Harnessing the Power of Chlorine Dioxide

A Cleaner and Safer Tomorrow
CHLORINE DIOXIDE

- Chemical formula: $\text{ClO}_2$
- Stable free radical: ![Stable free radical](image)
- Molecular weight: 67.45 g/mol
- CAS number: 10049-04-4
- Works over broad pH range, pH 2-10. Highly soluble in water as a gas.
- Environmental friendly, decompose to salt and water after use.
- Selective oxidation process, effective at lower dosage.
- Effective as a bactericide, virucide, sporicide, fungicide, algacide, odor eliminator and biofilm removal.
- Can not be compressed/shipped and needs to be generated onsite.
Disadvantages For Small and Medium Scale Application

- Capital costs
- Training
- Safety
- Maintenance
- Regulatory permits
- Transportation costs
- Disposal
MEMBRANE MICRO-REACTOR (M2R™) Platform Technology

• Proprietary platform technology which uses engineered membrane technology to generate chlorine dioxide and other antimicrobials in a controlled-release manner.

• M2R™ is a patented, portable, shelf-stable device for small and medium scale point-of-use applications of ClO₂.

• Versatile and efficient ClO₂ controlled-release mechanisms to address different performance requirements.

<table>
<thead>
<tr>
<th>Safety</th>
<th>Versatility</th>
<th>Cost</th>
</tr>
</thead>
</table>
| • Low conversion  
  • Short generation time | • High conversion  
  • Long generation time | • Low conversion  
  • Long generation time |

Ease-of-Use
MASS TRANSFER MECHANISM OF M2R™

Water-Activation Mechanism

**Step 1:** Water diffusion into M2R™ device through hydrophilic membrane.

**Step 2:** Chemicals’ dissolution.

**Step 3:** Dissolved chemicals exchange across hydrophilic membrane and chemical reaction takes place:

\[
5 \text{NaClO}_2 + 4 \text{H}^+ \rightarrow 4 \text{ClO}_2 + 4 \text{Na}^+ + \text{NaCl} + 2\text{H}_2\text{O}
\]

or

\[
2 \text{NaClO}_2 + \text{Na}_2\text{S}_2\text{O}_8 \rightarrow 2 \text{ClO}_2 + 2 \text{Na}_2\text{SO}_4
\]

**Step 4:** Chlorine dioxide (\(\text{ClO}_2\)) diffuses out of M2R™ device through hydrophobic membrane and/or gaps in the M2R™ device.
MASS TRANSFER MECHANISM OF M2R™

- No mixing or manipulating of chemicals
- Localized chemical reaction to maximize ClO₂ generation
- No electricity required, miniature self activated micro-reactor upon contact with water

Click Picture Above to Start Video (1 minute)
**Mass Transfer Mechanism of M2R™**

**Moisture-Activation Mechanism**

**Step 1:** Moisture introduced into M2R™ device through hydrophobic membrane with the assistance of deliquescent material.

**Step 2:** Acid powder becomes hydrated upon exposure to moisture.

**Step 3:** Partially dissolved acid (H⁺) absorbed into the inner membrane.

**Step 4:** H⁺ acidify the chamber containing sodium chlorite, and chemical reaction takes place.

**Step 5:** Generated ClO₂ diffuses out of M2R™ device through hydrophobic membrane.
**NosGUARD™**

- Self-activate to generate ClO₂ gas into environment. No spraying, pouring, wiping, aerosol cartridges, or batteries are required.

- Tri-action mechanism:
  - Oxidizing odor-causing compounds in the air.
  - Eliminating harmful microorganisms in the air.
  - Neutralizing harmful volatile organic compounds (VOC) in the air.

- Effective at controlling odors related to households, pets, molds/mildews, tobacco, food, fire and flood damage, garbage, and etc.

- Fast release (decontamination) and slow release (maintenance) product lines to meet different application requirements.
NosGUARD™ - APPLICATION

- Car/bus/RV interior deodorization
- Hotel tobacco smell removal
- Extend shelf life of cut flowers
- Fire and flood remediation
- Hunting gears/clothes scene removal
- Sport body armor odor control
- Military/police body armor/gears odor control
- Hospital chute room odor control
- Toilet hygiene maintenance
- Storage room maintenance
- Extend freshness of raw agricultural commodities
- Closet/locker deodorization
- Shoes deodorization
Residual gaseous ClO$_2$

One activated NosGUARD™ placed in the Ford Cobra car doors open after 57 minutes

- Instantaneous ClO$_2$ gas generation from NosGUARD™, fast penetration into interior of car (e.g., seat cushion) to eliminate the embedded odors.
- Fast dissipitation of residual ClO$_2$ gas from the car upon opening the car doors (at 57-60 minutes).
NosGUARD™ – STORAGE ROOM MAINTENANCE

- Independent product testing/validation from leading testing laboratory at Asia- SGS Hong Kong.

- Set up:
  - 2 x 2 x 2.5 m³ unventilated storage room, 40-50 % R.H @ room temperature
  - Total volatile organic compound (TVOC) measurement: ppbRAE TVOC Monitor
  - Total Bacteria Count (TBC) measurement: SAS bacteriological sampler, APHA plate count agar, incubation at 37°C for 48 hours.

<table>
<thead>
<tr>
<th>Sample</th>
<th>TVOC (ppbv)</th>
<th>TBC (cfu/m³)</th>
<th>TBC Removal Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before Treatment</td>
<td>670</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>24 hours After Treatment</td>
<td>620</td>
<td>3</td>
<td>90 %</td>
</tr>
</tbody>
</table>

- NosGUARD™ does not contribute to TVOC that are widely found in aerosol based odor control products (e.g., fragrant, odor masking chemicals, etc.)

- Reducing TBC level in the air, create a more hygienic environment.
## FEATURES AND BENEFITS OF NosGUARD™

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patented delivery system (Membrane Micro-reactor, M2R™)</td>
<td>Unique and scientifically proven technology</td>
</tr>
<tr>
<td>Built-in color indicator</td>
<td>Tangible/visual indication of product activity, user friendly</td>
</tr>
<tr>
<td>Active ingredient is USEPA registered</td>
<td>Product is regulated and safe</td>
</tr>
<tr>
<td>Design Flexibility</td>
<td>Customized products to solve user’s unique problems</td>
</tr>
<tr>
<td>Multifunctional and multiple applications</td>
<td>Destroys odors and the bacteria that caused odors</td>
</tr>
<tr>
<td>Versatility of chlorine dioxide</td>
<td>Kills bacteria, viruses, parasites</td>
</tr>
<tr>
<td></td>
<td>Sanitizer/Disinfectant/Sterilizer</td>
</tr>
</tbody>
</table>
**Avanflex™**

- Self-activate to generate ClO₂ solutions. Neutral pH solution, non corrosive as ClO₂ generated with acid.

- Multifunctional uses on surfaces as:
  - Deodorizer
  - Disinfectant
  - Sanitizer
  - Sterilizer

- Fast acting, effective at low usage concentration.

- Effective against biofilm, and kill bacteria hiding underneath it.

- Avanflex™’s ClO₂ solution can be used for mopping, spraying, soaking, dipping and flooding
AVANFLEX™ – CIO₂ GENERATION PROFILE

Chlorine Dioxide Generation Profile
One Avanflex™ (5.5 g) in 2 gallons (7.5L) tap water at 20 C

Time (minutes)

Concentration (ppm)
AVANFLEX™ – EFFICACY AT DIFFERENT USE CONCENTRATION

5 ppm
Spraying or dipping to reduce spoilage microorganisms, extend freshness and shelf life of raw agricultural commodities (e.g., fruit and vegetable)

20-50 ppm (Sanitizer)
Salmonella typhimurium
E. Coli
E. Coli O157:H7
Staphlococcus aureus
Klebsiella pneumonia
Penicillium digitatum
Fusarium solani
Botrytis Sp

100 ppm (Disinfectant)
Salmonella choleraesuis
Staphlococcus aureus
Pseudomonas aeruginosa
Methicillin-resistant S. aureus (MRSA)
Corona virus
Hepatitis A
Mycobacterium bovis (TB)
HIV-1
Poliovirus-1
Rotavirus
Feline Calicivirus
Trichophyton mentagrophytes
Enterrococcus faecalis
Influenza A virus
AVANFLEX™ – APPLICATION

- Hospital/clinic/nursing home - surfaces sanitation and disinfection
- Sport/gym facility - odor control and sanitation
- Hotel bathroom - odor control and sanitation
- Industrial shipping container - sanitation and disinfection
- Household - severe odor and mold/mildew removal
- Food processing facility - extend produce freshness and sanitizer
- Animal facilities - odor control, sanitation and disinfection
- Disaster area - surface sanitation and disinfection
- Emergency and non-emergency water fountain – biofilm removal and disinfection
Versan D100

- Self-activate to generate ClO₂ solutions for medical/dental instrument disinfection.

- Fast acting (10 minutes vs. hours), effective at lower usage (0.01%) concentration comparing to gluteraldehyde (2.5%).

- Does not allow pathogens to build up resistance, effective against biofilm builds up on instrument.

- Safer to use and more environmental friendly than gluteraldehyde.

- Easy to ship (dry chemicals), does not require electricity, suitable for remote application.

- Widely use by dentists at Belize Mission Project.
OdorScience is a leading developer and manufacturer of portable delivery systems for chlorine dioxide (ClO$_2$). This technology is based on proprietary membrane micro-reactor (M2R$^\text{TM}$) devices that use engineered membranes to deliver precise concentrations of ClO$_2$ gas and ClO$_2$ in solution.

**OdorScience**
1275 Kinnear Road
Columbus OH 43212
Tel: (614) 340-1862
Fax: (614) 487-3704