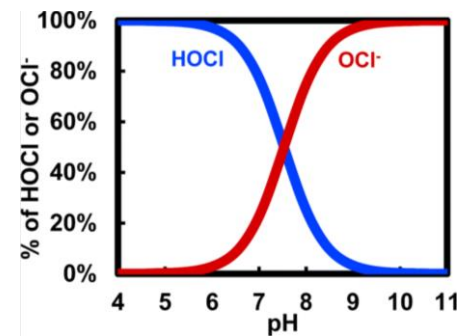


Comparison of Conventional Water Treatment & Chlorine Dioxide Water Treatment

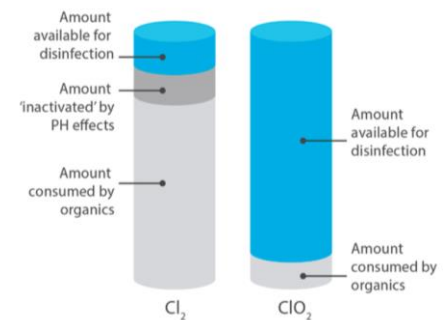
Chlorine has long been favored as disinfectant in various water treatment because of its bacterial effectiveness, low cost, convenience and relatively long hold residual. However, chlorination practices in water systems result in formation of trihalomethanes and other chlorinated organics that are undesirable from the viewpoint of water pollution control and human health specifically.

- “Use of Chlorine causes a tremendous range of mutagenicity in drinking water e.g. Mutagen X (MX)”
- “Use of chlorine causes TriHaloMethanes (THM)” e.g. chloroform, bromodichloromethane, dibromochloromethane and bromoform;
- Use of chlorine causes haloacetic acids (HAA) e.g. mono-, di, and trichloroacetic acids and mono- and dibromoacetic acids;
- *MX, THM and HAA are linked to cancer, miscarriages, stillbirths and birth defects;*
- *Mutagen X cancer potency is 170 times greater than chloroform.*



Source: Harvard Medical Dental & Public Health School – 25 January 2002

Chlorination of water usually comes together with the need of pH stabilizer, as Chlorine only works effectively on pH range of 6.5 to 7.5 therefore constant injection of pH stabilizer are required.



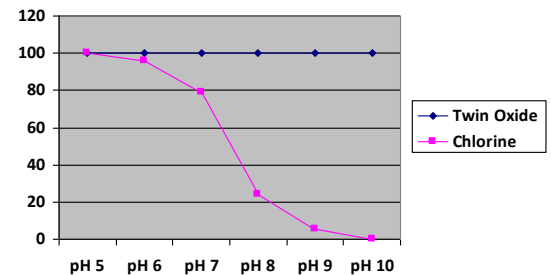
New Generation Water Treatment

Chlorine dioxide is used as both a disinfectant and an oxidant in critical and non-critical water treatment. It has several chemical advantages, which complement the conventional use of chlorine in water treatment.

Chlorine Dioxide is highly effective in controlling waterborne pathogens with effects of minimizing halogenated disinfectant by-products. Chlorine Dioxide is a broad-spectrum micro biocide against Viruses, Bacteria, Mold and Fungi. With kill rate of 99.9% in legionella species and other bacteria. Chlorine Dioxide is also an effective control strategy for odor and color especially Iron and Manganese removal.

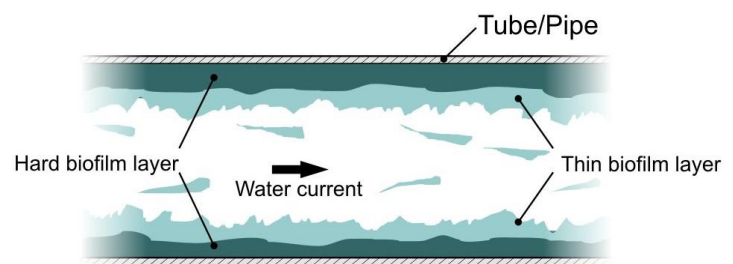
Chlorine dioxide will not react with many organic compounds, and as a result ClO₂ does not produce environmentally dangerous chlorinated organics.

Chlorine Dioxide remains stable in disinfection killing rate with a broad range of pH 4-10. Therefore, use of pH stabilizer is not required in cooling tower treatment system.



Chlorine Dioxide also disintegrate and dissolve biofilm effectively. They are groups of microbes that live on a variety of natural and man-made surfaces. Biofilms are usually described as a safe housing for them to live in. Biofilms also give bacteria protection from outside element. With the existence of biofilm, algae will start to appear and brings impact to the cooling capacity. Mechanical washing using high pressure jet are often a remedy. Labor cost and water cost are involved.

Biofilm are cause of biofouling in pipelines that direct the water. Biofouling in pipeline causes loss of water flow, pressure build up and most commonly corrosion. Therefore, removal and control of biofouling in pipe is one of the most important factors in water treatment.



New Generation Water Treatment

- The solution generates 5 available electrons from the chlorine dioxide molecule
- Does not react with water to form hypochlorous acid (no “free chlorine”)
- Does not contain chlorine, chloride or chlorate
- Does not react with ammonia, ammonium or most organic compounds
- Does not chlorinate organic materials, so decreases THM’s and HAA’s
- Higher action against all water born Micro Organisms and spore forming bacteria (Bacteria, Viruses, Protozoan, Fungi and Sediment)
- No resistance building of Micro Organisms
- Destroys algae related taste and odor compounds
- Steady bacterial, efficacy, action within a broad pH bandwidth (4-10)
- When applied the end-products are sodium sulphate (Na₂SO₄) and sodium chloride (NaCl). (substances common in water)
- Non-corrosive (shock dosing is possible)
- Higher material tolerance
- Higher efficiency in the removal of Iron and Manganese compounds
- Effective Removal of Prophylaxis on Bio Films
- Permanent use will remove and prevent Bio Films
- Removal of bio-fouling on RO-membranes and pipelines
- Powerful inorganic Oxidizing Agent with residual disinfection ability
- Transportable
- Low capital investment

Criteria	Chlorine	Chlorine Dioxide
Biofilm eradication in the water circuit	Only limited eradication in drinking water concentration due to lack of penetration of biofilm.	Chlorine Dioxide penetrates Biofilm completely and eradicate very well.
Deodorization	Production of smell and taste influencer by reaction with phenol, amines and algae.	Deodorization characteristic and therefore smell and taste causer in water like phenols, and taste causer in water like phenols, amines and algae are avoided and not produced.
pH-Value dependability during disinfection	Disinfection only at pH value <7.5 Limited disinfection of concrete based pipeline circuits.	Disinfection is pH-Value independent within a bandwidth of pH 4 – 10. Effective disinfection of concrete based pipeline circuits.
Building of cancer causing THM's and AOX	Strong building due reaction with organic material in water.	No THM building in drinking water. Very Limited AOX building.
Building of mucous glands or mucous membranes irritating chloramines	All amines are transformed to chloramines when reacting with chlorine.	No reaction with primary or secondary amines and therefore no chloramines are built. The typical swimming pool odour is disturbed by oxidation.
Biocide and anti-virus working	Good biocide characteristic. Bad anti-virus characteristic. The biocide characteristic decreases when the pH-Value exceeds >7.5.	Excellent biocide and anti-virus characteristic. Minimal effects of high efficiency killing rate with pH issue.
Algicidal effectiveness	Only when using high dosage of chlorine.	Excellent algicidal working by permanent disinfection with 0.2 to 0.5ppm dosage.
Oxidizing effectiveness	Strong oxidization that only oxidizes by AOX-building.	Up to 2.6 times stronger oxidation compared to chlorine. Oxidation take place by oxygen.
Net Stability	Temperatures >30°C disturbs chlorines rapidly.	Chlorine Dioxide remains stable with temperatures up to 45°C.
Level of Corrosion	High corrosion level	Level of corrosion is very limited.
Rinsing Capacity	Water containing chlorine has a strong adhesion characteristic and therefor a lots of rinsing water is required for the desired effects.	Excellent rinsing capacities and therefore less rinsing water are required for the desired effects.