

Taste and Odor Control with Chlorine Dioxide

Chlorine dioxide (ClO_2) is effective as both a disinfectant and an oxidant in water and wastewater treatment. Its selective reactivity makes chlorine dioxide more effective than other disinfectants at removing taste and odor compounds. Chlorine dioxide has been shown to be effective at a dosage of 1 mg/L in the control of taste and odors resulting from algae and decaying vegetation. Chlorine dioxide effectively oxidizes low threshold-odor compounds, including geosmin, 2,3,6-trichloroanisole (TCA), 2-methyl-isoborneol (MIB), and members of the pyrazine family¹. Chlorine dioxide has also been proven effective in destroying taste and odor-producing phenolic compounds, which are oxidized with minimal production of chlorophenol. Oxidation of other off-taste and odor-causing compounds, such as mercaptans and disubstituted organic sulfides has been demonstrated².

Application Description

Chlorine dioxide is far superior to chlorine for destroying phenols, algae, sulfides, iron and manganese contaminants present in source waters.

Phenols - Surface water often contains phenols from industrial effluents. When chlorine is used for disinfection, chlorophenols are formed resulting in taste and odor problems. Treatment with chlorine dioxide can destroy chlorophenols. Proper application requires several parts of chlorine dioxide per part of chlorophenol.

In solutions with chlorine dioxide in excess, the principal by-product is *p*-benzoquinone (45 to 65 percent). No chlorophenols are observed; simple organic acids (such as maleic and oxalic acids) are the remaining by-products. At pH 7 and above, the phenol reaction is rapid and complete, with all phenols consumed. Below pH 10, a minimum of 1.5 mg/L of chlorine dioxide oxidizes 1 mg/L of phenol to benzoquinone.

Algae - Chlorine dioxide has been shown to be effective in controlling algae growth. Chlorine dioxide is believed to attack the pyrrole ring of the chlorophyll. This cleaves the ring and leaves the chlorophyll inactive. Since algae cannot function without chlorophyll metabolism, they are destroyed. The reaction of chlorine dioxide with algae and their essential oils forms tasteless, odorless substances.

Algae control is carried out by adding chlorine dioxide to the reservoir at night (to prevent decomposition of chlorine dioxide by sunlight). The algae killing action is fast enough to be effective before the sun rises. A dosage of 1 mg/L has been reported to control algae populations.

Sulfides - Chlorine dioxide is not typically used to remove sulfides from potable water. However, it does rapidly oxidize hydrogen sulfide to sulfates in the pH range 5-9. Between pH 5-9, a minimum of 3.36 mg/L of chlorine dioxide should be used to instantly oxidize 1 mg/L of sulfide to sulfate.



Application Note

Feed Requirements

The required dosages will vary with source water conditions, the severity of contamination, and the degree of control desired.

For more information on dosage requirements specific to your application contact your Siemens Representative.

Method of Feed

Chlorine dioxide is a gas produced by activating sodium chlorite with an oxidizing agent or an acid source. Sodium chlorite is converted to chlorine dioxide through a chlorine dioxide generator and applied as a dilute solution. Chlorine dioxide solutions should be applied to the processing system at a point, and in a manner, which permits adequate mixing and uniform distribution. The feed point should be well below the water level to prevent volatilization of the chlorine dioxide. Do not apply sodium chlorite directly to potable water. Avoid co-incident feeding of chlorine dioxide with lime or powdered activated carbon.

Chlorine Dioxide Analysis

In addition to other monitoring requirements, the USEPA also requires that water systems using chlorine dioxide for disinfection or oxidation must monitor their system for chlorine dioxide and chlorite.

Chlorine Dioxide: For compliance monitoring for residuals of chlorine dioxide, one of the two approved methods specified in 40 CFR §141.131(c) must be used:

DPD Method, 4500-ClO₂ D, and
Amperometric Method II, 4500-ClO₂ E³.

Where approved by the state, systems may also measure residual disinfectant concentrations of chlorine dioxide by using DPD colorimetric test kits.

Sodium Chlorite: For compliance monitoring for chlorite, water systems must use one of three approved methods specified in 40 CFR §141.131(b):

Amperometric Method II, 4500-ClO₂ E
Ion Chromatography, EPA Method 300.0⁴, or
Ion Chromatography, EPA Method 300.1⁵.

The regulations further specify that Amperometric Titration may be used for routine daily monitoring of chlorite at the entrance to the distribution system, but that Ion Chromatography must be used for routine monthly monitoring of chlorite and for additional monitoring of chlorite in the distribution system.

References

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2. Warf, C.C. Jr., "Chlorine Dioxide and The Small Drinking Water System": published in "Providing Safe Drinking Water in Small Drinking Water Systems", Lewis Publishers, 121-131 (1998).
3. *Standard Methods for the Examination of Water and Wastewater*, APHA, AWWA and WEF, Washington, D.C. (20th Ed. 1998).
4. *Methods for the Determination of Inorganic Substances in Environmental Samples*. USEPA. 1993. EPA/600/R-93/100.
5. USEPA Method 300.1, *Determination of Inorganic Anions in Drinking Water by Ion Chromatography, Revision 1.0*. USEPA. 1997. EPA/600/R-98/118.

Siemens
Water Technologies

Germany
+49 8221 9040
wtger.water@siemens.com

United Kingdom
+44 1732 771777
wtuk.water@siemens.com

USA
+1 856 507 9000
wtus.water@siemens.com

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