GITASAN

Chlorine Dioxide Efficacy

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Gas **I**nfusion **T**echnology **A**nd **San**itation, is a patented process for delivering fixed amounts of Chlorine Dioxide gas in the environment to be decontaminated.

Chlorine Dioxide

As can be seen in the chart below, the size of a chlorine dioxide gas molecule is 0.124 nm, much smaller than microorganisms and viruses, allowing the gas to easily penetrate into any areas where these microorganisms might be concealed.

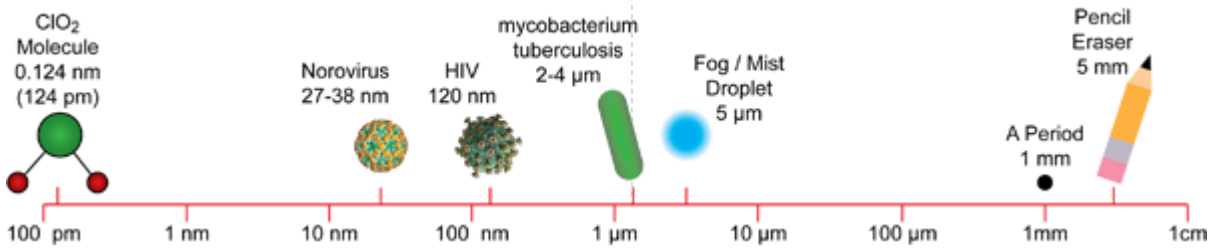
Chemical Properties

Although chlorine dioxide has "chlorine" in its name, its chemistry is radically different from that of chlorine. When reacting with other substances, it is weaker and more selective, allowing it to be a more efficient and effective sterilizer. For example, it does not react with ammonia or most organic compounds.

Chlorine dioxide oxidizes products rather than chlorinating them, so unlike chlorine, chlorine dioxide will not produce environmentally undesirable organic compounds containing chlorine. Chlorine dioxide is also a visible yellow-green gas allowing it to be measured in real-time with photometric devices.

Antimicrobial Properties

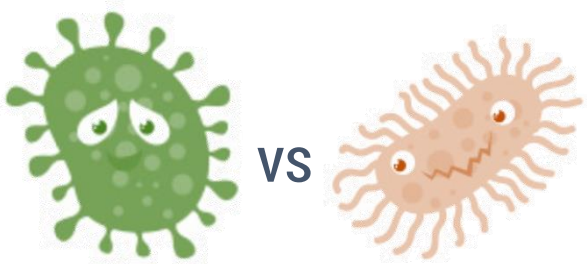
Chlorine dioxide (ClO2) acts as an oxidizing agent and reacts with several cellular constituents, including the cell membrane of microbes. By "stealing" electrons from them (oxidation), it breaks their molecular bonds, resulting in the death of the organism by the breakup of the cell. By altering the proteins involved in the structure of microorganisms, their enzymatic function is broken and causes very rapid bacterial kills. This oxidative attack on many proteins simultaneously is behind the potency of chlorine dioxide and also prevents microorganisms from mutating to a resistant form. Because of the selective reactivity of chlorine dioxide, its antimicrobial action is retained longer in the presence of organic matter than most other decontaminating agents.



Inactivation of spores vs bacteria

The difference between spore and bacterial inactivation is the same as the difference between sterilization and disinfection. For a chemical agent to be classified as a sterilant, it must be demonstrated to be effective at inactivating spores. Spores are among the hardest organisms to kill and for this reason sterilizing agents are considered the most rigorous decontaminating agents and offer complete kill of all antimicrobial life. Disinfection, on the other hand, does not require the complete inactivation of spores or all microbial life and is normally validated against a few vegetative bacteria species. For this reason, disinfecting agents are less rigorous decontaminating agents and are not as effective as sterilizing agents.

"Bacterial endospores are one of the most persistent forms of microbial life and typically require aggressive inactivation procedures. Vegetative bacteria are generally much more easily inactivated than are bacterial endospores.



This is primarily because the sensitive areas of bacteria are easily contacted by chemosterilizing agents. The spore, however, has a more complex structure than the vegetative bacterial cell. Its sensitive material is contained within a core and that core is surrounded by a cortex and spore coats. These coats tend to act as a permeability barrier to the entry of chlorine dioxide and other compounds" (Knapp, 2000).

Environmental impact

Chlorine dioxide's special properties make it an ideal choice to meet the challenges of today's environmentally concerned world and is an environmentally preferred alternative to elemental chlorine. When chlorine reacts with organic matter, undesirable pollutants such as dioxins and bio-accumulative toxic substances are produced. Thus, the EPA supports the replacement of chlorine with chlorine dioxide because it eliminates the production of these pollutants. It is a perfect replacement for chlorine, providing all of chlorine's benefits without any of its weaknesses and detriments. Most importantly, chlorine dioxide does not chlorinate organic material, eliminating the formation of trihalomethanes (THMs), haloacetic acids (HAAs) and other chlorinated organic compounds. This is particularly important in the primary use for chlorine dioxide, which is water disinfection. Other properties of chlorine dioxide make it more effective than chlorine, requiring a lower dose and resulting in a lower environmental impact.

Uses

Chlorine dioxide is widely used as an antimicrobial and as an oxidizing agent in drinking water, poultry process water, swimming pools, and mouthwash preparations. It is used to sanitize fruit and vegetables, and equipment for food and beverage processing, widely used also in life science research laboratories. It is also employed in the health care industry to decontaminate rooms, pass-throughs, isolators and also as a sterilant for product and component sterilization. Approximately 4 to 5 million pounds are used daily.

Water solubility

Unlike many decontaminating agents, chlorine dioxide has the unique ability to retain its sterilization capacity in water. In order to maximize process reproducibility it is best to avoid pools or puddles of water. However, if small amounts of water are present the efficacy of chlorine dioxide is not affected. The reason that small amounts of water will not impact sterilization efficacy is that chlorine dioxide is readily soluble in water. The partition coefficient (CClO2(H2O)/CClO2(air)) of chlorine dioxide at 22°C and 101 kPa is about 38 (Masschelein). And provided that the quantity of water is small the gas concentration in the water reaches equilibrium quickly .

What does it kill?

TYPE OF MICROORGANISM	
↓ Decreasing Resistance	**Bacterial Endospores** (*Clostridium, Bacillus*) **Mycobacteria** (*Mycobacterium*) **Non-enveloped, non-lipid viruses** (Parvoviruses) **Fungi** (*Aspergillus, Stachybotrys*) **Gram-negative vegetative bacteria** (*Escherichia, Pseudomonas*) **Gram-positive bacteria** (*Enterococcus, Staphylococcus*) **Enveloped, lipid viruses** (Influenza)

Efficacy

PHARMA/HOSPITAL APPLICATION

Chlorine Dioxide gas is a potent sanitizing agent which makes it ideal to remove moulds, pathogens, and even odours.

GITASAN is particularly suited for the removal of moulds and fungus in buildings or disinfection of horticultural or animal husbandry facilities: big volumes where wet micro condensation process as hydrogen peroxide can't reach every surface.

Its efficacy has been formally tested by NATA accredited laboratory:

Analysis Performed by Silliker Australia
COA No.: MEL-50513242-0
NATA Acc.: 2020
TGA Lic. No.: MI-09022005-LI-000428-1

12 Storey hospital in the USA wrapped in plastic for chlorine dioxide gas disinfection,
Source: SABRE ENVIRONMENTAL SERVICES LLC.

Analytical Results

Desc. 1:	Releasat 3BL			**Sample Number:**	452084790	
				Condition Rec'd:	NORMAL	
				Temp Rec'd (°C):	19.7	
Analyte	**Result**	**Units**	**Method Reference**	**Result Date**		**Loc.**
Bacillus atrophaeus	Not Detected	/Strip	M25	19/05/2013		
Desc. 1:	Releasat 3BR			**Sample Number:**	452084794	
				Condition Rec'd:	NORMAL	
				Temp Rec'd (°C):	19.7	
Analyte	**Result**	**Units**	**Method Reference**	**Result Date**		**Loc.**
Bacillus atrophaeus	Not Detected	/Strip	M25	19/05/2013		
Desc. 1:	Releasat 3TR			**Sample Number:**	452084795	
				Condition Rec'd:	NORMAL	
				Temp Rec'd (°C):	19.7	
Analyte	**Result**	**Units**	**Method Reference**	**Result Date**		**Loc.**
Bacillus atrophaeus	Not Detected	/Strip	M25	19/05/2013		
Desc. 1:	Releasat 3TL			**Sample Number:**	452084797	
				Condition Rec'd:	NORMAL	
				Temp Rec'd (°C):	19.7	
Analyte	**Result**	**Units**	**Method Reference**	**Result Date**		**Loc.**
Bacillus atrophaeus	Not Detected	/Strip	M25	19/05/2013		

Material compatibility

Chlorine dioxide gas is one of the most gentle decontaminating agents available. Our process generates a pure chlorine dioxide gas which is used every day to decontaminate sensitive materials ranging from laboratory scales, microscopes and computers, to complex machinery and entire assembly lines.

Oxidation Potential

A Scientific Measure of Corrosivity

Oxidation potential is a chemical property that measures the chemical's tendency to oxidize. This can also be thought of as the corrosion potential. The higher the value, the greater stronger the chemical's oxidizing (or corrosion) power. The table below shows common sterilant and their oxidation potential: chlorine dioxide is 47% less corrosive than Hydrogen Peroxide.

US EPA Study

Ref. Snyder, Emily, Indoor and Outdoor Decontamination Presentation at EPA Region 9 / ORD Homeland Security Research Workshop, July 14, 2011 San Francisco, CA.

The US EPA confirms that Hydrogen Peroxide (H2O2) is more corrosive than Chlorine Dioxide (ClO2) in a study performed in 2011:

Computers were exposed to both agents over the course of 6 months, tested ON and OFF, results:

H202 ON (S)	11
H202 OFF (S)	6
H202 ON (B)	7
H202 OFF (B)	4
Control	4
ClO2 ON	2
ClO2 OFF	3

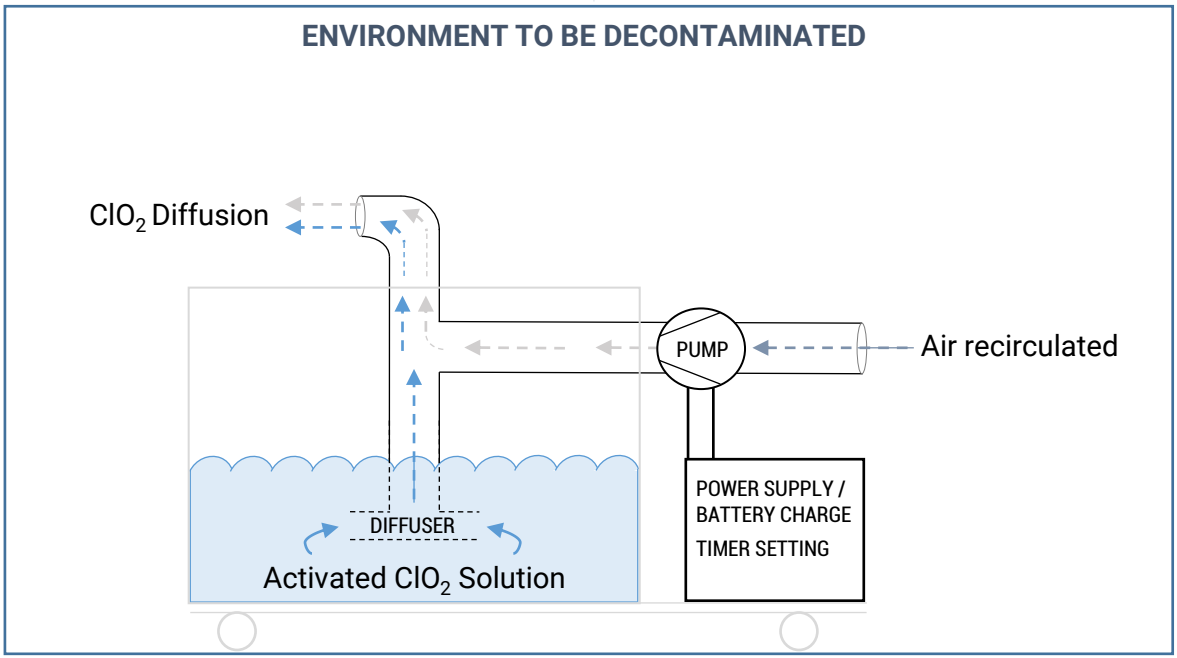
Chlorine dioxide had the lowest amount of failures.

Decontaminating Agent	Chlorine Dioxide	Bleach	Hydrogen Peroxide	Peracetic Acid	Ozone
Oxidation / Corrosive potential (V)	0.95	1.49	1.78	1.81	2.07

More corrosive

Advantages

- Chlorine Dioxide is well known as a highly **efficient biocidal disinfectant**.
- Chlorine Dioxide is a Gas therefore has own **diffusion capacity** without use of any device (i.e. VHP fans positioned in the rooms) and **penetration capacity**.
- **Not corrosive** at concentration used for sterilization (Log6 reduction).
- It decontaminates areas that you can't reach using just a liquid sanitizer.
- It is **not carcinogenic**
- It is more **effective, fast and convenient** than every other solution in the market.
- The American National Academy of Sciences determined that this decontamination process, using chlorine dioxide gas, should be "the **standard for building decontamination**".
- Chlorine dioxide process recognized and described by guidelines **NSF/ANSI-49:2008** for biological safety cabinets decontamination, both in liquid and gas status (Par.G.7.2.1 and G.7.3.2).



The GITASAN Process Flow diagram

FOR FURTHER INFORMATION

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