



Technical Bulletin
Updated: Sep. 5, 2019

Chlorine Dioxide (ClO₂) - safely sanitize, disinfect and deodorize

Chlorine Dioxide (ClO₂) is an U.S. EPA approved disinfectant, sanitizer, deodorizer, tuberculocide, algaecide, fungicide and U.S. FDA recognized food additive & preservative.



Micro-organic contamination is the leading cause of human death and suffering as well as industrial, commercial and agricultural losses.

CLO₂ Remedies is a BioSecurity Company specializing in customized biodegradable chlorine dioxide (ClO₂) solutions. ClO₂ is an exceptionally effective and versatile yet low toxicity anti-microbial that safely solves wide-spectrum contamination challenges better than chemical alternatives.

CLO₂ Remedies is dedicated to improving human health and industrial productivity by assisting clients identify cost-effective, high impact ClO₂ solutions to wide-spectrum, micro-organic challenges.

We help global commercial and humanitarian organizations overcome contamination and odors that impacts product quality, infrastructure and health of end-users with numerous ClO₂ products and delivery formats, including our own ClO₂ Tablet Solution, Reset Pure ClO₂.

Information given herein is offered in good faith as accurate, but without guarantee. Conditions of use and suitability of the product for particular uses are beyond our control; all risks of use of chlorine dioxide products are therefore assumed by the user, and WE EXPRESSLY DISCLAIM ALL WARRANTIES OF EVERY KIND AND NATURE, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE USE OR SUITABILITY OF THE PRODUCT. Reset ClO₂ makes no BIOCIDAL claims in USA.

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Chemical Definition

Chlorine Dioxide (ClO₂) is a chemical compound made up of one atom of chlorine and two atoms of oxygen.

Do not confuse ClO₂ with typical household chlorine bleach or HTH. Chlorine dioxide is actually **an oxidizing agent**, not a chlorinating agent.

Unlike alternative chemicals, ClO₂ reacts with organic matter through selective oxidation rather than substitution and **does not produce carcinogenic chlorinated byproducts**.

Terminology

Antimicrobial Pesticides

“Antimicrobial pesticides are substances or mixtures of substances used to destroy or suppress the growth of harmful microorganisms such as bacteria, viruses, or fungi on inanimate objects and surfaces.” **

ClO₂ is an antimicrobial pesticide that can be used in the following ways:

- 1. Sterilizer** - to eliminate or destroy: fungi, fungal spores, viruses, vegetative bacteria, bacterial spores.
- 2. Disinfectant** - used on nonliving surfaces and objects to destroy or irreversibly inactivate infectious fungi and bacteria.
- 3. Sporicide** - to inactivate bacterial spores.
- 4. Sanitizer** - to reduce microorganisms from the inanimate environment to safe levels.
- 5. Germicide** - to kill a number of microorganisms (e.g., viruses, fungi, bacteria)

** Reference: <https://www.epa.gov/pesticide-registration/what-are-antimicrobial-pesticides>

Test Data

ClO₂ is known to be effective on these tested organisms

For the complete list with references, send an email request.

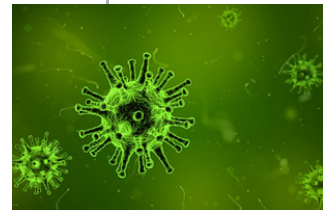
Bacteria

- E. coli (multiple)
- Leginella
- Salmonella (multiple)
- Staphylococcus (multiple)
- many others



Viruses

- Hepatitis A, B, C
- Parvovirus (multiple)
- Norwalk Virus
- Rotavirus
- many others



Bacterial Spores

- Bacillus anthracis
- Bacillus pumilus
- Bacillus subtilis (multiple)
- Clostridium sporogenes
- many others



Algae/Fungi/Mold/Yeast

- Aspergillus clavatus
- Aspergillus (multiple)
- Candida (multiple)
- Fusarium solani
- many others



Where to use CLO₂

CLO₂ is proven safe for use as directed on and around humans, pets, plants, food, water, materials and environment by both The Environmental Protection Agency and The World Health Organization and is currently used in the USA and EU in dozens of industries and hundreds of applications.

Below are typical places where CLO₂ is used.



Home and Apartment



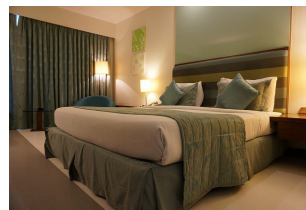
Boat and Marine



Tanks and Lines



Agriculture & Horticulture



Hotel and Motel



Trucks and RVs

Comparison

CLO₂ is superior when compared to other options

The chart below shows how well CLO₂ performs against alternatives.

Chlorine Dioxide Comparison Chart

Agent	Chlorine Dioxide	Sodium and Calcium Hypochlorite	Glutaraldehyde	Iodophor's	Quaternary Ammonium Compounds	Paracetic Acid
Performance	High	Moderate	Moderate to high	Moderate	Moderate to high	Moderate
Contact Time	Seconds to minutes	Minutes to hours	30 minutes to several hours	Minutes to hours	Minutes to hours	Minutes
Concentration	.1 - 100 ppm	1,000 - 10,000 ppm	500 - 10,000 ppm	500 - 10,000 ppm	100 - 10,000 ppm	30 - 200 ppm
pH	Neutral to Acidic	Alkaline	Neutral	Neutral to Acidic	Acidic to Neutral	Acidic
Corrosiveness	Negligible	Corrosive to iron and aluminum	Negligible	Corrosive to iron and stainless steel	Corrosive to iron, copper and brass	Corrosive to iron
Toxicity	Negligible	Harmful to tissues	Can cause skin irritation	Variable, iodine is extremely toxic	Can cause skin irritation	Skin and mucous membrane irritation
Biodegradable	High	Moderate to low	Moderate to high	Low	Low	High
Cost	Moderate to low	Low	Moderate to high	Moderate to high	Moderate to high	High

RECOMMENDED SPECIFICATIONS FOR CONTAINERS USED WITH CLO2 PRODUCTS FOR USE IN GENERATING OR STORING ACTIVATED SOLUTIONS

- + The container should be, or be comparable to, a UN-approved, liquid-resealable containment incorporating a gasket-sealing surface and locking mechanism.
- + Container construction should be of dark or opaque/UV-blocking (preferred) oxidation-resistant plastic or glass. SOME MATERIALS RECOMMENDED INCLUDE:
 - + High Density Polyethylene (HDPE)
 - + Polypropylene (PP)
 - + Polyethylene Terephthalate (PET) (PETE) + Polyvinyl chloride (PVC)
 - + Polycarbonate (PC)
 - + Glass (UV-blocking preferred)
 - + Gasket materials; silicone, viton or EPDM

DURING USE, DILUTING, APPLYING OR WORKING WITH ACTIVATED PRODUCT:

1. Always work in well ventilated area and avoid inhaling fumes of activated solution.
2. Wear protective gloves if hands will come in contact with activated solution.
3. Respiratory protection is not required under the limited exposure conditions of most normal use patterns. However, wear a NOISH/MSHA-approved respirator under the following conditions.
 - a. when applying activated solution with a high-pressure sprayer
 - b. when working with the product for extended period of time in a closed facility or in a poorly ventilated area.
 - c. when normal work-shift duties entail uninterrupted periods of applying the activated solution with mop, sponge or sprayer.
 - d. when opening the vessel containing stock activated solution (at least 500 ppm)
 - e. if OSHA inhalation exposure limits are reached or exceeded (see the SDS)
4. DO NOT USE PRODUCT IN A MANNER INCONSISTENT WITH ITS LABEL.

IF YOU REQUIRE CHLORINE DIOXIDE TEST STRIPS:

Chlorine dioxide solutions may be tested with STANDARD chlorine dioxide test strips, readily available on the internet by various purveyors. (i.e. www.grainger.com). WARNING: Chlorine test strips will not work with ClO₂ .

OR, IF TEST STRIPS INDICATE CONCENTRATION (PPM) LOWER THAN DESIRED:

1. Check expiration date on Test Strip container. If expired, then recheck using fresh a Test Strip from a container that has not reached its expiration date.
2. If the original container has not expired or if the recheck indicates a lower than desired concentration, then do one of the following:
 - If the application solution was prepared directly to the end-concentration (not diluted from a higher concentration), discard the solution and activate a fresh (unused batch). Recheck concentration level after waiting the proscribed time of product activation. OR

- If the application solution was prepared by diluting a solution from a higher concentration, add small amounts of the higher concentration solution to the application. About 10% of the volume of the application solution at a time, until the chlorine dioxide test strips indicates the desired concentration. Stir or mix the solution gently after each addition. Use a fresh chlorine dioxide test strip for each test.

ClO₂ Vaporizing

Any confined space and all its contents

DEODORIZATION & DISINFECTION OF POROUS & NON-POROUS SURFACES IN RESIDENTIAL & COMMERCIAL PROPERTIES; HOTELS & MOTELS; AUTO, TRUCK, BUS & RV'S; BOAT & MARINE; GYMS, LOCKER ROOMS & ATHLETIC EQUIPMENT; NURSING HOMES, DAYCARE CENTERS, SCHOOLS & CHURCHES, AGRICULTURE & HORTICULTURE ENVIRONMENTS.

- Chlorine dioxide (ClO₂) vapor is an exceptionally effective and versatile yet low toxicity odor, mold & smoke eliminator.
- ClO₂ is a water soluble gas which penetrates the visible and non-visible barriers spraying, fogging, mops, sponges, can not. The objective of Vaporizing is to release as much of the ClO₂ from the concentrate into the CONFINED SPACE as possible.
- ClO₂ is a very small molecule 0.124 Nanometers in size . There are roughly 8 Chlorine Dioxide Molecules in 1 Nanometer. 1,000 Nanometers = 1 Micron. e.g., ClO₂ vapor can penetrate into very small areas.
- As a gas ClO₂ will completely and evenly fill any confined space, giving it unmatched distribution and diffusion.
- No post ClO₂ vapor application rinsing or wiping is required. Simply air out the confined space before re-occupying it.

Vapor

Deodorization for all porous and non-porous surfaces

PROTOCOL: 1 Gram Chlorine Dioxide per 5 square feet (w/10' ceilings)

1. Preparation

- Create and/or seal treatment area so that it is a 'confined space' without direct sunlight; i.e. close windows/doors/shades, etc. Remove all visible odor sources.
- Then remove people, plants and pets from the 'confined space' during the treatment period. Furniture and general room contents will not be harmed by ClO₂ Vapor Treatments. Use same protocol as when using thermal foggers; disarm fire detectors, turn off pilot lights in appliances/ burners and inform the the local fire department that you are going to be doing a chemical fog.

2. **Select appropriate chlorine dioxide vapor product**

- Nearly all in-place chlorine dioxide is marketed & sold globally in 'grams of chlorine dioxide' produced. There are many different chlorine dioxide formats including Tablets, Sachets, Sponges & Powders. Usage, Cost and Regulatory Fit are the three primary variables in product selection.
- Nearly all formats and products generate chlorine dioxide vapor when they are added to water.

3. **Vapor Activation**

- Activate your desired chlorine dioxide vapor product. Use individual product activations in highly fragmented spaces. Most in-place chlorine dioxide products begin generating chlorine dioxide vapor in a range of minutes to hours.

4. **Vapor Activation Treatment**

- 3 to 24 hours – depending on issue severity of issue.

5. **Air-out the 'confined space'** before re-entering and re-occupying If you smell a chlorine-like odor, continue to air-out space.

6. **Safely dispose the remaining ClO₂ solution** down toilet/drain.

For best results, use a small aerator to agitate the ClO₂ concentrate products. Any low cost, \$10 Amazon sourced fish-type. Aerators are highly effective at rapidly pushing ClO₂ out of the concentrate and shortening treatment times, but are not required with any ClO₂ product. Without aeration, ClO₂ vapor will release from ClO₂ product concentrates for up to 24 hours.

Vapor

Disinfection and Mold Elimination for all porous and non-porous surfaces

PROTOCOL: 1 Gram Chlorine Dioxide per 1 square foot (w/10' ceilings)

1. **Preparation**

- Create and/or seal treatment area so that it is a 'confined space' without direct sunlight; i.e. close windows/doors/shades, etc. Remove all visible odor sources.
- Then remove people, plants and pets from the 'confined space' during the treatment period. Furniture and general room contents will not be harmed by ClO₂ Vapor Treatments. Use same protocol as when using thermal foggers; disarm fire detectors, turn off pilot lights in appliances/ burners and inform the the local fire department that you are going to be doing a chemical fog.

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Liquid SANITIZER

For hard, non-porous **FOOD** contact surfaces

As a sanitizer for stainless steel and other hard, nonporous food contact surfaces such as tanks, transfer lines and other food processing equipment in food processing plants such as poultry, fish & meat and in restaurants, commissaries, dairies, beverage and bottling plants, breweries & wineries:

1. Activate ClO₂ according to directions for use on product label.
2. Remove all gross food particles and soil (visible organic mater) prior to using pre-flush, pre-soak or pre-scrape treatment.
3. Clean surface thoroughly using a suitable detergent and rinse with clean, potable water before sanitizing.
4. Prepare a **10 ppm solution** in accordance with instructions.
5. To apply: spray, mop, sponge or swap surfaces OR fill, flush, immerse or circulate in tanks, lines and equipment in solution.
6. After sanitizing, allow surfaces or equipment to air dry. Do not rinse sanitized surface.
7. Dispose of product packaging and/or sachet per product label instructions.

Liquid SANITIZER

For hard, non-porous **NON-FOOD** contact surfaces

ALL POROUS & NON-POROUS SURFACES IN RESIDENTIAL & COMMERCIAL PROPERTIES; HOTELS & MOTELS; AUTO, TRUCK, BUS & RV'S; BOAT & MARINE; GYMS, LOCKER ROOMS & ATHLETIC EQUIPMENT; NURSING HOMES, DAYCARE CENTERS, SCHOOLS & CHURCHES, AGRICULTURE & HORTICULTURE ENVIRONMENTS.

As a sanitizer for non-food contact surfaces and equipment such as clothing, upholsteries, athletic equipment, carpets, beddings, furniture, floorings, sealed concrete, finished woods, metals, vinyls & plastics, counter tops, stainless steel or hard-surface equipment, glazed tile floors, walls and ceilings:

1. Activate ClO₂ according to 'Directions for Use' on product label.
2. Clean all surfaces thoroughly with a suitable detergent and rinse with water prior to sanitizing.
3. Prepare a **solution of 20 ppm**, per instructions on label.
4. To apply: spray, mop, sponge or swap surfaces OR fill, flush, immerse or circulate in tanks, lines and equipment, ensuring the target surfaces remain visibly wet **for at least one minute**. When applying these solutions using a high-pressure sprayer, wear a NOISH/MSHA -approved respirator for chlorine dioxide.
5. After sanitizing, allow surfaces or equipment to air dry. Do not rinse sanitized surface.
6. Dispose of product packaging and/or sachet per product label instructions.

Liquid DISINFECTANT and deodorization

For hard, porous and non-porous **NON-FOOD** contact surfaces

ALL POROUS & NON-POROUS SURFACES IN RESIDENTIAL & COMMERCIAL PROPERTIES; HOTELS & MOTELS; AUTO, TRUCK, BUS & RV'S; BOAT & MARINE; GYMS, LOCKER ROOMS & ATHLETIC EQUIPMENT; NURSING HOMES, DAYCARE CENTERS, SCHOOLS & CHURCHES, AGRICULTURE & HORTICULTURE ENVIRONMENTS.

As a disinfectant for non-food contact surfaces and equipment such as clothing, upholsteries, athletic equipment, carpets, beddings, furniture, floorings, sealed concrete, finished woods, metals, vinyls & plastics, counter tops, stainless steel or hard-surface equipment, glazed tile floors, walls and ceilings:

1. Activate ClO₂ according to 'Directions for Use' on product label.
2. Remove all gross food particles and soil (visible organic mater) prior to using pre-flush, pre-soak or pre-scrape treatment.
3. Clean tank, line or surface thoroughly using a suitable detergent and rinse with clean, potable water before sanitizing.
4. Prepare a **100 ppm solution** in accordance with instructions.

5. To apply: spray, mop, sponge or swap surfaces OR fill, flush, immerse or circulate in tanks, lines and equipment, ensuring the target surfaces remain visibly wet for at least TEN minutes. Longer Time Equals Better Results. When applying these solutions using a high-pressure sprayer, wear a NOISH/MSHA -approved respirator for chlorine dioxide.
6. After disinfecting, allow surfaces or equipment to air dry. Do not rinse disinfected surface.
7. Dispose of product packaging and/or sachet per product label instructions.

DISINFECTANT USES IN MEDICAL AND DENTAL OFFICES, LABORATORIES, HOSPITALS, CLINICS, MORGUES AND INSTITUTIONS

CLO2 Remedies chlorine dioxide products are not to be used as a terminal sterilant/high-level disinfectant on any surface or instrument that (1) is introduced directly into the human body, either into or in contact with the blood stream or normally sterile areas of the body OR (2) contacts intact mucous membranes but which does not ordinarily penetrate the blood barrier or otherwise enter normally sterile areas of the body. These products may be used to clean or decontaminate critical or semi-critical medical devices prior to sterilization or high-level disinfection.

To disinfect non-porous, hard surfaces and equipment such as stainless steel or glazed tile floors, walls and ceilings, less steel cold rooms and walk-in incubators:

1. Activate ClO₂ according to 'Directions for Use' on product label.
2. Clean all surfaces thoroughly with a suitable detergent and rinse with water prior to sanitizing.
3. Prepare a ClO₂ solution of 100 ppm, per instructions on label.
4. To apply: spray, mop, sponge or swap surfaces OR fill, flush, immerse or circulate in tanks, lines and equipment, ensuring the target surfaces remain visibly wet for at least TEN minutes. When applying these solutions using a high-pressure sprayer, wear a NOISH/MSHA -approved respirator for chlorine dioxide.
5. After sanitizing, allow surfaces or equipment to air dry. Do not rinse disinfected surface.
6. Dispose of product packaging and/or sachet per product label instructions.

To disinfect equipment tops, bench tops, biological hoods, incubators, stainless steel equipment and instruments:

1. Activate ClO₂ according to 'Directions for Use' on product label.
2. Remove all animals and feed from the facility to be disinfected.
3. Remove all litter and manure from the floors, walls and surfaces of barns, pens, stalls, chutes and other structures occupied or traversed by animals. Empty all troughs, racks and other feeding and watering appliances.
4. Prepare a ClO₂ solution of 100 ppm, per instructions on label.

For general application with sprayer:

1. Clean all surfaces thoroughly with a suitable detergent and rinse with water prior to disinfecting.
2. Using a commercial sprayer, saturate all surfaces with the solution maintaining visible wetness for a period of at least TEN minutes. When applying these solutions using a high-pressure sprayer, wear a NIOSH/MSHA-approved respirator appropriate for chlorine dioxide.
3. After treatment, ventilate buildings, coops or other enclosed spaces before reentering. Do not house poultry or employ equipment until treatment has been absorbed, set, or dried.
4. Dispose of product packaging and/or sachet per product label instructions.

As a disinfecting soak:

1. With soap or detergent, thoroughly clean halters, ropes or other types of equipment used in handling and restraining animals and forks, shovels and scrapers used in removing litter and manure. Rinse with water.
2. Fill container or vat with a ClO₂ 100 ppm solution and immerse items for a period of at least TEN (10) minutes.
3. Discard solution in sanitary drain or as ordinary non-hazardous waste. Do not reuse solution.
4. Thoroughly scrub treated feed racks, troughs, automatic feeders, fountains and waterers with soap or detergent and rinse with potable water before use.
5. Dispose of product packaging and/or sachet per product label instructions.

Disinfect for beverage, water systems and lines:

To disinfect lines, holding tanks and other equipment used in fountain drink and other beverage preparation, storage, transfer, and dispensing operations or to disinfect the lines and storage tanks of potable water storage systems aboard aircraft, boats and RVs (clean in place applications)

- Prior to disinfecting, clean tanks and flush thoroughly with clean, potable water.

HORTICULTURE

HORTICULTURAL DISINFECTANT, SANITIZER, ALGAECIDE, FUNGICIDE AND SLIME REMOVER/INHIBITER

TREATS/CONTROLS/INHIBITS: Algae (*Phormidium boneri*) and Fungi (*Penicillium digitatum*, *Botrytis* sp., *Fusarium solani*, *Pythium aphanidermatum*, *Pythium irregulare*, *Fusarium oxysporum* f. sp. *bassicum* (Fob))

Chlorine dioxide products, when used as directed:

1. disinfects non-porous hard surfaces, pots, flats, flower buckets and cutting tools;
2. sanitizes non-porous hard surfaces, racks, stands, work areas, benches and cutting tools;
3. removes or inhibits (under continuous treatment) re-establishment of slime in irrigation/transfer lines and systems; treats, controls and prevents build-ups of soil-borne plant diseases and other algae, fungi and attendant slimes on: soils used to grow nursery stocks, bedding plants, flowering plants and ornamentals; on cut flowers and other cuttings, seedlings and seeds; and on and

within greenhouse equipment and structures such as irrigation/transfer lines and systems, pots, floors, ventilation ducts and equipment, storage rooms, growing tables, evaporative coolers, plastics, benches and flower pots; and controls bacteria counts, maintains freshness and extends shelf life for cut flowers.

NOTE: Do not use products at concentrations higher than those recommended for each application. When applied directly to plants, seeds, cuttings or flowers as directed, Chlorine dioxide solutions do not cause adverse cosmetic effects, as testing and experience has demonstrated. However, testing has not been performed on EVERY plant species and users are advised to spot-test chlorine dioxide before applying it widely.

Active solution may be irritating if breathed. If applying solution inside greenhouse or enclosed area using a high pressure sprayer, wear a NIOSH/MSHA-approved respirator appropriate for chlorine dioxide; after treatment, ventilate greenhouse before reentering.

To disinfect non-porous hard surfaces, including stainless steel, glazed tiles, sealed concrete and sealed and finished wood used in horticultural applications:

1. Activate ClO₂ according to 'Directions for Use' on product label or packaging.
2. Pre-clean all surfaces prior to application of disinfection solution. Sweep and remove all plant debris. Use power sprayer to wash all surfaces to remove loose dirt.
3. Prepare solutions in indicated concentrations and ensure surfaces are wetted and remain visibly wet for the times noted below and in instructions associated with the chosen application. Dispose of product as indicated on package.

FOR WORK AREAS, BENCHES AND EVAPORATIVE COOLERS

Prepare a 100ppm solution in accordance with the instructions above OR dilute higher strength solutions appropriately.

Spray or swab work area and bench surfaces before each work period and again after each planting is completed to help control the transfer of diseases. Spray or swab evaporative cooler surfaces, ensuring visible wetness for at least TEN (10) minutes. When applying these solutions using a high-pressure sprayer, wear a NIOSH/MSHA-approved respirator appropriate for chlorine dioxide.

FOR REMOVING SLIME AND RETARDING ITS REEMERGENCE; bacteria (*Erwinia chrysanthemi*), algae (such as *Phormidium boneri*) and fungi (such as *Penicillium digitatum*, *Botrytis* sp., *Fusarium solani*, *Pythium aphanidermatum*, *Pythium irregulare*, *Fusarium oxysporum* f. sp. *Basiliicum* (Fob)); and for continuous treatment to inhibit their re-establishment in irrigation systems, flood floors, flooded benches, misting systems, humidification systems, recycled water systems and capillary mats:

1. Activate ClO₂ according to 'Directions for Use' on product label.
2. Pre-clean all surfaces prior to application of disinfection solution. Sweep and remove all plant debris. Use power sprayer to wash all surfaces to remove loose dirt.
3. Prepare chlorine dioxide solutions in indicated concentrations and ensure surfaces are wetted and remain visibly wet for the times required or are applied continuously as noted below.
4. Dispose of the packaging as directed on label.

AS AN INITIAL OR REMEDIAL TREATMENT TO DISINFECT AND REMOVE SLIME, ALGAE AND FUNGI FROM WATER HOLDING TANKS AND IRRIGATION/TRANSFER LINES (CLEAN-IN-PLACE APPLICATION)

Flush tank thoroughly with clean water.

1. Prepare a ClO₂ solution of 50 ppm, per instructions on label.
2. Fill tank completely with the 50 ppm solution. Run solution through transfer lines and appliances until the chlorine dioxide green solution appears at the outlets. Top-off tank with solution. Circulate or let stand in tank and lines for at least TWENTY (20) minutes. Overnight if possible. More Time equals Better Results.
3. Drain tanks and lines. Rinse with potable water. Resume normal operations.

FOR CONTINUOUS TREATMENT TO INHIBIT THE RE-ESTABLISHMENT OF SLIME, ALGAE AND FUNGI

1. Prepare a ClO₂ solution of 0.25 ppm (100ppm diluted 1:400) per instructions on label. Use the 0.25 ppm solution to operate the water system following normal application procedures.

NOTE: Use ultra-low range CHLORINE DIOXIDE test strips to verify concentration at downstream production points. Organic loads vary across water supplies and will influence injection levels necessary to ensure 0.25 ppm concentration at emitter hoses, mist nozzles and drip tubes.

As an algacide and fungicide for treating, preventing, suppressing and controlling horticultural diseases in commercial greenhouses, garden centers and nurseries:

1. Activate ClO₂ according to 'Directions for Use' on product label.
2. Pre-clean all surfaces prior to application of disinfection solution. Sweep and remove all plant debris. Use power sprayer to wash all surfaces to remove loose dirt.

3. Prepare chlorine dioxide solutions in indicated concentrations and ensure surfaces are wetted and remain visibly wet for the times required or are applied continuously as noted below. Dispose of the packaging as directed on label.

AS AN INITIAL OR REMEDIAL TREATMENT TO KILL ALGAE AND FUNGI ON SURFACES, EQUIPMENT, GREENHOUSE STRUCTURES, GLAZING, PLASTIC, BENCHES, WALKWAYS, FLOORS, WALLS, FAN BLADES, VENTILATION DUCTS, WATERING SYSTEMS, COOLERS AND STORAGE ROOMS:

1. Activate ClO₂ according to 'Directions for Use' on product label.
2. Prepare a **10 ppm solution**. i.e. **100ppm diluted 10:1**.
3. To apply: spray, mop, sponge or swap surfaces ensuring the target surfaces remain visibly wet for at least ONE (1) HOUR. When applying these solutions using a high-pressure sprayer, wear a NOISH/MSHA -approved respirator for chlorine dioxide.

NOTE: heavy growth of algae or fungi may require scrubbing to remove dead growth.

AS A WEEKLY TREATMENT TO KILL ALGAE AND FUNGI ON SURFACES, EQUIPMENT, GREENHOUSE STRUCTURES, GLAZING, PLASTIC, BENCHES, WALKWAYS, FLOORS, WALLS, FAN BLADES, VENTILATION DUCTS, WATERING SYSTEMS, WATERING SYSTEMS:

COOLERS AND STORAGE ROOMS:

1. Activate ClO₂ according to 'Directions for Use' on product label.
2. Prepare a **10 ppm solution**. i.e. **100ppm diluted 10:1**.
3. To apply: spray, mop, sponge or swap surfaces ensuring the target surfaces remain visibly wet for at least ONE (1) HOUR. When applying these solutions using a high-pressure sprayer, wear a NOISH/MSHA -approved respirator for chlorine dioxide.

As a dip to control and suppress bacteria (*Erwinia chrysanthemi*) on cuttings and cut flowers:

1. Activate ClO₂ according to 'Directions for Use' on product label.
2. Prepare a 5 ppm solution. i.e. 100ppm diluted 10:1.
3. Briefly dip cuttings or cut flowers and ensure they remain visibly wet with solution for at least one minute.
4. Dispose of the packaging as directed on label.

To maintain freshness and extend shelf life for cut flowers:

1. Prepare a 5 ppm solution. i.e. 100ppm diluted 10:1.
2. Unbundle the flowers to preclude bunching and place in vase on display on in cold storage in the 5 ppm chlorine dioxide solution. Solution may include 2% sucrose.
3. Refresh solution every 24 hours.
4. Dispose of the packaging as directed on label.

AGRICULTURE

APPLICATIONS FOR FRESH-CUT FRUITS & VEGETABLES

Chlorine dioxide products may be used to reduce spoilage or pathogenic microorganisms on cut or processed fruits and vegetables in food processing facilities, such as during flume and washing operations, and in other commercial food preparation areas. Depending on decontamination needs/contamination levels, use at concentrations up to 10 ppm to produce the desired microbial reductions on processed fruits and vegetables.

- Prepare a 10 ppm ClO₂ solution per product package directions. OR
- Prepare a 500 ppm stock solution and use a dilution device appropriate to the end concentration desired:
 - for 10 ppm, use a 1:50 dilution device (one part 500ppm solution to 49 parts water)
 - for 5 ppm, use a 1:100 dilution device (one part 500ppm solution to 99 parts water)
 - for 3 ppm, first dilute 500ppm solution to @300 ppm by adding 2 parts water to 3 parts 500 ppm solution; then use a dilution device (ONE part 300 ppm solution to 99 parts water)

TO EXTEND THE SHELF-LIFE AND FRESHNESS OF FRUITS AND VEGETABLES IN FOOD PROCESSING FACILITIES.

CHLORINE DIOXIDE WILL REDUCE CONCENTRATIONS OF SPOILAGE MICROBES ON RAW AGRICULTURAL COMMODITIES (RACS) INTENDED FOR COMMERCIAL FOOD PROCESSING.

1. Activate ClO₂ according to 'Directions for Use' on product label.
2. WASH AND THOROUGHLY RINSE FRUITS AND VEGETABLES WITH CLEAN, POTABLE WATER.
3. Prepare a 5 ppm chlorine dioxide solution.
4. Apply to fruits and vegetables by: either immersing/dipping in a tank of 5 ppm solution for ONE (1) minute OR using an application-specific sprayer (the industry standard fan or cone spray nozzle pattern) to cover all surfaces evenly with a 5 ppm spray. Replenish immersion solution at the rate of depletion; verify 5 ppm concentration using CHLORINE DIOXIDE TEST STRIPS. Empty and wash immersion tanks with every shift change.
5. Follow application to fruit and vegetables with a potable water rinse or canning, blanching or cooking.

PROCESS WATER APPLICATIONS:

ANTIMICROBIAL APPLICATIONS TO CONTROL THE BUILDUP OF MICROBES IN PROCESS WATERS FOR FRUITS AND VEGETABLES AND ASSOCIATED TANKS, FLUMES AND LINES

Chlorine dioxide products will inhibit microbial growth in water used PROCESS WATERS for fruits and vegetables. Appropriate for small to large volume applications.

NOTE:

- a. Replacement and replenishment intervals will vary with microbial challenge presented by fruits and vegetables treated. Recommended beginning concentrations of 5 ppm, with adjustments to ensure a residual concentration between 0.25 and 5 ppm depending on microbial challenge and operation-specific factors.
- b. Apply chlorine dioxide solution continuously or intermittently to achieve a residual concentration level between 0.25 - 0.50 ppm.
- c. Regularly confirm concentration of process water using CHLORINE DIOXIDE TEST STRIPS or other measurement tools (i.e. Oxidation Reduction Potential (OPR) metering)
 1. At regular intervals or before beginning a shift, clean tanks, flumes and lines using normal procedures and follow with potable water rinse. In conditions of severe microbial accumulation (or when slime is visible), it is advisable to treat the thoroughly cleaned system with an antimicrobial treatment before returning the system to normal operation. See "Antimicrobial and General Cleaning Applications for Water Lines and Tanks in Potable Water Systems" for recommendation on cleaning severely contaminated tanks.
 2. Activate appropriate ClO₂ according to 'Directions for Use' on product label based on the capacity of the tanks or system, anticipated replenishment/replacement cycle based on expected microbial loads and specific application method, once through or recycled. The optimal concentration necessary to ensure a residual concentration of between 0.25 and 5.0 ppm will vary across operations.

For 'ONCE-THROUGH' process designs, generate Remedies chlorine dioxide to the desired end concentration in the systems operating tank OR **generate a stock 500 ppm solution** external to the tank and meter the stock solution in adequate volume to raise the volumes of process water to desired concentration via mechanical injection or by batch-loading.

For 'RECYCLE' process designs, generate a **500 ppm stock solution** external to the the tank and inject activated solution in sufficient volume to raise the PROCESS WATER to the desired concentration via mechanical injection or by batch-loading.

SANITIZING FINAL RINSE OF PRE-CLEANED OR NEW RETURNABLE OR NON-RETURNABLE CONTAINERS

This product may be used as a final sanitizing rinse for plastic, glass or metal returnable and non-returnable bottles, cans, caps kegs and beverage containers & racking.

1. Wash bottles, cans or containers with detergent or cleaning solution and rinse with potable water.
2. Activate ClO₂ according to 'Directions for Use' on product label.
3. Prepare a ClO₂ solution of 50 ppm, per instructions on label.

To apply: spray, mop, sponge or swap surfaces ensuring the target surfaces remain visibly wet for at least THIRTY (30) SECONDS (including drying time). When applying these solutions using a high-pressure sprayer, wear a NIOSH/MSHA -approved respirator for chlorine dioxide.

WATER SYTEMS:

ANTIMICROBIAL AND GENERAL CLEANING USES FOR NON-POTABLE WATER APPLICATIONS INVOLVING RECIRCULATING WATER SYSTEMS (I.E., COOLING TOWERS, PAPER MILLS AND DECORATIVE FOUNTAINS).

Chlorine dioxide products help remove, control and inhibit reemergence of algae, fungi and other organic buildups in recirculating cooling water systems, including cooling towers and decorative and ornamental fountains. Chlorine dioxide can be used as a periodic treatment or during continuous operations in antimicrobial applications involving algae, fungi or bacteria.

1. Activate appropriate ClO₂ according to 'Directions for Use' on product label.
2. Follow Tank & Line Instructions for Use or PROCESS WATER Instructions.
3. Residual target concentrations are 0.5 ppm to 1 ppm. Follow process water test protocols.

AS AN INITIAL OR REMEDIAL TREATMENT FOR RECIRCULATING COOLING WATER SYSTEMS, WATER HOLDING TANKS AND DECORATIVE AND ORNAMENTAL FOUNTAINS

1. Achieve a 5 ppm solution. Verify 5 ppm concentration using CHLORINE DIOXIDE TEST STRIPS.

FOR THE CONTINUOUS TREATMENT TO INHIBIT THE RE-ESTABLISHMENT OF SLIME, ALGAE OR FUNGI

1. Achieve a 0.5 ppm concentration. i.e. 10ppm diluted 20:1
2. Verify 0.5 ppm concentration using CHLORINE DIOXIDE TEST STRIPS.

NOTE: Check residual chlorine dioxide concentration using CHLORINE DIOXIDE TEST STRIPS. If the residual chlorine dioxide concentration falls below 0.1 ppm, add more 500 ppm chlorine dioxide CONCENTRATE to system (about 1 gallon of 500 ppm solution per 1,000 gallons of cooling or fountain water) to increase the residual chlorine dioxide concentration to about 0.5 ppm. Verify with test strips.

INSTRUCTIONS WHEN USING A DOSING PUMP AS AN INITIAL OR REMEDIAL TREATMENT FOR RECIRCULATING COOLING WATER SYSTEMS, WATER HOLDING TANKS AND DECORATIVE AND ORNAMENTAL FOUNTAINS

1. Achieve a 5 ppm solution RESIDUAL concentration. 100ppm diluted 20:1 or 10ppm diluted 2:1. Verify 5 ppm concentration using CHLORINE DIOXIDE TEST STRIPS.

INSTRUCTIONS WHEN USING A DOSING PUMP FOR CONTINUOUS TREATMENT TO INHIBIT THE RE-ESTABLISHMENT OF SLIME, ALGAE OR FUNGI

1. Set the dosing pump to achieve a continuous concentration of chlorine dioxide between 0.25 ppm and 0.5ppm.
2. In order to maintain this concentration and the appropriate dosing, consider the volume of water in the system, half-life (makeup/blowdown rate), evaporative rate and windage loss of the system. Verify 5 ppm concentration using CHLORINE DIOXIDE TEST STRIPS. If dosage falls below 0.25 ppm, increase the dosage rate.

FOR PERIODIC TREATMENT TO INHIBIT THE RE-ESTABLISHMENT OF SLIME, ALGAE OR FUNGI

1. Achieve a 0.5 ppm concentration. 10ppm diluted 20:1 or 100ppm diluted 200:1
2. Verify 0.5 ppm concentration using CHLORINE DIOXIDE TEST STRIPS.

REPEAT WEEKLY or on first indications of increased slime, algae or fungi.for each 1,000 gallons in a system (resulting in chlorine dioxide solution of 1 ppm)

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Chlorine Dioxide is known to be effective on these tested organisms
 (References follow)

Bacteria	Ref.
<i>Blakeslea trispora</i>	28
<i>Bordetella bronchiseptica</i>	8
<i>Brucella suis</i>	30
<i>Burkholderia mallei</i>	36
<i>Burkholderia pseudomallei</i>	36
<i>Campylobacter jejuni</i>	39
<i>Clostridium botulinum</i>	32
<i>Corynebacterium bovis</i>	8
<i>Coxiella burneti</i> (Q-fever)	35
<i>E. coli</i> ATCC 11229	3
<i>E. coli</i> ATCC 51739	1
<i>E. coli</i> K12	1
<i>E. coli</i> O157:H7 13B88	1
<i>E. coli</i> O157:H7 204P	1
<i>E. coli</i> O157:H7 ATCC 43895	1
<i>E. coli</i> O157:H7 EDL933	13
<i>E. coli</i> O157:H7 G5303	1
<i>E. coli</i> O157:H7 C7927	1
<i>Erwinia carotovora</i> (soft rot)	21
<i>Fransciella tularensis</i>	30
<i>Fusarium sambucinum</i> (dry rot)	21
<i>Fusarium solani</i> var. <i>coeruleum</i> (dry rot)	21
<i>Helicobacter pylori</i>	8
<i>Helminthosporium solani</i> (silver scurf)	21
<i>Klebsiella pneumonia</i>	3
<i>Lactobacillus acidophilus</i> NRRL B1910	1
<i>Lactobacillus brevis</i>	1
<i>Lactobacillus buchneri</i>	1
<i>Lactobacillus plantarum</i>	5
<i>Legionella</i>	38
<i>Legionella pneumophila</i>	42
<i>Leuconostoc citreum</i> TPB85	1
<i>Leuconostoc mesenteroides</i>	5
<i>Listeria innocua</i> ATCC 33090	1
<i>Listeria monocytogenes</i> F4248	1
<i>Listeria monocytogenes</i> F5069	19

Bacteria	Ref.
<i>Listeria monocytogenes</i> LCDC-81-861	1
<i>Listeria monocytogenes</i> LCDC-81-886	19
<i>Listeria monocytogenes</i> Scott A	1
Methicillin-resistant <i>Staphylococcus aureus</i> (MRSA)	3
Multiple Drug Resistant <i>Salmonella typhimurium</i> (MDRS)	3
<i>Mycobacterium bovis</i>	8
<i>Mycobacterium fortuitum</i>	42
<i>Pediococcus acidilactici</i> PH3	1
<i>Pseudomonas aeruginosa</i>	3
<i>Pseudomonas aeruginosa</i>	8
<i>Salmonella</i>	1
<i>Salmonella</i> spp.	2
<i>Salmonella</i> Agona	1
<i>Salmonella</i> Anatum Group E	1
<i>Salmonella</i> Choleraesuis ATCC 13076	1
<i>Salmonella</i> choleraesuis	8
<i>Salmonella</i> Enterica (PT30) BAA-1045	1
<i>Salmonella</i> Enterica S. Enteritidis	13
<i>Salmonella</i> Enterica S. Javiana	13
<i>Salmonella</i> Enterica S. Montevideo	13
<i>Salmonella</i> Enteritidis E190-88	1
<i>Salmonella</i> Javiana	1
<i>Salmonella</i> newport	4
<i>Salmonella</i> Typhimurium C133117	1
<i>Salmonella</i> Anatum Group E	1
Shigella	38
<i>Staphylococcus aureus</i>	23
<i>Staphylococcus aureus</i> ATCC 25923	1
<i>Staphylococcus faecalis</i> ATCC 344	1
Tuberculosis	3
Vancomycin-resistant <i>Enterococcus faecalis</i> (VRE)	3
<i>Vibrio</i> strain Da-2	37
<i>Vibrio</i> strain Sr-3	37
<i>Yersinia enterocolitica</i>	40
<i>Yersinia pestis</i>	30
<i>Yersinia ruckerii</i> ATCC 29473	31

Bacterial Spores	Ref.
<i>Alicyclobacillus acidoterrestris</i>	17
<i>Bacillus coagulans</i>	12
<i>Bacillus anthracis</i>	10
<i>Bacillus anthracis Ames</i>	30
<i>Bacillus atrophaeus</i>	14
<i>Bacillus atrophaeus ATCC 49337</i>	31
<i>Bacillus megaterium</i>	12
<i>Bacillus polymyxa</i>	12
<i>Bacillus pumilus ATCC 27142</i>	12
<i>Bacillus pumilus ATCC 27147</i>	11
<i>Bacillus subtilis (globigii) ATCC 9372</i>	11
<i>Bacillus subtilis ATCC 19659</i>	31
<i>Bacillus subtilis 5230</i>	12
<i>Clostridium. sporogenes ATCC 19404</i>	12
<i>Geobacillus stearothermophilus ATCC 12980</i>	11
<i>Geobacillus stearothermophilus ATCC 7953</i>	31
<i>Geobacillus stearothermophilus VHP</i>	11
<i>Bacillus thuringiensis</i>	18

Chemical Decontamination	Ref.
Mustard Gas	
Ricin Toxin	10
dihydronicotinamide adenine dinucleotide	24
microcystin-LR (MC-LR)	25
cylindrospermopsin (CYN)	25

Beta Lactams	Ref.
Amoxicillin	29
Ampicillin	29
Cefadroxil	29
Cefazolin	29
Cephalexin	29
Imipenem	29
Penicillin G	29
Penicillin V	29

Viruses	Ref.
Adenovirus Type 40	6
Canine Parvovirus	8
Coronavirus	3
Feline Calici Virus	3
Foot and Mouth disease	8
Hantavirus	8
Hepatitis A Virus	3
Hepatitis B Virus	8
Hepatitis C Virus	8
Human coronavirus	8
Human Immunodeficiency Virus	3
Human Rotavirus type 2 (HRV)	15
Influenza A	22
Minute Virus of Mouse (Parovirus)(MVM-i)	8
Minute Virus of Mouse (Parovirus)(MVM-p)	8
Mouse Hepatitis Virus (MHV-A59)	8
Mouse Hepatitis Virus (MHV-JHM)	8
Mouse Parvovirus type 1 (MPV-1)	8
Murine Parainfluenza Virus Type 1 (Sendai)	8
Newcastle Disease Virus	8
Norwalk Virus	8
Poliovirus	20
Rotavirus	3
Sialodscryoadenitis Virus (Coronavirus)(SDAV)	8
Simian rotavirus SA-11	15
Theiler's Mouse Encephalomyelitis Virus (TMEV)	8
Vaccinia Virus	10

Algae/Fungi/Mold/Yeast	Ref.
<i>Alternaria alternata</i>	26
<i>Aspergillus aeneus</i>	28
<i>Aspergillus aurolatus</i>	28
<i>Aspergillus brunneo-uniseriatus</i>	28
<i>Aspergillus caespitosus</i>	28
<i>Aspergillus cervinus</i>	28
<i>Aspergillus clavatonanicus</i>	28
<i>Aspergillus clavatus</i>	28
<i>Aspergillus egyptiacus</i>	28
<i>Aspergillus elongatus</i>	28
<i>Aspergillus fischeri</i>	28
<i>Aspergillus fumigatus</i>	28
<i>Aspergillus giganteus</i>	28
<i>Aspergillus longivesica</i>	28
<i>Aspergillus niger</i>	12
<i>Aspergillus ochraceus</i>	28
<i>Aspergillus parvathecicus</i>	28
<i>Aspergillus sydowii</i>	28
<i>Aspergillus unguis</i>	28
<i>Aspergillus ustus</i>	28
<i>Aspergillus versicolor</i>	28
<i>Botrytis species</i>	3
<i>Candida spp.</i>	5
<i>Candida albicans</i>	28
<i>Candida dubliniensis</i>	28
<i>Candida maltosa</i>	28
<i>Candida parapsilosis</i>	28
<i>Candida sake</i>	28
<i>Candida sojae</i>	28

Algae/Fungi/Mold/Yeast	Ref.
<i>Candida spp.</i>	5
<i>Candida tropicalis</i>	28
<i>Candida viswanathii</i>	28
<i>Chaetomium globosum</i>	7
<i>Cladosporium cladosporioides</i>	7
<i>Debaryomyces etchellsii</i>	28
<i>Eurotium spp.</i>	5
<i>Fusarium solani</i>	3
<i>Lodderomyces elongisporus</i>	28
<i>Mucor circinelloides</i>	28
<i>Mucor flavus</i>	28
<i>Mucor indicus</i>	28
<i>Mucor mucedo</i>	28
<i>Mucor rademosus</i>	28
<i>Mucor ramosissimus</i>	28
<i>Mucor saturnus</i>	28
<i>Penicillium chrysogenum</i>	7
<i>Penicillium digitatum</i>	3
<i>Penicillium herquei</i>	28
<i>Penicillium spp.</i>	5
<i>Phormidium boneri</i>	3
<i>Pichia pastoris</i>	3
<i>Poitrasia circinans</i>	28
<i>Rhizopus oryzae</i>	28
<i>Saccharomyces cerevisiae</i>	3
<i>Stachybotrys chartarum</i>	7
T-mentag (athlete's foot fungus)	3

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