



# TWINOXIDE

- APPLICATIONS IN WATER DISINFECTION -





# INTRODUCTION TWINOXIDE



- TwinOxide International B.V.
- Founded in 2003
- Production, commercialisation, development of applications of TwinOxide 0.3% chlorine dioxide solution
- Design of preparation and dosing equipment
- Present (and past 5 years)
- Development of enhanced preparation and dosing equipment
- Improved safety, automation and control
- Development of large volume applications and equipment



# DISINFECTION OF POTABLE WATER

## Commonly used disinfectants

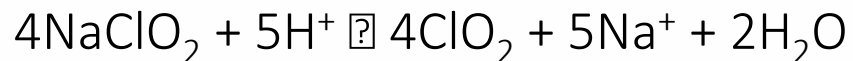
- Chlorine / Hypochlorite
  - Concerns – THMs, HAAs, MX
  - Efficacy reduced by high pH
  - Poor on Cryptosporidium, Algae and biofilm
- Chloramine
  - Concerns – THMs, HAAs, MX, Nitrosamines, Cyanogen Compounds
  - Poor on Cryptosporidium, moderate on Algae and Biofilm
- Chlorine Dioxide
  - No THM, HAA, etc Disinfection By-Products effective on all types of Micro-organism and Biofilm



# WHAT IS TWINOXIDE

*Safe, easy, efficient and consistent technic to produce a 0.3% chlorine dioxide solution from two solid powder precursors.*

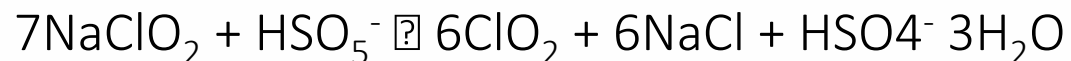
Classic method for generation of Chlorine Dioxide:



Excess acid used (2 to 3.5 times) to drive yield

Low pH (<1) with high Chloride – very corrosive

TwinOxide





# TWINOXIDE CHARACTERISTICS

TwinOxide solids  
more contained on  
spillage or leakage



Liquid Leakage



Liquid Spillage



Solid Spillage

- Powerful and rapid acting disinfectant
- Effective on all micro-organisms
- No known resistance by micro-organisms
- No harmful Disinfection By-Products

## Superior replacement for other disinfectants:

Chlorine ( $\text{Cl}_2$ )

Bromine ( $\text{Br}_2$ )

Halogen Donors (Misc)

Chloramines ( $\text{CH}_2\text{Cl}$ )

Hydrogen peroxide ( $\text{H}_2\text{O}_2$ )

Peracetic acid ( $\text{CH}_3\text{COOOH}$ )



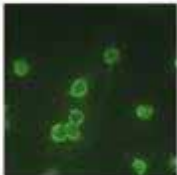
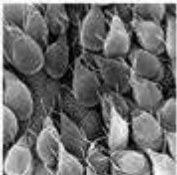


# EFFICACY OF CHLORINE DIOXIDE

*Ct<sub>99%</sub> value = Concentration (ppm) and time (minutes) required to obtain a 99.9% kill*

The lower the Ct<sub>99.9%</sub> the more efficient the biocide

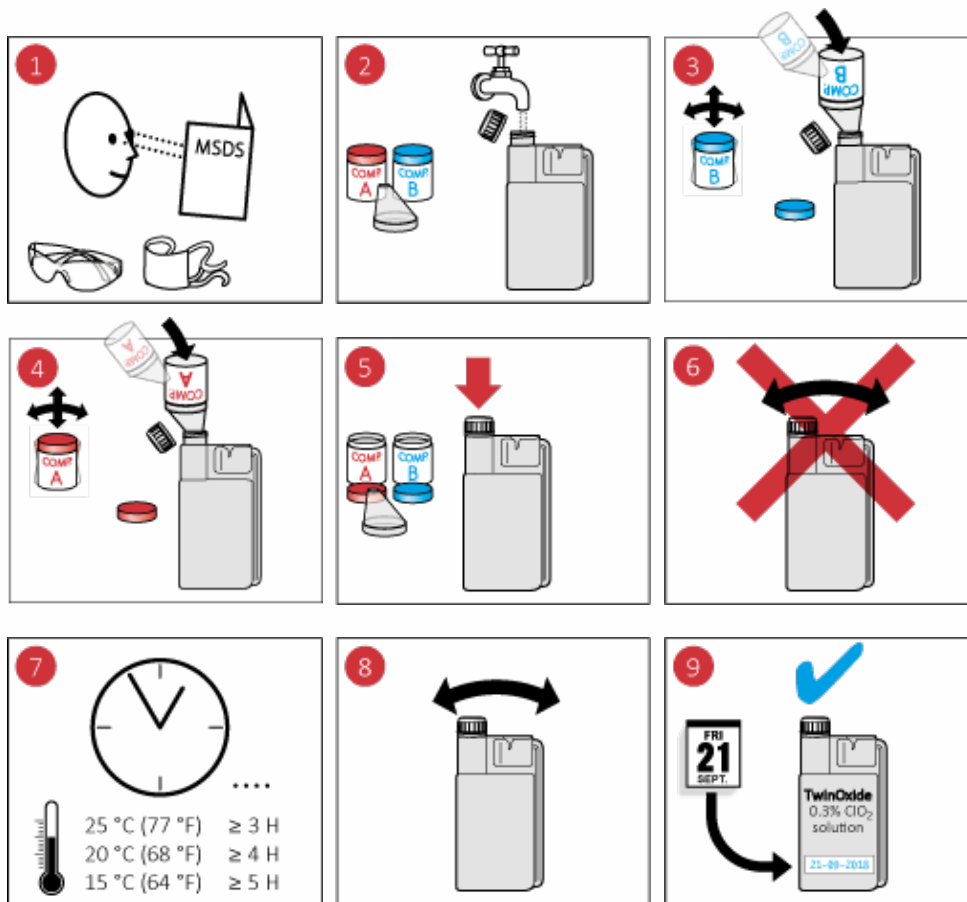
Guidelines for Drinking Water Quality | World Health Organization 2008

|                                                                                                                                           |                                                                                                                                    |
|-------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|
|  <b>Bacteria</b><br>ClO <sub>2</sub> 0.19 ppm/min        |  <b>Viruses</b><br>ClO <sub>2</sub> 2.8 ppm/min   |
|  <b>Cryptosporidium</b><br>ClO <sub>2</sub> 40 ppm/min |  <b>Giardia</b><br>ClO <sub>2</sub> 7.3 ppm/min |

- rapid kill
- low residual disinfectant concentration



# PREPARATION AND DOSING





# STABILITY

## TwinOxide 0.3% $\text{ClO}_2$ Solution

- Store in dark - UV light /photolysis degrades
- Store cool - stability decreases with temperature
- Nominally “Up to one month”  
20 days at 22°C
- Legally transportable

## TwinOxide Powder Components

- Component A – predominantly Sodium Chlorite
- Component B – predominantly Sodium Bisulfate  
plus oxidant peroxymonosulfate
- Both have a shelf-life of 5 years unopened



# COST [1/2]

Depends on many factors and variables

## Raw Water Quality

- Source - surface water, ground water?
- Organics and ammonia  
Consume halogens DO NOT AFFECT  $\text{ClO}_2$
- $\text{Fe}^{2+}$ ,  $\text{Mn}^{2+}$ ,  $\text{S}^{2-}$ ,  $\text{NO}_2^-$ ,  $\text{CN}^-$   
Consume both halogens and  $\text{ClO}_2$

1 ppm  $\text{Fe}^{2+}$  consumes 1.21 ppm  $\text{ClO}_2$

1 ppm  $\text{Mn}^{2+}$  consumes 2.45 ppm  $\text{ClO}_2$

1 ppm  $\text{S}^{2-}$  consumes 2.10 ppm  $\text{ClO}_2$

1 ppm  $\text{H}_2\text{S}$  consumes 5.2 ppm  $\text{ClO}_2$

1 ppm  $\text{NO}_2^-$  consumes 1.47 ppm  $\text{ClO}_2$

1 ppm  $\text{CN}^-$  consumes 5.19 ppm  $\text{ClO}_2$

Basic indication € 0.02 to € 0.05/m<sup>3</sup>



# COST [2/2]

Depends on many factors and variables

Dosing equipment

- Size
- Degree of automation, monitoring and control

Basic indication € 300 to € 4,000

ROI / Pay Back Time

Much is implicit – DBPs, carcinogenicity, taste, odour, safety, container return/disposal, chlorinator/generator maintenance



# PACKAGING



1 | 5 | 10 | 25 | 50 | 100 | 200 | 500 | 1,000 Liter  
0.3%  $\text{ClO}_2$  Solution



100 ml  
0.1%  $\text{ClO}_2$  Solution



# APPROVALS FOR TWINOXIDE [1/2]

Various approval for use in the Food Industry and Drinking Water Treatment

- DIN EN 12671 - Chemicals used for treatment of water intended for human consumption - Chlorine dioxide generated in situ.
- NSF International (NSF)
- Hygiene-Institut des Ruhrgebiets, Gelsenkirchen, Germany - for contact with food and drinking water.



# APPROVALS FOR TWINOXIDE [2/2]

## Approvals Registered Notified

- Austria
- Belgium
- Bulgaria
- Czech Republic
- Germany
- Hungary
- Italy
- Macedonia
- Montenegro
- Poland
- Portugal
- Romania
- Switzerland

In-situ generated biocides not included in all European Country approval lists Spain, TwinOxide approved but it is simply because they follow the European standards in other EU Countries. They do not have a special approval protocol. . e.g.

France, TwinOxide is listed, but because there is not any relative business, not yet progressed for Part 5 approval.



# CHLORITE AND CHLORATE

3 samples tested by an Independent Laboratory (Eurofins Environment)

“Worst Case” Chlorine dioxide 3800 ppm

Chlorite 480 ppm

Chlorate 528 ppm

WHO

0.4 ppm  $\text{ClO}_2$  max



At 0.4 ppm  $\text{ClO}_2$

0.7 ppm Total  $\text{ClO}_2^- + \text{ClO}_3^-$

Chlorite 0.051 ppm

Chlorate 0.056 ppm



0.11 ppm Total



# USA MUNICIPAL SUPPLY

100,000 – 5,700,000 litres/day

Out of compliance – THMs

Fines, threat of forced plant closure

Changed from Chloramine to TwinOxide mid 2016

Well water pH 9.5 to 11

Dosage 1 ppm  $\text{ClO}_2$

0.8 ppm pre-disinfection –  $\text{H}_2\text{S}$  contamination

0.2 ppm for disinfection

Minimal investment

THMs reduced from 120 ppb to ND

HAAs reduced to ND

Improved taste and odour



# EUROPE MUNICIPAL SUPPLY

200,000 – 800,000 litres/day

Ground Water source

**Biofilm throughout the distribution system using incumbent chloramine treatment**

Initial dose 0.7 ppm  $\text{ClO}_2$  for 3 months

After increasing residual concentration of  $\text{ClO}_2$  at end of pipe

Dosage reduced to 0.3 ppm  $\text{ClO}_2$

Further reduced to 0.2 ppm  $\text{ClO}_2$  after 6 -8 months

Over the years of TwinOxide application, residual disinfectant concentrations reduced to 0.05 to 0.10 ppm  $\text{ClO}_2$

Whole distribution system maintained under control – no biofilm

**Ammonia contaminated Ground Water**

Plant Managers do not want to produce Chloramines and/or associated Disinfection By-Products



# AFRICA DRINKING WATER SUPPLY

Several applications

400,000 – 300,000,000 litres/day

Logistics / transport / safety – solids preferred  $\text{Ca}(\text{OCl})_2$  commonly used

Paper bags – spoilage, spillage, accidents

Difficulty maintaining Chlorine Residual

Iron and Manganese oxidation issues

Poor Algae control resulting in blooms

Poor / lack of Biofilm control

TwinOxide resolved these issues and proved to be a superior alternative to  $\text{Ca}(\text{ClO})_2$

TwinOxide supplied in UN Approved Containers

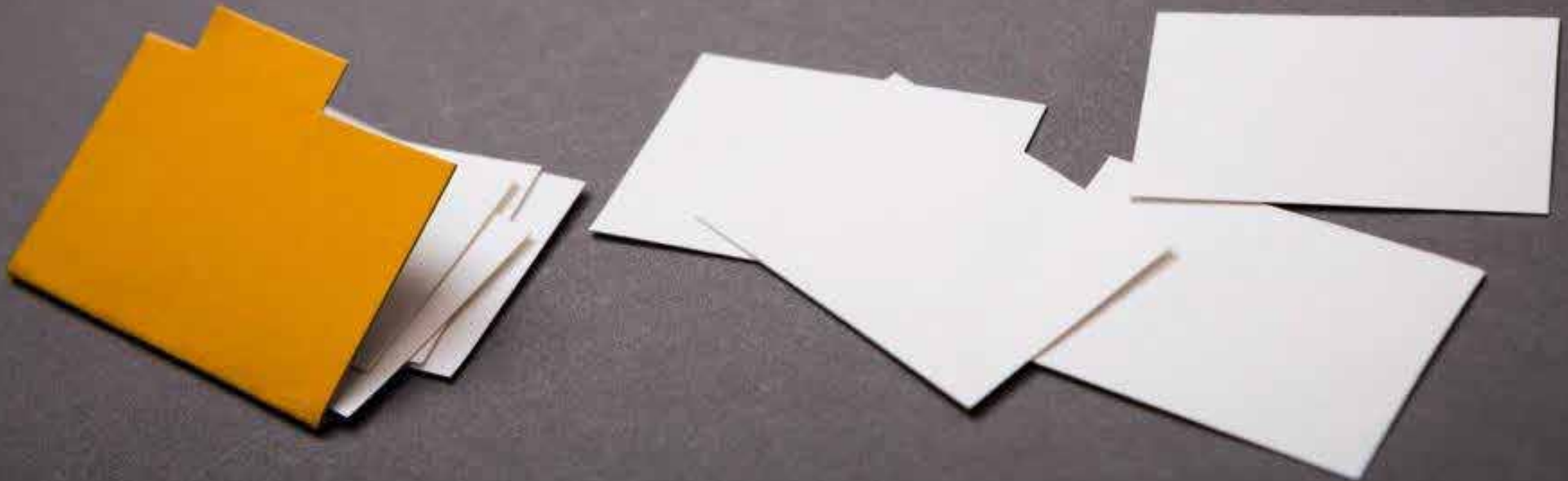


# WHAT IS TWINOXIDE SEEKING?

- Partners, Agents, Distributors to expand markets in New Applications and/or Countries / Territories not yet covered.
- Conduct independent or joint application trials or feasibility studies under mutually agreed terms and conditions.



# APPENDICES





# APPROVALS FOR TWINOXIDE

Various approval for use in the Food Industry and Drinking Water Treatment

- **DIN EN 12671** - Chemicals used for treatment of water intended for human consumption - Chlorine dioxide generated in situ.
- American National Standards Institute (**ANSI**)
  - approval for treatment of drinking water.
- United States Environmental Protection Agency (**EPA**)
  - for use as a biocide.
- Kosher and Halal Certified Products
- Food Standards Australia New Zealand (FSANZ) approval for washing, peeling and disinfection.



## Ct Chlorine Dioxide (ppm min)

|                           |      |          |
|---------------------------|------|----------|
| Escherichia coli          | 0.25 | >99.999% |
| Lactobacillus brevis      | 5    | >99.999% |
| Pediococcus damnosus      | 5    | 99.999%  |
| Pseudomonas aeruginosa    | 1    | >99.999% |
| Staphylococcus aureus     | 1    | 99.999%  |
| Staphylococcus faecal     | 0.25 | >99.999% |
| Penicillium expansum      | 40   | 99.999%  |
| Saccharomyces cerevisiae  | 5    | >99.999% |
| Saccharomyces cerevisiae  | 1    | >99.999% |
| Saccharomyces dlastaticus | 1    | >99.999% |



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