ProClean™ Decontamination Solutions:
Highlighting Chlorine Dioxide

The #1 concern in the food industry is food safety, and microbial contamination is one of the biggest concerns of the food supply. The food processing industry utilizes chlorine dioxide as a preferred method for resetting the microbial environment and ensuring the safety of foods being prepared for humans and animals alike. There is sometimes confusion and conflicting information regarding the properties and capabilities of chlorine dioxide. The following explains why chlorine dioxide is the choice for the safe elimination of microbial contaminants in the food processing industry.

Chlorine Dioxide is a Biological Sterilant

Chlorine Dioxide was classified as a sterilant by the EPA in 1988. Sterilants are defined by their ability to destroy bacterial spores, thus confirming that all other microbial life including any bacteria, mold, yeast, virus, or other microorganisms present in a treatment area has been eliminated. Chlorine dioxide penetrates the cell wall of microorganisms and destroys the DNA, therefore disrupting all metabolic functions. Chlorine dioxide is a powerful biocide over a wide pH range and produces no hazardous by-products. It is far less corrosive than hydrogen peroxide and peracetic acid, and more effective than quaternary ammonia and sodium hypochlorite (chlorine bleach). Studies from the FDA and EPA show that chlorine dioxide is effective in eliminating over 20 of the most common harmful pathogens, including *Salmonella, Listeria, A. Coli, Clostridia, B. anthracis (anthrax)*, and several species of fungal molds, and yeasts.

No Residue - Immediately Resume Production

Unlike some vapor-based products such as hydrogen peroxide which leaves a residue, chlorine dioxide gas does not leave a residue.

Hydrogen Peroxide and peracetic acid are applied as a 'dry fog' (vapor) which leave a residue, necessitating a post-treatment cleaning, and often requiring an extended period before resuming plant operations to allow the chemical concentrations to dissipate and reach levels safe for human habitation. This residue is attributed to the nature of these products and their composition. Chlorine dioxide does not leave a residue and does not require post-treatment cleaning Processing plants can be immediately re-occupied and begin production once gas levels have reached the safe human habitation level of 0.1 parts per million, typically within 60 minutes of gas cessation.

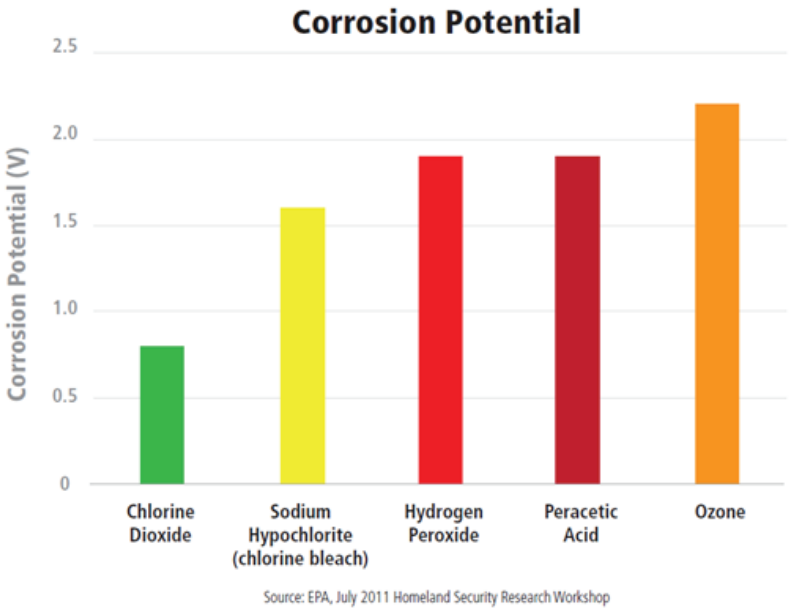
Material Compatibility

Chlorine dioxide is compatible with all grades of stainless steel and many other metals. Concerns about chlorine dioxide corrosion are most likely due to confusing it with chlorine or chlorine gas. Also, some liquid chlorine dioxide solutions are produced by mixing a sodium chlorite base with an acid (most commonly citric acid) which creates a liquid acidified chlorine dioxide solution as well as chlorous acid and acidified sodium chlorite. It is these acidic by-products that can cause the corrosion of metals.

Rigorous testing of stainless-steel exposure to chlorine dioxide has shown no signs of material compatibility with concentrations as high as 900,000 ppm *hours (50,000 ppm for 18 hours). A typical food facility fumigation service is less than 1,500 ppm *hours, which is 600 times less than the testing method used on stainless steel!

The exception to any evidence of corrosion on stainless steel would be due to poorly passivated welds, and/or other deposits resident on the stainless steel which may show signs of oxidation.

Commonly used food plant chemicals such as sodium hypochlorite, peracetic acid, and hydrogen peroxide are much more corrosive than chlorine dioxide. The following chart illustrates that chlorine dioxide is far less corrosive than the other microbial materials listed below.



Source: EPA, July 2011 Homeland Security Research Workshop

Chlorine dioxide gas will not corrode electronics or metals such as aluminum, zinc, copper, brass, or galvanized steel. In addition, no corrosion is observed when using materials such as stainless steel, Lexan, and various other plastics such as Delrin, Teflon, and ultra-high molecular weight polyethylene (UHMWPE). Other than unpainted mild steel, which may show signs of light oxidation, no other metals will be affected by chlorine dioxide. Below are photographs of stainless steel exposed to 50,000 ppm over an 18-hour period (900,000 ppm*hours), and unpainted mild steel exposed to a typical microbial treatment exposure of ~200 ppm over 8 hours (~1,600 ppm*hours)

ProClean™ Decontamination Solutions: Chlorine Dioxide

Stainless Steal

50,000 ppm for 18 hours
(9000,000 ppm*hours)

Pre-Treatment

Post-Treatment

Unpainted Mild Steal

200 ppm for 8 hours
(1,664 ppm*hours)

Pre-Treatment

Post-Treatment

Not All Chlorine Dioxide is Created Equal

There are several methods of producing chlorine dioxide. IFC utilizes a process that creates a safe and effective 99.5% pure chlorine dioxide gas that DOES NOT require humidity controls and produces guaranteed sterilization results.

Other methods that utilize highly corrosive chlorine gas in their process, requiring humidification of the area being treated. If humidity is not high enough then highly corrosive chlorine gas may be present in the treatment area, increasing the possibility of corrosion on metals and other materials.

NOT Explosive When Used Normally

Chlorine dioxide must be created at the point of use and cannot be compressed or stored. If chlorine dioxide is compressed, it may be explosive, and this is the reason why the myth of explosive potential during a treatment process may exist. The concentration at which chlorine dioxide gas is used for food facility treatment is more than 1,000 times less than the explosive threshold. This makes the risk of explosion ZERO as explosive concentrations cannot be achieved during the treatment process. IFC does not incorporate any chlorine dioxide compressed gas, in any form, in the chlorine dioxide treatment process.

Chlorine Dioxide is Not a Carcinogen

There is no evidence that chlorine dioxide is a carcinogen. Chlorine dioxide is used to treat municipal drinking water supplies and to rinse various fruits, vegetables, and meats. Both the EPA and FDA have approved the use of chlorine dioxide for use in these instances.

Chlorine Dioxide Remains Active in Water

Chlorine dioxide does not react with water, has a neutral pH in water, and stays active as chlorine dioxide within the water. This enables it to kill organisms within the water, as well as any on the surface beneath the water. This trait is unique to chlorine dioxide among other decontaminating agents.

When mixed with water, chlorine bleach (sodium hypochlorite) forms hydrochloric acid. Hydrogen peroxide, by contrast, will dilute in water and cannot kill organisms within or beneath the water.

Chlorine Dioxide versus Other Treatment Agents

Chlorine dioxide is a gas. It is scientifically and statistically less corrosive than hydrogen peroxide, peracetic acid, ozone, and sodium hypochlorite (bleach), and is used routinely to decontaminate rooms, suites, and many other spaces.

As a gas, chlorine dioxide expands to uniformly fill the space it is contained within, regardless of the effect of gravity. This allows the gas to contact all surfaces within a space in equal concentrations, guaranteeing an even level of decontamination throughout. Its small molecular size coupled with this distributive property allows the gas to easily penetrate microscopic cracks and crevices. Chlorine dioxide does not condense on surfaces; therefore, in case of emergency, the gas can be aerated down to safe levels quickly. This means that in the event of leakage, chlorine dioxide gas can be removed making the area safe quickly.

At levels below the 0.1 ppm human exposure safety level, chlorine dioxide gas smells somewhat like a swimming pool allowing personnel to be aware of a leak at very low levels.

Hydrogen Peroxide & Peracetic Acid

Hydrogen peroxide and/or peracetic acid are injected as a vapor (also known as a dry fog) into a treatment area. Unlike the drug store use of 3% hydrogen peroxide, the industrial use of hydrogen peroxide is typically at 35%. As the hydrogen peroxide vapor condenses, the condensate's hydrogen peroxide concentration can increase from 35% to almost 80%. This increase in concentration adds to hydrogen peroxide's corrosive nature, as noted in its incompatibility with some epoxy finishes on walls and flooring as well as other materials. Also, hydrogen peroxide is odorless, and any leakage cannot be easily identified.

Hydrogen peroxide and peracetic acid is a liquid at room temperature and therefore condense on surfaces. This condensate adds to the level of corrosiveness and takes much longer to dry and aerate from space, needing hours if not overnight before it is safe for human habitation.

Summary

Chlorine dioxide gas and chlorine dioxide aqueous solutions, when applied safely and effectively, are more effective in killing bacteria, mold, and spores and far less corrosive than most other microbial decontamination products. Due to its nature as a gas that does not condense on surfaces, a facility can be re-occupied, and operations can resume immediately upon aeration and reducing gas level to the 8-hour safety level of 0.1 ppm or less, often within a few hours of cessation of gas production.

A significant added value in using IFC is our capability to completely manage the facility, including sealing of the treatment area to assure gas concentrations are met. The #1 cause of treatment failure is poor sealing. IFC can deploy chlorine dioxide services for areas ranging from small electric cabinets to entire plants up to several million cubic feet.

Since the 1920s, chlorine dioxide has been known for its disinfecting properties. It was recognized as a chemo-sterilizing agent in 1984; and in 1988, it was registered with the US Environmental Protection Agency (US EPA) for use as a sterilant. The USDA has deemed chlorine dioxide as certified for organic use in crop production, as an algicide, disinfectant, and sanitizer. In addition, no corrosion is observed when using materials such as stainless steel, Lexan, and various other plastics such as Delrin, Teflon, and ultra-high molecular weight polyethylene (UHMWPE). With appropriate delivery equipment and care, chlorine dioxide is a safe and effective means of decontamination. A significant safety feature of chlorine dioxide is that it has a distinct odor much like a swimming pool, making even minor leaks self-alerting, well below the human habitation safety limit. Both gaseous and aqueous phase chlorine dioxide has been proven to be effective sterilizing agent that has broad and high biocidal effectiveness. Both forms of chlorine dioxide have been reported to effectively inactivate bacteria, viruses, bacterial spores, and algae.