

Section 5.4

Disinfection with Chlorine Dioxide



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Water and Wastewater Treatment Engineering

Physicochemical Technology

1. Characters of chlorine dioxide

- ClO_2 is a **yellowish-green** gas with acrid odor under room temperature.
- Extremely unstable, both gas and liquid chlorine dioxide are explosive. Thus it should be prepared on site and used as aqueous solution.
- Soluble in water with a solubility 5 times of the chlorine's; and It exists in water as dissolved gas, without any hydrolysis.



2. Characters of disinfection with chlorine dioxide

- Very effective disinfectant, has good inactivation on bacteria and viruses.
in pH 6-9, its disinfection efficiency is weaker than ozone, but better than free chlorine.
- Disinfection is not affected by pH, and does not react with ammonia.
- Stability in water is worse than chloramines, but better than free chlorine.
- No formation of disinfection byproducts such as trihalomethanes.
- However, chlorine dioxide disinfection costs more than chlorine one.



3. Preparation of chlorine dioxide

(1) Sodium chlorite-acid method:

- $5\text{NaClO}_2 + 4\text{HCl} = 4\text{ClO}_2 + 5\text{NaCl} + 2\text{H}_2\text{O}$
- $5\text{NaClO}_2 + 2\text{H}_2\text{SO}_4 = 4\text{ClO}_2 + 2\text{Na}_2\text{SO}_4 + \text{NaCl} + 2\text{H}_2\text{O}$



3. Preparation of chlorine dioxide

(2) Sodium chlorite-hypochlorite method:

- $\text{Cl}_2 + \text{H}_2\text{O} = \text{HClO} + \text{HCl}$
- $2\text{NaClO}_2 + \text{HClO} + \text{HCl} = 2 \text{ClO}_2 + 2\text{NaCl} + \text{H}_2\text{O}$



3. Preparation of chlorine dioxide

(3) Sodium chlorate-hydrochloric acid method



(4) Electrolysis method

- From sodium hypochlorite generator.
- By electrolysis of sodium chlorate solution, the solution containing ClO_2 (10%-20%) and NaClO (dominant) would be obtained on site.



4. Dosage of chlorine dioxide

- Disinfection in water treatment
 - Dosage between 0.2 to 0.5 mg/L
 - Contact time: no less than 30 min
 - Residual $\text{ClO}_2 \geq 0.1 \text{ mg/L}$ in effluent; $\geq 0.02 \text{ mg/L}$ at the end of pipelines.
- Disinfection in wastewater treatment
 - Secondary effluent, dosage between 6-15 mg/L



5. Disinfection byproducts

- The intermediate product is chlorite (ClO_2^-), which is harmful to human health.
- “*Standards for drinking water quality*” rules that the highest permit concentrations of chlorite and chlorate are both 0.7 mg/L.

