Nitrate Reduction

Nitrate (NO_3^-) and nitrite (NO_2^-) are compounds that are naturally formed when nitrogen (N) combines with oxygen (O). Nitrate is used mainly in inorganic fertilizers, but is also used as an oxidizing agent, in the production of explosives and for glass making. Nitrates also naturally occur in plants as a key nutrient. Nitrates and nitrites are frequently added to processed meats as a food preservative. They are also formed endogenously in mammals, including humans. Nitrate is secreted in saliva and then converted to nitrite by oral microflora.

Nitrogen is essential for all living things—human bodies need nitrates to some extent, as they prevent the growth of bacteria—but excessive consumption may lead to serious health complications. Ingesting excessive nitrates in drinking water may lead to "blue baby syndrome", a condition some babies are born with, causing the overall skin color to have a blue or purple tinge. The nitrates bind to hemoglobin (the compound which carries oxygen in blood to tissues in the body), and results in chemically-altered hemoglobin (methemoglobin) that impairs oxygen delivery to tissues, resulting in the blue color of the skin and may lead to brain damage, coma or even death. In adults, the inability to carry oxygen through the blood may cause dizziness, headaches, irritability and blue tones to the skin. Some studies have also suggested that higher levels of nitrates or nitrites may lead to increased incidence of cancer in adults and increased incidence of brain tumors, leukemia and nasopharyngeal (nose and throat) tumors in children.

Due to health considerations, the maximum contaminant limit for nitrate in drinking water has been set at 10 mg/L nitrate as nitrogen (44.3 mg/L as NO_3) in the United States and Canada. A similar guideline of 50 mg/L as NO_3 has been set by the World Health Organization (2011), while the European Community (EC) standards allow a maximum admissible concentration of 50 mg/L as NO_3 and a guide level of 25 mg/L as NO_3.

The nitrate concentration in surface water is normally low (0-18 mg/L) but can reach high levels (several hundred mg/L) due to agricultural runoff, the use of pesticides or contamination from wastewater sources. Most nitrate contamination is a result of intensive agricultural processes and the use of nitrogen-containing fertilizers (containing nitrate as well as ammonia, ammonium, urea and amines). After fertilization, crops take up a relatively small portion of nitrogen (approximately 25-30%) and the residual nitrogen compounds end up in the groundwater and surface water. This groundwater or surface water is then treated to become drinking water with acceptable nitrate concentration levels.

NITRATE REDUCTION BY REVERSE OSMOSIS

United States Environmental Protection Agency (U.S. EPA, 2010) lists reverse osmosis (RO) as an accepted potable water treatment method for nitrate removal. RO membrane elements may be used to simultaneously desalinate (reject dissolved ions) and remove many other contaminants including particulates and organic constituents. Estimated rejection rates for sodium nitrate ($NaNO_3$) can be as high as 93-98%, respectively.

MICRODYN-NADIR offers a wide range of RO elements that have been successfully used in drinking water systems. For more information, please refer to Drinking Water.

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