

CHLORINE DIOXIDE DISINFECTION SYSTEM FOR DESALINATED WATER IN QATAR- power point

Khalid Yahya Abid and Abdurrahman Ali Al-Naama

Qatar General Electricity and Water Corporation

PO BOX, 41, Doha - Qatar



safe drinking water

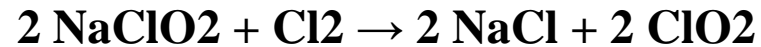
Meeting the goal of clean, safe drinking water requires a multi-barrier approach that includes:

- Protecting source water from contamination,
- Appropriately treating raw water,
- And ensuring safe distribution of treated water to consumers' taps.



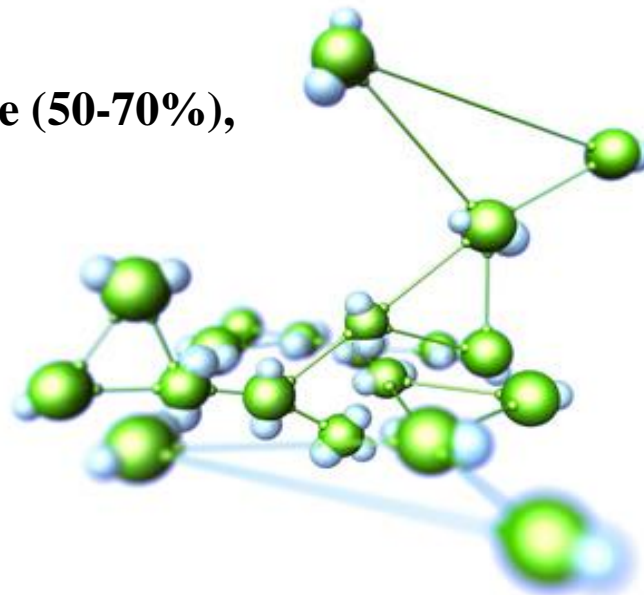
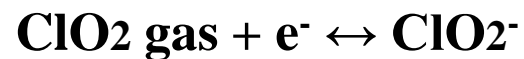
Chemical Preparation of Chlorine Dioxide

Chlorine dioxide should be generated on the spot because it is unstable.
There are two main alternative production methods as follows :



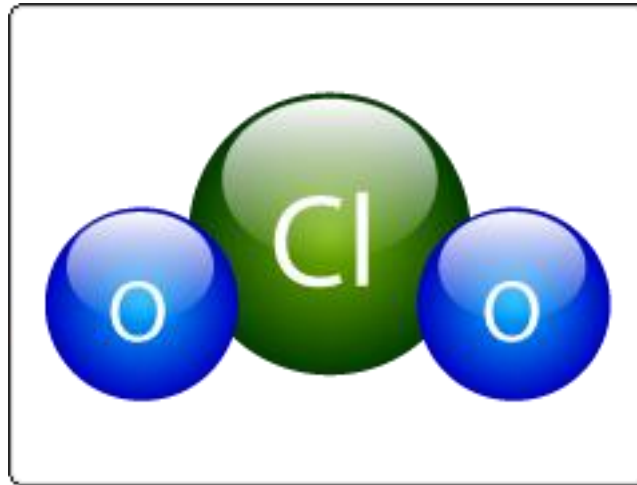
Chlorine Dioxide in the water

Once chlorine dioxide gas (greenish-yellow) applied in water, ClO_2 decays on its own to invisible, harmless concentrations of various sodium salts including chlorite (50-70%), chlorate and chloride ion :

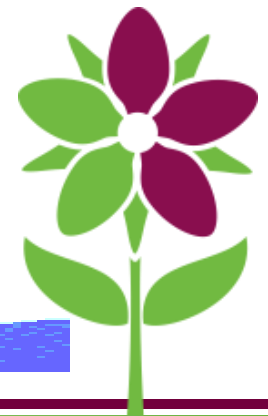


Why using ClO₂ is better ...?

- It is very stable during the time in the distribution pipes .
- Easily measure concentrations .
- Approved by EPA as a primary drinking water disinfectant .



- Chlorine dioxide can be fed into the water system at various points (e. g cold water supply, hot water supply, and reservoirs) depending on where disinfection is desired .
- Generators forming chlorine dioxide are relatively simple mixing chambers .
- Provides better taste and odor control than chlorination.
The odor threshold for $\text{ClO}_2 = 1\text{-}15 \text{ mg/l}$, almost 10 times higher than the minimum required to cause problems .



- **Typical dose for ClO₂ preoxidation= 0.2-0.8 mg/l .**
- **Superior to control legionella bacteria and the biofilms in water distribution systems .**
- **Chlorine dioxide is about 5 times as effective as chlorine (in consideration of pH and temperature) for organism's inactivation (CT- Values) (e.g. Giardia and Cryptosporidium) .**



CT values for Chlorine & Chlorine Dioxide (the lower values the better inactivation).

Organism	Chlorine / Hypochlorite	Chlorine Dioxide	Inactivation (CT) %
Guardia	19	3.7	90
Cryptosporidium	>7200	6	90
viruses	1.0	4.3	99.9

- **Effective over a broad range of pH (while for chlorine is 7.5 – 8) .**
- **Chlorine dioxide is less corrosive than chlorine .**
- **Oxidation Reduction Potential (ORP) as follows:**

$\text{Cl}_2 = 1.36 \text{ V}$

$\text{ClO}_2 = 0.95 \text{ V}$

So ORP for chlorine dioxide is much lower, and oxidation capacity is much greater than chlorine.

(ORP: measures the strength or speed of oxidation –the disinfection-).

- **Formation of chlorite byproduct is very low and well under the WHO guideline (0.7 mg/l)**
- **as well as for chlorate (0.7 mg/l) which it is very limited .**
- **Does not oxidize bromide ion, so no formation of bromate. It forms Bromate when pH is less than 5 .**
- **Does not produce THM like chlorine .**
- **It oxidizes iron, manganese and sulfides .**



- **Chlorine dioxide may produce a complete process .**
- **Disinfection is an oxidation process. Chlorine dioxide is one of the best oxidants.**
- **Below is a comparison between chlorine with some of its derivatives and chlorine dioxide:**

Oxidant	Cl ₂ %	NaClO ₂ %	NaClO %	ClO ₂ %
Oxidation Capacity	100	157	93	263

Controlling of chlorite ions

- **By controlling the ClO_2 generator when there is;**
 - Precise operation
 - Proper maintenance
 - Using new technology.
- **Using granular activated carbon, these can change the chlorite ions to chlorate by:**
 - Adsorption
 - Chemical reduction
- **Ferrous ion concentration of 3.5 – 4 mg / l removes chlorite ions within 3 to 5 seconds.**
- **Sulfur reducing agents (e.g thiosulfate, metabisulfite, and sulfite) can reduce chlorite and chlorate concentrations.**

Disadvantages of using chlorine dioxide

By products formation of chlorite and chlorate limits the dosage of chlorine dioxide.

- **Disinfection efficiency of chlorine dioxide is reduced significantly at low temperature .**
- **Production of chlorine dioxide must be generated on-site, because it is been affected by: high temperature, pressure, intense sun light and UV radiation.**
- **More costly than chlorine.**

Comparison between chlorine and chlorine dioxide in power rating and their byproducts

	Chlorine / Hypochlorite	Chlorine Dioxide
Disinfection power rating	Medium	Strong
By-products	THM BrO ₃ Chloramines Chlorophenols	Chlorite Chlorate

Improvement of Bromate levels after using Chlorine Dioxide in Qatar

Bromate ($\mu\text{g/l}$) with Chlorine	Bromate ($\mu\text{g/l}$) with Chlorine Dioxide
7.8	<2
1.68	<2
<2	<2
<2	<2
<2	<2
12	<2
5.39	<2
<2	<2
7.55	<2
10.9	<2
14.7	<2
Average 11	<2



General considerations and conclusions

- Chlorine dioxide looks like chlorine but its chemistry is totally different.
- Any disinfectant has its own advantages and disadvantages.
- The capability of any disinfectant depends upon: pathogens, pH, temperature and the water quality.
- Chlorine dioxide is very stable during time in the distribution pipes.
- Formation of chlorite is very low and well under the WHO guideline value .
- Chlorate can be minimized adopting new production technology able to form highly pure chlorine dioxide solutions .



THANK YOU

