Nitrates in Drinking Water

You may be concerned about nitrates in drinking water after reading articles in your local newspaper on “blue-baby syndrome” (methemoglobinemia). Or perhaps you’ve just had your water tested and you want to know what the numbers mean.

The facts on nitrates are important to rural well owners all across Pennsylvania. Where do nitrates come from? How much nitrate is too much? What can you do to eliminate this contaminant from your water supply? Read on to find out the answers to these questions.

The Facts On Nitrate

Source

Nitrates are naturally occurring. All rainfall and groundwater aquifers contain some nitrate-nitrogen. However, contaminated rural water supplies provide a clue for discovering other nitrate sources. Nitrate accumulates in agricultural watersheds where farmers spread inorganic fertilizers and animal manures on cropland. Nitrogen not taken up by crops can leach through the soil to groundwater and then flow to recharge areas or private wells. Residents in rural communities typically use on-lot septic systems and some homeowners rely on lawn fertilizers. These too can be sources of nitrate in drinking water.

Health Effects

Health effects of nitrate in drinking water are most significantly linked to methemoglobinemia, also known as “blue-baby syndrome.” Baby formula mixed with nitrate-contaminated water exposes infants to nitrate.

In infants 0-4 months old, the nitrate is converted to nitrite in the infant’s stomach. Nitrite binds to oxygen molecules in red blood cells depleting oxygen and potentially suffocating the baby. An obvious symptom of nitrate poisoning is bluish skin color, especially around the eyes and mouth. If detected at this early stage, methemoglobinemia is rarely fatal, readily diagnosed, and rapidly reversed with clinical treatment. After the age of six months, methemoglobinemia is not a threat since the nitrate converting bacteria are no longer present in the baby’s stomach.

Nitrates in drinking water can also affect certain adults and small children. Pregnant women can pass methemoglobin on to developing fetuses and low birth weights have been attributed to high nitrates in water. However, nursing mothers do not pass nitrites to infants via their milk. Children between the ages of 12 to 14 have shown delayed reactions to light and sound stimuli from drinking water containing greater than 105 mg/l of nitrate. In general, studies by the World Health Organization and the National Academy of Sciences reveal that consumption of nitrates in drinking water does not represent a significant health risk to the adult population.

Standards

To protect infant health, the Environmental Protection Agency (EPA) and the Pennsylvania Department of Environmental Protection (DEP) established standards and limits for nitrates in public water supplies. Supplies should not contain more than 45 mg/l of nitrate or 10 mg/l of nitrate-nitrogen. While private wells do not fall under EPA or DEP jurisdiction, it is advisable that they meet these limits.

Finally, nitrate may be an indicator of other contaminants in your water supply. Other soluble substances like pesticides can be more harmful than nitrate. So if you have discovered nitrate in your water supply, you might consider having water tested for other substances which are potential contaminants in your area.

Solving The Nitrate Problem

To solve the nitrate problem, you can substitute bottled water for drinking and cooking water, eliminate the nitrate source, use an alternate water supply or treat the water before using it.

Bottled Water

You may consider purchasing bottled water for drinking and cooking. For “at risk” family members (infants and pregnant mothers), this is an effective, low cost means of decreasing health risks.

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Consider the Source

In the long term, preventing nitrate contamination at the source is more effective than treating it. So consider the nitrate source. Check your septic system. Is the absorption field properly handling the wastewater? Check your well. Is it properly constructed with casing, grouting and a cover to prevent surface water from entering? Have you constructed adequate diversion ditches to keep runoff from the well? What about the well itself? Is it shallow or deep? Are you located in an agricultural area where your well draws from nitrate-contaminated groundwater? Note that shallow wells and springs are particularly prone to nitrate contamination.

Once you discover the nitrate source, take actions to reduce or eliminate nitrate leaching. For septic system failures, this may mean having the tank pumped or replacing a drainage field. For well contamination, you may correct the problem simply by diverting surface water away from the well. Also insure that the well casing extends at least a foot above ground and has a suitable cap. If your well is too shallow, developing a new well that drains water from a less contaminated aquifer may be the only answer.

With agricultural nitrate leaching, often you may have no control of the nitrate source. But you still have another option before turning to treatment equipment. You might consider mixing high and low nitrate water. Although this reduces the total mixed nitrate concentration, note that blended water still may not be safe for infants.

Treatment for Nitrate

Once a water supply becomes contaminated with nitrate, it is costly to treat. While treatment to meet drinking water needs is practical, treatment of larger quantities like livestock supplies is costly. Ion exchange units, reverse osmosis, or distillation all remove nitrate from drinking water. Note that boiling water does not remove nitrates and is not a treatment alternative. In fact, it increases nitrate concentrations as water evaporates.

An **ion exchange unit** operates much like a household water softener. A softener filters calcium and magnesium laden water through a resin coated with sodium ions. As water flows through the unit, the resin releases its sodium ions and readily trades them for the calcium and magnesium. For nitrate removal, the resin exchanges chloride ions for nitrate and sulfate ions in the water. After treating many gallons of water, the resin will “run out” of chloride. Regenerating the resin with a concentrated solution of sodium chloride (you can use bicarbonate instead of chloride) recharges it for further treatment. Figure 1 shows how the ion exchange process works.

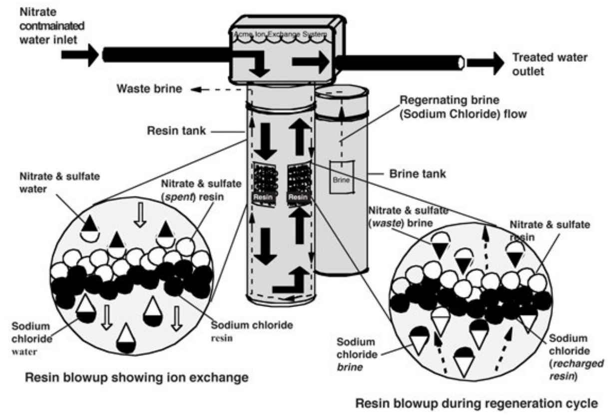

Figure 1. An ion exchange unit showing nitrate removal. The blowup on the right shows what happens during regeneration.

Ion exchange does have drawbacks. Because the resin prefers to absorb sulfate, water high in sulfates hinders the nitrate exchange and reduces system effectiveness. If the resin becomes saturated, it releases the nitrates in place of sulfates, resulting in an increased nitrate concentration in the “treated” water. Also, nitrate ion exchange can make the water corrosive. Neutralizing the water after it leaves the unit reduces this effect. Finally, ion exchange can be expensive and requires maintenance. Since the backwash brine will be high in nitrates, care must be given to its disposal.

Reverse osmosis is another treatment mechanism. Figure 2 shows the reverse osmosis process. As water enters the unit under pressure, it pushes against a cellophane-like plastic sheet or cellulose—also called a semipermeable membrane. The membrane acts like a sieve, leaving ions like nitrates on one side and allowing ion-free water to pass through the membrane. How well the membrane filters the water is measured by the rejection rate. That is, how much nitrate will the membrane reject? Estimates are around 83 to 92 percent of the incoming nitrate. Naturally, knowing the original nitrate concentration in the water is important. If nitrate-nitrogen levels are extremely high (greater than 110 mg/l) up to 90 percent may be removed. Unfortunately, remaining nitrate-nitrogen may still result in drinking water that exceeds the standards of 10 mg/l nitrate-nitrogen.

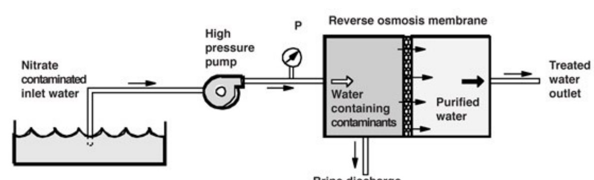

Figure 2. A schematic of the reverse osmosis process.

Reverse osmosis requires a sediment filter, storage tanks, a membrane, and an activated carbon filter. Units usually operate at the point of use—kitchen tap, bathroom sink, etc. Many factors like water pressure and temperature, membrane selection, and proper maintenance influence performance. Carefully review these factors with a water specialist before making purchasing decisions.

While reverse osmosis can be an effective nitrate remover, it has disadvantages. Reverse osmosis is expensive. Added to the equipment costs are the high energy costs for operation. Reverse osmosis is also a slow inefficient process, sometimes producing only a few gallons a day of purified water, while wasting up to 90 percent of the incoming water. This is especially true for low pressure systems.

Distillation is a traditional method for removing minerals and other components from water. Water is boiled, cooled and condensed. The condensed water is then free of solids, salts, heavy metals—anything that won't volatilize. Boiling the water also inactivates microorganisms.

Distillers also have limitations. Like reverse osmosis, distillation is a slow process. A typical home unit produces about a gallon of water every four to five hours. Distillation uses much energy and produces heat which taxes air conditioners in the summer months. Energy costs are about 30 cents per gallon produced. Ultimately, these units require frequent cleaning to remove accumulated scales.

Recognizing these facts about nitrates in your drinking water can help you make wise decisions about the quality of your water. Though nitrates concern many Pennsylvania residents, proper testing will confirm the problem and adequate treatment will eliminate it.

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Penn State College of Agricultural Sciences research and extension programs are funded in part by Pennsylvania counties, the Commonwealth of Pennsylvania, and the U.S. Department of Agriculture.

Code: F136