Chlorine Dioxide Presentation

For

Daparak, Inc
Agenda

- Who We Are
- Markets and Application Areas
- Product and Services We Offer
- Chlorine Dioxide Applications
- Chlorine Dioxide Generation
- Analytical Equipment
- References/Estimated Costs/Questions
Who We Are - Overview

- Sherri Downing – General Manager/Owner
- Ben Fox – Operations Manager/Owner
- Martin Doughty – Warehouse/Logistics Manager
- Mark Kern – Technical Services Manager
- Parker Downing – Web Designer/Office Assistant
- Andy Urbanowski - GENESYS Design Consultant
Who We Are - Overview

- Premier municipal water treatment service company
- Full line of water treatment products and services focused on municipal potable water and wastewater needs
- Regional player in the US Municipal Water Market covering Midwest (MO, KS, OK, NE, AR, IA, IL, TX, LA)
- State of the art, low cost manufacturing and distribution facility located in La Cygne, KS
- Women Owned - Small Business
- Company owned box truck with liftgate for deliveries
Who We Are - Overview
Applications

- Algae Control
- Aeration Basins
- Biofilm/ Legionella Control
- Clarification
- Color Removal
- Cooling Water
- Contaminant Destruction
- Dewatering
- Disinfection
- Effluent Treatment
- Emulsion Separation
- Filtration Aids
- Iron & Manganese Removal
- Odor & Corrosion Control
- Preoxidation Technology
- Process Aids
- Process Water
- Solids Handling
- Taste & Odor Control
- THM & HAA\textsubscript{5} Control
- TOC Reduction
- Wastewater Systems
Products

- Sodium Chlorite -25%
- Liquid Ammonium Sulfate (LAS)
- Liquid Sodium Permanganate
- Coagulants – Liquid Alum & ACH
- Proprietary Coagulants
- Polymers – Solution and Emulsion
- Corrosion Inhibitors
- Sequestering Agents
- Sodium Hypochlorite – 12.5%
- Hydrochloric Acid – 15%
- Powdered Activated Carbon
- Copper Sulfate – 25%
- Iron Salts (Ferric & Ferrous)
- Sulfuric Acid – 98%, 93%, 70%
- Sodium Hydroxide - 50%, 25% (Caustic Soda) –Diaphragm, Membrane
- Dry Potassium Permanganate
Products and Services

Equipment

- Modular dosing equipment (pumps) - Grundfos
- Chlorine dioxide generation equipment – GENESYS chlorine dioxide unit
- Corrosion test racks
- Analytical test equipment - GE TOC unit
Technical Services Offering

Services

- Technical evaluations
- Engineered installations
- System monitoring and maintenance
- Inventory Management
- Turn key installations
- Seven-day 24 hour emergency service
Chlorine Dioxide
Why Chlorine Dioxide for Municipal Water Treatment?

- Extremely effective primary and post-disinfectant
- Inactivates Giardia Lamblia and Cryptosporidium oocysts
- No strong pH dependence with disinfection efficiency
- Strong chemical oxidant - taste and odor control, color removal, iron and manganese removal
- Does not form brominated or chlorinated trihalomethanes (THM’s) or haloacetic acids (HAA’s)
- Does not react with bromides or ammonia
- Enhances coagulation and filtration
- Controls zebra mussels
- Biofilm
Disinfection By Products (DBPs)
Trihalomethanes (THM)

- THMs are a class of organic compounds formed when three of the hydrogen atoms in the methane molecule are replaced with three halogen atoms (chlorine or bromine).

- Regulated at 80 ppb.
Haloacetic Acids (HAA\textsubscript{5})

- Haloacetic Acids are a group of chemicals formed when free chlorine reacts with naturally occurring matter (NOM) in water.
- There are nine (9) known Haloacetic Acids
- Currently only five of the HAAs are regulated by EPA.
- Regulated at 60 ppb
DBP’s Reduction Alternatives

- Low capital easily implemented
  - Changing chlorination application point
  - Optimization of sedimentation & filtration
  - Use of multiple disinfectants (*chloramines*)
  - Use of chlorine dioxide

- High capital/long lead times
  - Granular activated carbon (*GAC*)
  - Membrane filtration
  - Ozone/GAC
Replacing Cl₂ with ClO₂

The conversion from Cl₂ to ClO₂ as a disinfectant occurs easily since we use the same injection points for both chemicals.

Regulations

- **USEPA:**
  - MRDL = 0.8 mg/L chlorine dioxide
- **Disinfection by-products (DBPs)**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>THMs</td>
<td>80 µg/L</td>
</tr>
<tr>
<td>HAAs</td>
<td>60 µg/L</td>
</tr>
<tr>
<td>Chlorite</td>
<td>1 mg/L</td>
</tr>
<tr>
<td>Bromate</td>
<td>10 µg/L</td>
</tr>
</tbody>
</table>
Other Chlorine Dioxide Applications
Disinfection with ClO$_2$

- Broad spectrum biocide and viricide
  - Effective against bacteria, viruses, spores, fungi, molds, algae and biofilm

- Effective against *Giardia* and *Cryptosporidium*

- Lower CT values for compliance

- Maintains disinfection efficacy at pH 9 or higher
Taste & Odor Control

- May not be one chemical solution
- Geosmin particularly difficult to remove
- Limited to the amount of ClO$_2$ you can add (MCL for ClO$_2^-$ of 1.0 mg/L)
- Consider a combination of chemical solutions
  - Oxidant and PAC (carbon)
  - Oxidants at low levels with enhanced coagulation
Fe and Mn Oxidation

- Rapid oxidation of soluble manganese
  - 0.49-2.45 parts ClO₂ oxidizes 1 part manganese depending on pH > 7

- Oxidizes Fe⁺² to Fe⁺³
  - 0.25-1.2 parts of ClO₂ oxidizes 1 part of iron depending on pH > 5

- Improved settling and longer filter runs
Zebra Mussel Control

- Studies and practical experience show control of zebra mussels

- Apply through diffuser ring at intake

- Evansville, IN and Brockport, NY (several years)

- Veliger Control at 0.25-0.50 ppm continuous feed
ClO₂ Application Points

- Raw water
  - Algae Control
  - Biofilm Control
  - Macrofouling (Zebra Mussel/Clams)

- Presettled water
  - THM/ Mn

- Secondary basin – Iron and Mn

- Prior to filtration for trace residual

- Distribution System
  - Chlorite inhibits nitrification
  - Can use in conjunction with Chloramines for post disinfection
Chlorine Dioxide Generation
What is Chlorine Dioxide?

- Odor - similar to chlorine
- Color - yellow - green
- Density - about 2.4 times that of air
- Highly soluble in water
- Threshold odor - 0.1 PPM
- Solutions produced for potable water treatment range between 0.1% and 0.5%
- Unstable as gas so must be generated on site and absorbed into water
How Is ClO$_2$ Supplied?

- Chlorine dioxide is generated at point of use
  - DOT forbids road transport of ClO$_2$
  - Liquefied pure gas too energetic – heat, light and shock sensitive

- End user purchases a process designed to deliver product upon demand

- Product quality varies with process

- Generator capacities range from pounds/day to tons/day
Principles of \( \text{ClO}_2 \) Generation

- Produced from one of two precursors
  - Sodium chlorate (\( \text{NaClO}_3 \))
  - Sodium chlorite (\( \text{NaClO}_2 \))

- Chemistry is either......
  - Acid conversion using mineral or organic acids
  - Conversion involving chlorine in some form: aqueous chlorine; gaseous chlorine; bleach plus acid to produce chlorine in generator
  - Electrochemical
Chlorine Dioxide Generators

1-Chemical Systems (NaClO₂)
- Electrochemical
  - PureLine

2-Chemical Systems (NaClO₂/Cl₂)
- NaClO₂/Direct HCl
  - ProMinent/Grundfos/IDI
- Vapor phase Cl₂
  - Sabre/D&F/Siemens
- Solid Matrix
  - CDG (Severn Trent)
- Aqueous Cl₂
  - IDI/Capital Controls/Siemens

3-Chemical Systems (NaClO₂/NaClO₃)
- NaClO₂/NaOCl/HCl
  - Vapor Phase
    - Sabre/D&F/Siemens
  - Low pH
    - IDI/Capital Controls
- NaClO₃/H₂SO₄/H₂O₂
  - Eka Chemicals
Overall reaction simple and very efficient

\[ 2\text{NaClO}_2 + \text{Cl}_2 \rightarrow 2\text{ClO}_2 + 2\text{NaCl} \]

- 2 chlorites give 2 chlorine dioxides = 100%
  - Maximum theoretical efficiency = 100%
- Maximum practical efficiency = 95-98%
2 Chemical System – Sabre/D&F
3-Chemical ClO₂ Generation
Hypochlorite/Acid Conversion of Chlorite

- Generation of chlorine \textit{in situ}

- Two step reaction

\[
\text{NaOCl} + 2\text{HCl} & \rightarrow \text{Cl}_2 + \text{NaCl} + \text{H}_2\text{O} \quad (1) \\
2\text{NaClO}_2 + \text{Cl}_2 & \rightarrow 2\text{ClO}_2 + 2\text{NaCl} \quad (2)
\]

- 2 chlorites form 2 chlorine dioxides $= 100\%$
  - Maximum theoretical efficiency $= 100\%$
  - Achievable practical efficiency $= 95\text{-}98\%$
3-Chemical ClO2 Generation - Sabre
3-Chemical ClO2 Generation - Sabre
PLC Control Box – D&F
Alarm Screen

Current Alarms/Warnings

Alarm/Warning History
Built In Analog Diagnostics
Example Help for Sensor Hook Up

Wiring an Analog Input Sourcing Sensor

When wiring to a sourcing sensor, the power for the 0-4-20mA loop is provided by the sensor itself.

Wire the positive (+) lead from the sensor to the top terminal on the analog input block, which is the input.
(By convention, the positive wire is usually white, or red)

Wire the negative (-) lead from the sensor to the DC Common terminal, which is the 2nd from the bottom.
This wire is usually black.

The shield wire should be landed on the green and yellow terminal at the bottom of the terminal block.
The shield wire SHOULD NOT be connected at the sensor but rather cut back, and taped. This is done to prevent noise from a ground loop.

Go Back
Example Terminal Wiring Help
Overview Screen – Local or Remote
Performance Screen
Example – Pop Up Help
Set up Generator Equipment
Analytical Testing Requirements
60 – 70 % of chlorine dioxide dosage in drinking water goes to chlorite which is regulated to a maximum of 1.0 mg/l

Maximum dosage is about 1.5 mg/l unless chlorite removal is implemented.
Chlorite

- Chlorite is a by-product of chlorine dioxide.
- Associated with nervous system defects.
- Chlorite MCL 1.0 ppm
- There are some benefits of Chlorite however.
Chlorite has been shown to control nitrification in distribution systems.

Nitrification control possible with doses below the MCL 1.0ppm.

Some plants feeding Chlorite directly into distribution to accomplish this.
ClO$_2$/Chlorite Measurement

- Amperomteric titration
  - takes about 30 minutes per sample
  - can measure ClO$_2$ and chlorite

- Colorimetric methods:
  - very fast, easy
  - DPD, lissamine green B, chlorophenol red
  - under assessment by EPA (DPD is approved)
  - cannot measure chlorite
Severn Trent Manual Amperometric Titrator
Hach AutoCAT 9000 Amperometric Titrator
References

- City of Muskogee, OK – Flow Paced Unit
- Board of Public Utilities, KS – Flow Pace Unit
- City of Harrisonville, MO – 3 Chem Manual
- City of Garden City, MO – 3 Chem Manual
- And many more
Estimated Cost

- 3 Chemical Manual - $30,000 - $40,000
- 2 Chemical Manual - $25,000 - $35,000
- 3 Chemical Automatic - $75,000-$100,000
- 2 Chemical Automatic - $75,000 - $100,000
Questions?