is to dilute the nitrate-polluted water by blending it with water from another source that has low nitrate concentrations. Blending the two waters produces water that is low overall in nitrate concentration. However, blended water is not considered safe enough for infants.

There is no simple way to remove all nitrate from your water. Although it is common to think of boiling, softening, or filtration as a means of purifying water, none of these methods reduce nitrate contamination. Boiling water is, in fact, the worst thing to do because it actually concentrates the nitrate. Softening and filtration do nothing at all to remove nitrate.

For more information on water treatment, contact your local Virginia Cooperative Extension office

Remember that nitrate is an essential nutrient for plant growth. Only when there is too much nitrate in the soil does it become a problem in water. Routine water testing is important to protect the health of families. If nitrate levels in a water supply exceed the present water quality standards, low-nitrate water must be provided for infants to drink. Nitrogen management, the only long-term solution to nitrate contamination, requires consideration of all aspects of nitrogen use. The problem of nitrate contamination is not a simple one, but it must be faced to protect families, animals, and the environment.

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