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FS 604

Nitrates in South Dakota Drinking Water



Cooperative Extension Service
South Dakota State University
U.S. Department of Agriculture

Nitrates in South Dakota Drinking Water

By

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South Dakota citizens are becoming increasingly aware of and concerned with nitrate in household drinking water. Also, concern is expressed about the danger to livestock from the use of high nitrate water. *This publication deals with the nitrate problem as it pertains to drinking water used for human consumption.* A companion publication, Fact Sheet Number 603 "Nitrates in Livestock Waters," deals with nitrates in livestock water.

Laboratories frequently report the nitrate content of water in various expressions of measurement. Since this is often confusing, this publication attempts to define and equate these measurement expressions. The scope and sources of the nitrate problem are discussed and toxicity levels given. Proper sample taking techniques are explained and control actions recommended.

Laboratory Expressions Clarified

The *presence* of nitrates in water is usually expressed in two ways: nitrate-nitrogen ($\text{NO}_3\text{-N}$) or nitrate (NO_3).

The *quantity* present may be expressed in either

parts per million (p.p.m.) or in milligrams per liter (mg/l).

The conversion numbers for these expressions are:

1. To change nitrate-nitrogen ($\text{NO}_3\text{-N}$) to nitrate (NO_3), multiply by 4.43.
2. To change nitrates (NO_3) to nitrate-nitrogen ($\text{NO}_3\text{-N}$), multiply by 0.23.
3. Parts per million (p.p.m.) and milligrams per liter (mg/l) are both used when reporting laboratory results. For practical purposes 1 p.p.m. = 1 mg/l. One p.p.m. may be expressed in terms of one pound per million pounds of water, one drop per million drops of water, or similar common measurements.

The terms nitrite-nitrogen ($\text{NO}_2\text{-N}$) and nitrites (NO_2) are sometimes referred to in literature, but are seldom used in laboratory reports. Nitrites are much more harmful than nitrates, but only small amounts are ever found in the water itself. The changing of nitrates to nitrites in the digestive tract is what causes the health hazard and will be explained later. When using the conversion numbers above do not confuse nitrates with nitrites.

Maximum Limits

Before stating the permissible levels of nitrates in drinking water as recommended by the 1962 U. S. Public Health Service Drinking Water Standards, a brief discussion of how nitrates poison may be helpful.

Nitrates as such, are not very harmful; however, when they are acted on by microorganisms in the digestive tract, they tend to change from the nitrate form to the nitrite form and become much more toxic. They are toxic because after being absorbed into the blood they make the hemoglobin, or red oxygen-carrying blood pigment, incapable of carrying oxygen and symptoms of asphyxiation (lack of oxygen) appear. The change in the blood is described as a change from hemoglobin to methemoglobin. This term is the origin of the condition called methemoglobinemia, commonly referred to as "blue babies" when it occurs in infants.

The body blood does not give up the struggle easily, however, because the blood also contains an enzyme capable of changing the blood back to hemoglobin. However, infants seem to be less capable of making this reversal of the blood condition. Therefore there is a lower toxicity level for infants.

The Public Health

Nitrates above the level listed on the next page are considered to be of health significance; amounts above 10 p.p.m. as nitrate-nitrogen have caused methemoglobinemia which can cause death of an infant under 6 months of age. Nitrate levels above 115 p.p.m. nitrate-nitrogen have caused irritation of the mucous linings of the gastrointestinal tract and bladder, with symptoms of diarrhea and diuresis in adults. The values given above allow for a reasonable margin of safety.

Maximum Limits

Persons affected	Expressed as Nitrate Nitrogen (NO ₃ -N)	Expressed as Nitrates (NO ₃)
For infants under 6 months of age	10 p.p.m.	45 p.p.m.
For older children and adults	115 p.p.m.	500 p.p.m.

Scope of the Nitrate Problem

There were 1,949 private water samples from farms, ranches, and rural homes tested for nitrate-nitrogen during calendar year 1972 by the South Dakota Department of Health Laboratory. Of these samples, 259 (13.3%) contained nitrate-nitrogen above 10 p.p.m. and 34 (1.7%) contained nitrate-nitrogen above 115 p.p.m. All samples submitted for bacteriological analysis from private water supplies are tested for nitrate-nitrogen. All reports from the State Department of Health Laboratory are in terms of nitrate-nitrogen.

The table summarizing water supply samples from private sources illustrates the extent of the nitrate-nitrogen problem by counties.

Source of Nitrate Contamination

Nitrates occur in the soil, animal excreta, crop residues, human wastes, some industrial wastes and nitrogen fertilizers. All are possible sources of nitrate contamination of both surface and groundwaters. Nitrates are soluble and will move with water.

Groundwater is the dominant source of drinking water in South Dakota. Its protection from contamination is, therefore, very important. Protection of water supplies by proper construction and location of wells as shown on pages 11 through 13 in Extension Circular 671, "Safe Rural Water Supplies," is an important first step. Sealing of abandoned wells is also important, since the groundwater does move, although quite slowly in most cases.

Shallow wells are more likely to contain nitrates

than deep wells, since they are more susceptible to the effects of leaching, especially in sandy or light soils. Having a deep well, however, is no guarantee against

Summary of water supply samples from private sources tested by the South Dakota Department of Health between January 1, 1971 and August 18, 1972 that were higher than 10 p.p.m. of nitrate-nitrogen.

Counties	parts per million			
	10-50	51-114	115-450	450+
Beadle	1	1		
Brookings	11	9	3	1
Brown	4	3	1	
Charles Mix	1			
Clay		1		
Clark	3	3		
Codington	24	8	8	
Corson	1			
Custer	3			
Davison			1	
Day	7	3	1	
Deuel	8	6		
Dewey	2			
Edmunds		1	1	
Fall River	1			
Grant	2	3	2	
Gregory	16	5		
Haakon		1		
Hamlin	8	1	2	
Hand		1		
Hanson	2	1	1	
Harding	2			
Hughes	3	3		1
Jerauld	3	1		
Kingsbury			2	
Lake			2	
Lincoln	3	2	1	
Marshall	3			
McPherson	6	2	1	1
Meade	2			
Mellette	2			
Minnchaha	8			
Moody	4		1	
Pennington	2			
Perkins			1	
Potter		2		
Roberts	4	1		
Spink	2			
Sully		1		
Tripp	4	3	1	
Union	4			
Walworth	4	1	2	
Yankton	1	1		
Totals	151	64	31	3

entrance of contamination from surface sources, if the well is not properly constructed. If a properly constructed deep well does contain nitrates, the source of contamination may be a considerable distance away and therefore difficult or impossible to locate.

Surface waters used for drinking purposes are also susceptible to nitrate contamination, although locating the source is usually easier since water and possible nitrate sources can be seen quite easily.

Some ponds are used as a drinking water source in South Dakota. Their location is very important. Page 19 of Extension Circular 671 discusses pond location.

Water Testing and Sample Taking

Water samples for nitrate-nitrogen analysis should be collected in special bacteriological sample bottles obtained from the State Department of Health Laboratory in Pierre. Special sampling procedures are not necessary for nitrate samples; however, when testing for nitrate, bacteriological testing should also be done. The two forms of contamination are somewhat related and are often found together, although it is not unusual to have bacteriologically *safe* water and water with nitrate-nitrogen above 10 p.p.m., or bacteriologically *unsafe* water with *no nitrate-nitrogen*.

A bacteriological water sample should be collected from a single, cold hard water faucet and the faucet flamed with a propane torch prior to sampling. The water should also be permitted to run for about 5 minutes to assure that a fresh sample of water from the well is being collected.

Nitrate levels have been known to fluctuate, depending upon local conditions. When nitrate-nitrogen levels are above the recommended limits, additional sampling should be conducted at 2-month intervals before changing water supplies. Additional sampling is especially important when nitrate-nitrogen levels are above 115 p.p.m. Drinking water should be obtained from another source during this test period.

Recommended Control Actions

The level of nitrate in a water supply can be reduced by certain ion exchange resins, electro dialysis or reverse osmosis processes. The higher cost of reducing the nitrates must be weighed against the availability of another source of water, cost of hauling and amount needed. *Filtering does not remove nitrates. Allowing the water to stand does not remove them. Boiling makes the situation even worse since nitrates are not destroyed, part of the water passes off as steam and the net result is more p.p.m. of nitrates than before boiling.*

While chlorination is highly effective in removing bacteriological contamination from water, it is not effective in removing nitrates. See Fact Sheet 603, "Nitrates in Livestock Water" for further discussion.

Other alternatives to reducing nitrate-nitrogen are:

1. Locate the source of contamination and try to remove it. Adequate sealing of the well or establishing good drainage away from the well may solve the problem in the case of groundwater. Effectiveness of this procedure will depend upon the amount of nitrate-nitrogen contamination present. Controlling drainage into ponds is usually effective.

2. If the source cannot be located or controlled, establishment of a new water source is recommended. Seeking groundwater from a deeper source is often effective. Be sure the new well is properly sealed and located.

If Analysis Shows High Nitrates

1. Do not panic.
2. Arrange for drinking water from another source while you investigate your situation.
3. Have additional samples analyzed as recommended here.
4. Try to locate the source or cause of contamination and remove it.
5. If high analysis persists, weigh the cost of nitrate removal against the cost of establishing a new source.
6. Take appropriate action.

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