NSF/ANSI Standard
for Drinking Water Additives —

Drinking water treatment chemicals — Health effects

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6 Disinfection and oxidation chemicals

6.1 Coverage

This section covers products used in drinking water disinfection and oxidation processes. It is not intended to include ambient air.

6.2 Definitions

6.2.1 disinfection: The process of destruction, inactivation, or rendering harmless of certain microorganisms, usually vegetative forms of pathogenic bacteria, viruses and protozoa.

6.2.2 low-bromate hypochlorite: A hypochlorite product contributing a bromate residual in the finished drinking water of less than or equal to ~~0.001~~ 0.003 mg/L at its maximum use level. The maximum use level for a low-bromate hypochlorite will be based on 10 mg Cl_2/L and may not be adjusted to meet the low-bromate SPAC of 0.003 mg/L.

Reason: The current level of 0.001 mg/L is too low to provide an effective alternative for evaluation of hypochlorites with lower bromate concentrations. Changing this level is intended to not only allow evaluation to a more achievable criteria now, but being consistent with the bromate SPAC reduction proposed to take effect on January 1, 2013, it will assist with transition to the new criteria. In addition, the low-bromate designation will be restricted to products that can meet the SPAC of 0.003 mg/L when dosed at 10 mg/L Cl_2/L. Adjustments to MULs will not be allowed to obtain the low-bromate status.

6.2.3 oxidation: The process through which a substance combines with oxygen. The conversion of organic or inorganic materials by loss of electrons.

6.3 General requirements

6.3.1 General information about the products covered in this section is summarized in table 6.1.

6.3.2 Hypochlorite treatment chemicals

Bromate is a known contaminant of the hypochlorite chemical production process. Based on the limited number of sources of bromate in drinking water (ozonation is another known source), the SPAC for

bromate has been determined to be 0.005 mg/L, 50% of the US EPA MCL of 0.010 mg/L. All hypochlorite treatment chemicals shall meet the bromate SPAC of 0.005 mg/L.

NOTE – Revisions to bromate requirements of this section have been made and are located in Annex G of this Standard. Please refer to that annex for additional details. The revisions contained in Annex G are informational at this time and are scheduled to be incorporated into this section January 1, 2013.

Reason: Refer to Annex G (attached) for additional details.

6.3.2.1 General

Bromate is a known impurity of the hypochlorite chemical production process. Because of the potential cancer risk associated with human exposure to bromate, it is recommended that production or introduction of bromate into drinking water be limited. The two major sources of bromate in drinking water are ozonation of water containing bromide and use of hypochlorite treatment chemicals containing bromate (sodium and calcium hypochlorites). All hypochlorite treatment chemicals shall meet the bromate Single Product Acceptable Concentration (SPAC) of 0.005 mg/L.~~10~~

Hypochlorite treatment chemicals that meet the requirements of this Standard, but that do not meet the definition of a low-bromate hypochlorite (see 6.2.2) shall include the following statement in manufacturer's product literature that references this Standard:

The maximum use level for hypochlorite products is based on 10 mg Cl_2/L. However, in certain circumstances a hypochlorite product may only meet the bromate SPAC of 5 ug/L if the maximum use level is lowered to a concentration of less than 10 mg Cl_2/L. In these instances, the following statement shall be included on the product packaging and/or bill of lading:

> "This product has been restricted to a maximum use level (MUL) that is less than 10 mg Cl_2/L, the typical use level for hypochlorite products under NSF/ANSI Standard 60."

Although the maximum use level may be less than 10 mg Cl_2/L, it shall not be less than 2 mg Cl_2/L.

6.3.2.2 Low-bromate hypochlorite treatment chemicals

All low-bromate hypochlorite treatment chemicals shall not exceed ~~10~~ 30% of the bromate MCL, or ~~0.001~~ 0.003 mg/L. The manufacturer's use instructions that reference this Standard for hypochlorite products evaluated as low-bromate shall include the following statement:

> "Based on testing to the requirements of NSF/ANSI 60, use of this product at a dose of [maximum use level] or less is expected to contribute a bromate residual of ~~0.001~~ 0.003 mg/L or less to the finished drinking water."

> NOTE – This statement is intended to provide guidance to water utilities using ozonation who wish to minimize additional bromate residuals in the treated drinking water.

(Page footnote)

~~10 Beginning January 2004, the Single Product Acceptable Concentration (SPAC) for bromate will be lowered to 0.003 mg/L, unless it is demonstrated to the Joint Committee on Drinking Water Additives by the manufacturers of hypochlorite treatment chemicals that the drinking water industry demand for hypochlorite chemicals cannot be adequately met unless the SPAC remains at 0.005 mg/L. Please reference the Foreword of the Standard for additional information on the bromate SPAC.~~

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(Footnote in Table D1 – U.S. Environmental Protection Agency and Health Canada, NSF/ANSI 60 drinking water criteria)

[4] ~~The Joint Committee on Drinking Water Treatment Chemicals is considering the lowering of the Single Product Acceptable Concentration (SPAC) for bromate to 0.003 mg/L, unless it is demonstrated to the Joint Committee on Drinking Water Treatment Chemicals by the manufacturers of hypochlorite treatment chemicals that the drinking water industry demand for hypochlorite chemicals cannot be adequately met while the SPAC remains above 0.005 mg/L. Please note that this change is still under evaluation by the NSF Joint Committee on Drinking Water Treatment Chemicals. At this time, it has not been demonstrated that the drinking water industry demand for hypochlorite chemicals cannot be adequately met at the lower SPAC. The next revision of this standard will be made up to date with the decision of the Joint Committee.~~Revisions to bromate requirements of this section have been made and are located in Annex G of this Standard. Please refer to that annex for additional details. The revisions contained in Annex G are informational at this time and are scheduled to be incorporated into this section January 1, 2013.

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Annex G[1]

(informative)

Revisions to the evaluation of bromate

G.1 Background

Bromate is a known impurity of the hypochlorite chemical production process. Because of the potential cancer risk associated with human exposure to bromate, its introduction into drinking water has been regulated by the USEPA and Health Canada. The two major sources of bromate in drinking water are ozonation of water containing bromide and use of hypochlorite treatment chemicals containing bromate (sodium and calcium hypochlorites).

Bromate was first noted as a contaminant in hypochlorite to the Drinking Water Additives Joint Committee in 2000. At that time, the Chlorine Institute and the Chlorine Chemistry Council (now the Chlorine Chemistry Division of ACC), on behalf of hypochlorite manufacturers, presented the current capability of the industry to produce low-bromate hypochlorite products and reported that adding bromate as a required analysis against the Single Product Allowable Concentration (SPAC) of 0.001 mg/L in effect at the time would result in significantly fewer certified hypochlorite products.

The SPAC of 0.001 mg/L in effect at the time was based on the US EPA MCL of 0.010 mg/L bromate divided by the default source contribution factor in the standard of 10. Using the data-driven source contribution approach enabled in Annex A and accounting for up to three sources of bromate in drinking water (ozonated water containing bromide, bromate containing hypochlorites, and a 3rd unspecified source) the SPAC calculates to 0.003 mg/L. The SPAC was ultimately accepted at 0.005 mg/L in 2002 based on the two known sources, but as an interim measure only.

G.2 Reduction in the Single Product Acceptable Concentration

To reduce the burden of bromate in drinking water, a reduction in the level of bromate in hypochlorite drinking water chemicals is required. Beginning January 1, 2013, the Single Product Allowable Concentration for bromate will be lowered to 0.003 mg/L.

G.3 Additional information on bromate

Bromate is a disinfection by-product that may be formed when water containing bromide is disinfected with ozone. A second source of bromate in drinking water results from the use of sodium and/or calcium hypochlorite products. Bromide originates in the raw material, known as brine, used to manufacture these product types. Brine solution is fed into an electrolytic cell that cleaves the sodium (or calcium) ion and chloride ion. With the addition of water, sodium (or calcium) hydroxide and chlorine are formed. These two chemicals are then brought together to form either sodium or calcium hypochlorite.

There are three different electrolytic cell types that may be used: mercury, membrane and diaphragm. Studies have shown that if a mercury or membrane electrolytic cell is used, 80% of the bromide originating from the brine will end up in the chlorine while the remaining 20% ends up in the sodium or calcium hydroxide. When a diaphragm cell is used, 40% of the bromide ends up in the chlorine and 60% in the sodium or calcium hydroxide. When the chlorine and sodium (or calcium) hydroxide are combined to produce the hypochlorite product the bromide ion is converted to bromate.

Bromate has been classified as a B2, probable human carcinogen (sufficient data in animals; no data in humans). Studies of carcinogenicity in rats reported tumors at multiple sites, including the kidney, the thyroid, and the peritoneum. The exact mechanism by which bromate causes tumors is not known, however it is assumed that the mode of action that produced the tumors in rats is relevant to humans.

EPA has classified bromate as a carcinogen that interacts with DNA and established a MCLG of 0. The MCL value of 10 ug/L was developed based on available analytical detection methods which were reliable only to a practical quantification limit (PQL) of 0.010 mg/L (EPA, 1994). Analytical methods are now available that can reliably measure bromate concentrations as low as 1 ug/L (EPA, 2003).

The current MCL of 10 ug/L is equivalent to a lifetime cancer risk of 2×10^{-4}, a value that is greater than the EPA's acceptable range of 10^{-4} to 10^{-6} . This higher risk factor was deemed acceptable based on additional considerations such as the potential risk associated with a decrease in current levels of microbial protection and risks from increases in levels of disinfection by-products from other disinfectants. Health Canada has also set their Maximum Acceptable Contaminant (MAC) level at 10 ug/L and determined the lifetime cancer risk to be 2.19×10^{-4} . The MAC was designated as an interim value because the lifetime cancer risk associated with ingesting drinking water containing 10 ug/L bromate is greater than the range that is considered to be essentially negligible (HC, 1998).

When setting the MCL, the main focus of bromate contamination was ozonation systems. EPA's Technical Working Group estimated that hypochlorite solutions contributed an average of 1 ug/L bromate wheras ozone systems contributed less than 10 ug/L bromate but approximately 20% contributed greater than 5 ug/L bromate. Based on this data, non-ozone systems are not required to monitor for bromate.

G.4 References

Health Canada (1998) Guidelines for Canadian Drinking Water Quality: Guideline Technical Document — Bromate. Water, Air and Climate Change Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario. http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/doc_sup-appui/bromate/index_e.html

U.S. EPA. 2003d. National primary drinking water regulations: Stage 2 disinfectants and disinfection byproducts rule; National primary and secondary drinking water regulations: *Federal Register.* August 18, 2003 68 (159): 49547-49596. Proposed rule.

U.S. EPA. 1994a. National Primary Drinking Water Regulations; Disinfectants and Disinfection Byproducts; Proposed Rule. Fed. Reg., 59:145:38668. (July 29, 1994).

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