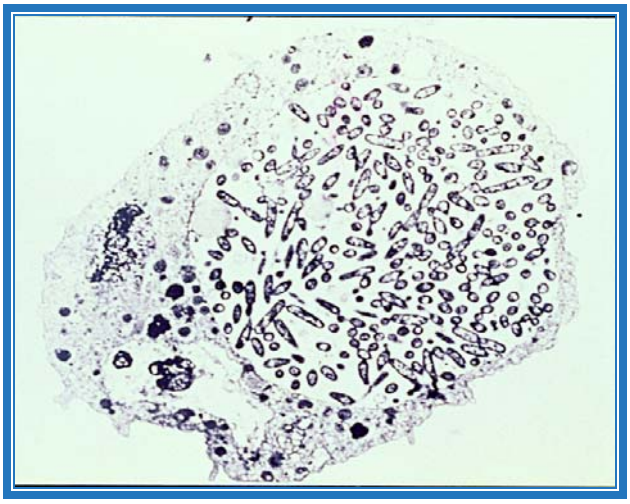
Chlorine Dioxide Fact Sheet

Biocidal Efficacy Of Chlorine Dioxide (ClO_2)

Introduction

Microbial infection is responsible for hundreds of thousands of illnesses and thousands of deaths each year in the United States. Frequent outbreaks of disease have been linked to food handling and processing (Salmonella, Shigella, and E. Coli), drinking water (Giardia, Cryptosporidium) and hotels, cruise ships, hospitals and office buildings (Legionella).



Legionella

Significance of Biofilm

A related major problem is biofilm. When certain microbes reach a surface, they attach themselves by producing polysaccharides (similar to a spider web in design and function). This material is sticky and very difficult to remove. Channels are formed in this film, through which water flows. The sticky web catches nutrients and other microbes that pass by, providing food and a quick growth mechanism. Problems associated with biofilm growth include: 1) fouled heat exchange equipment in cooling systems, 2) increased corrosion rates on equipment, and 3) formation of a habitat for pathogenic organisms. Even if all waterborne microorganisms are eliminated, regrowth quickly occurs due to bacterial communities and nutrients in the biofilm.

Chlorine Dioxide

Chlorine dioxide (ClO_2) is a highly effective, environmentally-friendly biocide. It is a selective oxidant that attacks planktonic and sessile bacteria, disinfects surfaces, and rapidly reduces biofilms. ClO_2 is a stable, dissolved gas that is a strong bactericide and virucide at concentrations as low as 0.1 ppm. With minimal contact time, it is highly effective against pathogenic organisms such as Legionella, amoebal cysts, Giardia cysts, E. Coli, and Cryptosporidium. ClO_2 reduces biofilms so bacterial regrowth is significantly impeded.

ClO_2 does not ionize to form weak acids (as chlorine and bromine do) in aqueous solutions. This allows ClO_2 to be effective over a wide pH range.

Biocidal Efficacy

ClO_2 is arguably the best biocide approved by the USEPA and FDA. Unlike chlorine, it does not form carcinogenic disinfectant byproducts (THMs and HAAs), and it is more effective at lower dosing levels.

The criteria for disinfection, as defined by the USEPA, are as follows. ClO_2 meets all of these criteria.

1. a 99.9% reduction in Giardia lamblia (3 log reduction)
2. zero lactose fermenting coliform
3. less than 10 cfu/mL non-lactose fermenting coliforms and
4. 99.99% reduction in enteric virus (4 log) concentrations.

Chlorine Dioxide Approvals

- United States Environmental Protection Agency (USEPA)
- United States Food and Drug Administration (FDA)
- Building Services Research and Information Association of the UK (BSRIA)

Disinfectant Power of ClO_2

ClO_2 is shown to be an effective disinfectant at residual concentrations between 0.2 and 0.8 ppm. ClO_2 penetrates the cell wall of the microorganism and disrupts metabolic functions. This is more efficient than other oxidizers that “burn” whatever they come in contact with. This allows lower effective concentrations to be used. ClO_2, like ozone, is a dissolved gas that penetrates biofilm by molecular diffusion. However,

unlike ozone, ClO_2 is stable and soluble, allowing it to travel to the base of the film where it attacks microorganisms and attacks and loosens the biofilm at its point of attachment. Other oxidizers react mostly on the surface of the biofilm to form an oxidized layer, like charring on wood. This precludes further penetration. No biocide has proved to control biofilm better than ClO_2.

Applications

Cooling Towers and Loops: ClO_2 controls algae, planktonic bacteria, biofilm and scale for maximum efficiency of heat exchangers and ancillary equipment. ClO_2 is more stable than other oxidizing biocides and compatible with most water treatment chemistry. This "selective oxidation" makes ClO_2 ideal for systems with corrosion problems.

Potable Water: ClO_2 is EPA-approved for both pretreatment and final disinfection of drinking water. In pre-treatment, it effectively removes iron and manganese and promotes flocculation. It also removes taste and odor components as well as halogenated disinfectant byproduct precursors e.g. trihalomethanes (THM's). In post-treatment, it provides a lasting residual throughout the distribution system.

Food and Beverage: ClO_2 provides excellent microbiological control in flume waters, packaging operations and process disinfection. It is ideal for the washing of cut fruits, vegetables and poultry (FDA approved) as well as bottling and brewery applications. ClO_2 does not react with most "organics" in flume water, which makes it a very effective disinfectant. It also neutralizes foul smelling secondary and tertiary amines formed in the meat packing industry.

Waste Treatment and Odor Control: ClO_2 safely oxidizes phenols, cyanides, aldehydes, and mercaptains, reduced sulfur compounds and some pesticides. It is useful in both waste treatment and scrubber systems.