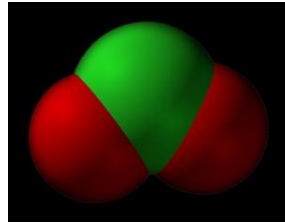


## Hypochlorous Acid (HOCl) & Chlorine Dioxide (ClO<sub>2</sub>)



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Hypochlorous acid (HOCl) is a natural biocide/disinfectant and sanitizer which is the same as the material produced in the human body for natural pathogen defense. It is a safe and the least toxic biocide and yet is one of the highest rated oxidizing agents at an efficacy of approx. 1.5 times stronger than Chlorine Dioxide (ClO<sub>2</sub>) for microbial control. It is used for killing and /or mitigating hundreds of different bacteria, viruses, mold, fungi, and algae in the healthcare, food, agriculture, and industrial processes such as water treatment and numerous industrial markets including oil and gas. It can be manufactured on or near the site where required in large or small quantities at economical pricing contingent on the severity of contamination and environmental conditions at the point of application. The HOCl is produced by the Electrochemical Activation process which has been used successfully for several decades. The materials and method needed are simple ordinary salt, clean water and electricity for the specially designed, computer automated electrolysis units which can be leased or purchased. These units can be onsite or at a central staging location where product can be delivered for onsite use by transport, totes or drums. The concentrations for 99.99% kill are generally very low (0.0005% to 0.05%) or 5 - 500 ppm. Effective kill times upon contact with most microbial organisms are from a few seconds to minutes. The pH of the HOCl product for optimal handling and effectiveness is 6 – 7.5.

Additionally HOCl can effectively replace triazine and amine units for the elimination of H<sub>2</sub>S in sour environments producing oil, natural gas and water.

**Chlorine Dioxide (ClO<sub>2</sub>) is a very effective biocide with good contact kill efficacy on numerous microbial agents as well but has several issues of concern which include the following:**

- **Potential for dangerous gases (chlorine- Cl<sub>2</sub>)**
- **Corrosive thus requiring 316 stainless steel**
- **Strength and efficacy affected by UV rays ( sunlight; extreme heat, greater than 100 F.; extreme cold (<32 F) making shelf life very short**
- **ClO<sub>2</sub> is safer today than a few years ago but remains a potentially unstable substance due to the effects of UV or sunlight causing large amounts of chlorine to be produced**
- **ClO<sub>2</sub> creates by-products such as chlorite and chlorate and chlorine residual which when reacted with organic matter can form halogenated by-products**
- **ClO<sub>2</sub> is harmful to skin in its concentrated form**
- **It is less effective for the deactivation of rotaviruses and E.Coli bacteria**
- **Under pressure ClO<sub>2</sub> can be explosive.**
  
- **Must be generated onsite with mobile equipment thus requiring a significant footprint on already crowded frac sites. However it can be positioned to pre-treat frac water ponds thereby eliminating the need to be positioned amidst the pumping equipment. This however may take place days ahead of pumping which may allow significant return of microbial growth in water supplies to be used for treatment thus requiring either re-treatment or the use of other biocides during pumping or have a ClO<sub>2</sub> set-up integrated amongst the frac pumping units.**
  
- **ClO<sub>2</sub> does not form chloramines or bromides and does facilitate the removal of iron and magnesium from water but as a result may precipitate them as oxides ( rust and magnesium salt)**
  
- **It is more expensive in the long term than other biocides particularly HOCl because of its low cost to manufacture.**