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NEW YORK STATE
- HUMAN HEALTH FACT SHEET -

Ambient Water Quality Value for Protection of Sources of Potable Water

SUBSTANCE: Nitrate, expressed as nitrogen

CAS REGISTRY NUMBER: 14797-55-8

AMBIENT WATER QUALITY VALUE: 10 milligrams/liter (10 mg/L) (nitrate, expressed as nitrogen)

BASIS: Specific MCL and Nononcogenic Effects

INTRODUCTION

Nitrate and nitrite are naturally occurring inorganic ions which make up part of the nitrogen cycle (US EPA, 1985, 1989). Nitrate is more stable than nitrite, and most nitrogen-containing compounds in natural waters, including nitrite, tend to be converted to nitrate. Thus, nitrite levels in water are generally negligible (NAS, 1981). However, the human toxicity of nitrate is due primarily to the reduction of ingested nitrate to nitrite. The nitrite reacts with hemoglobin to form methemoglobin, which does not transport oxygen to the tissues. This leads to cell, tissue, and organ damage due to lack of oxygen. Because nitrate is converted to nitrite the toxicity of nitrate and nitrite may be additive. Consequently, the toxicity of each ion and the combined toxicity of both ions are generally assessed. For this fact sheet, the physical, chemical, and toxicological properties of nitrate have been reviewed (NAS, 1981; US EPA, 1979a,b, 1985, 1989, 1991). The following ambient water quality values were derived using these and other references and the procedures outlined in 6 NYCRR 702.2 through 702.7. Water quality values for nitrite and for nitrate/nitrite combined are derived in separate fact sheets.

SPECIFIC MCL AND PRINCIPAL ORGANIC CONTAMINANT CLASS (702.3)

Nitrate has a Specific MCL of 10 mg/L (nitrate, expressed as nitrogen) as defined in 6 NYCRR 700.1. This is a maximum contaminant level for drinking water established by the New York State Department of Health under the State Sanitary Code (10 NYCRR Part 5, Public Water Systems). Therefore, a water quality value of 10 mg/L (the Specific MCL) can be derived based on 6 NYCRR 702.3(a). Nitrate is not in a principal organic contaminant class as defined in 6 NYCRR 700.1.

ONCOGENIC EFFECTS (702.4)

Oncogenic effects were not observed in limited long-term studies with mice exposed to dietary doses of nitrates (NAS, 1981). Treated-related tumor incidences were increased in rats given oral doses of sodium nitrite and secondary amines, but were not increased in rats given sodium nitrite alone. The increased incidence of tumors in rats dosed with both compounds was attributed to the endogenous formation of N-nitrosoamines, which are known carcinogens. Epidemiological studies of persons exposed to elevated levels of nitrate or nitrite in food, water or workplace air provide equivocal evidence for an association between exposure and increased incidences of gastric or pulmonary tumors. Although these data raise concerns, they are inadequate to evaluate the oncogenic potential of nitrate or nitrite (NAS, 1981; US EPA, 1991).

NON-ONCOGENIC EFFECTS (702.5)

Ingested nitrate is converted to nitrite, which is acutely toxic and causes methemoglobinemia (an elevated blood level of methemoglobin), cyanosis, and vascular collapse in infants (US EPA, 1987a,b; Walton, 1951). The effects are rapidly reversible and are not cumulative. Walton (1951) classified the reported cases of nitrate-induced infant methemoglobinemia according to the the nitrate level in the drinking water used to make the infant's formula. Among the 214 cases where the drinking-water level was measured, none occurred in infants consuming water containing 10 mg/L (nitrate, expressed as nitrogen) or less. There were five cases among infants exposed to water containing levels from 11 to 20 mg/L; 36 cases in infants exposed to levels from 21 to 50 mg/L; and 173 cases in infants exposed to 50 mg/L or more. Additional studies support these results (US EPA, 1987a,b, 1994a). Thus, 10 mg/L (nitrate, expressed as nitrogen) is a no-observed-effect level for methemoglobinemia in infants fed water-based formula.

Infants up to 3 months old are the most sensitive subpopulation to methemoglobin formation; their intestinal tract contains high levels of bacteria that are able to reduce 100% of ingested nitrate to nitrite (adults and older children only reduce about 10%), their enzymatic capacity to change methemoglobin back to hemoglobin is limited and they have fetal hemoglobin, which is more susceptible to methemoglobin formation than mature hemoglobin (US EPA, 1994a). Additionally, the studies on infant methemoglobinemia had a large number of

subjects and since the national drinking water standard of 10 mg/L (nitrate, expressed as nitrogen) was enacted in 1975, there have been no reported cases of methemoglobinemia associated with public drinking-water supplies. Therefore, an uncertainty factor for variation among humans is unnecessary. Because the infants in the Walton study obtained 100% of their food (and nitrates) from water-based formula, the relative contribution of water to total nitrate intake is 100%. Given the above, a reference dose (expressed as a concentration) that is protective of formula-fed infants, older children and adults is 10 mg/L (nitrate, expressed as nitrogen).

The corresponding reference dose (expressed per unit body weight per day) at the nitrate concentration of 10 mg/L (nitrate, expressed as nitrogen) is 1.6 milligrams per kilogram per day (1.6 mg/kg/day) (nitrate, expressed as nitrogen), based on the the assumptions that 4-kg infants consume 0.64 L of water (as formula) per day (US EPA, 1994a). Using these exposure factors to derive an ambient water quality value based on acute toxic effects (such as methemoglobinemia) is permitted under 6 NYCRR 702.5(d) and yields a value of 10 mg/L (nitrate, expressed as nitrogen) when 100% of the reference dose is allocated to drinking water.

CHEMICAL CORRELATION (702.7)

A value based on chemical correlation was not derived because there were sufficient data to derive a value based on non-oncogenic effects (6 NYCRR 702.5).

OTHER STANDARDS AND GUIDELINES

Under the Safe Drinking Water Act, the federal maximum contaminant level goal (MCLG) and the maximum contaminant level (MCL) for nitrate are both 10 mg/L (nitrate, expressed as nitrogen) (US EPA, 1991). Under New York State Department of Health regulations on drinking-water standards (10 NYCRR Part 5), the Specific MCL for nitrate is also 10 mg/L (nitrate, expressed as nitrogen). The World Health Organization's recommended guideline for nitrate in drinking water is 50 mg/L (as nitrate), which is approximately equal to 10 mg/L (nitrate, expressed as nitrogen) (WHO, 1993).

SELECTION OF VALUE

According to 6 NYCRR 702.2(b), the selected ambient water quality value shall be the most stringent of the values derived using the procedures found in 6 NCYRR 702.3 through 702.7. This value is 10 mg/L (nitrate, expressed as nitrogen) (based on a Specific MCL and acute, nononcogenic effects) and is the value selected as the water quality value for nitrate.

REFERENCES

NAS (National Academy of Sciences). 1981. The Health Effects of Nitrate, Nitrite, and N-Nitroso Compounds. Washington, DC: National Academy Press.

6 NYCRR (New York State Codes, Rules and Regulations). Water Quality Regulations, Surface Water and Groundwater Classifications and Standards: Title 6 NYCRR, Chapter X, Parts 700 - 705. Albany, NY: New York State Department of Environmental Conservation.

10 NYCRR (New York State Codes, Rules and Regulations). Public Water Systems: Title 10 NYCRR, Chapter 1, State Sanitary Code, Subpart 5-1. Albany, NY: New York State Department of Health, Bureau of Public Water Supply Protection.

U.S. EPA (U.S. Environmental Protection Agency). 1985. National Primary Drinking Water Regulations; Proposed Rule. Fed. Register. 50:46936-47022.

U.S. EPA (U.S. Environmental Protection Agency). 1987a. Final Draft for the Drinking Water Criteria Document on Nitrate/Nitrite. Washington, DC: Office of Drinking Water.

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U.S. EPA (U.S. Environmental Protection Agency). 1991. National Primary Drinking Water Regulations; Final Rule. Fed. Register. 56:3526-3597.

U.S. EPA (U.S. Environmental Protection Agency). 1994a. Nitrate. On-Line as of December 1. Integrated Risk Information System (IRIS). Cincinnati, OH: Office of Research and Development, Environmental Criteria and Assessment Office.

U.S. EPA (U.S. Environmental Protection Agency). 1994b. Nitrite. On-Line as of December 1. Integrated Risk Information System (IRIS). Cincinnati, OH: Office of Research and Development, Environmental Criteria and Assessment Office.

Walton, G. 1951. Survey of literature relating to infant methemoglobinemia due to nitrate-contaminated water. Am. J. Public Health. 41:986-996.

WHO (World Health Organization). 1993. Guidelines for Drinking-Water Quality, 2nd edit., vol. 1: Recommendations. Geneva: World Health Organization.

SEARCH STRATEGY: ON-LINE TOXICOLOGIC DATABASE

Medline CD ROM (1984 to November, 1993) was searched linking nitrate with the keywords "adverse effects," "toxicity," and "neoplasms."

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