OZONE TECHNOLOGY AND APPLICATIONS

presented to:
NEW FOUNDLAND WATER TREATMENT TECHNICAL CONFERENCE March 2002
by:
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What is Ozone?

- Ozone in an allotrope of the Oxygen molecule it is O3 instead of O2
- Ozone is very unstable it reverts back to O2 with a half life of 20-30 min at room temperature. For that reason it can not be stored and need to be produced on site from ambient air.
- Ozone is a very strong oxidant much more powerful then Chlorine.
Ozone Production

- UV Lamp
  - Ave. ozone production/UV lamp
    - 0.1 wt%
Ozone Production

- **Corona Discharge**
  - Ave. Ozone production
    - 0 - 10 wt%
  - **Energy Consumption**
    - 20 kWh/kg O₃ with air (LF)
    - 10 kWh/kg O₃ with O₂ (LF)
    - 10 kWh/kg O₃ with air (HF)
    - 5 kWh/kg O₃ with O₂ (HF)
## Ozone Reactivity

<table>
<thead>
<tr>
<th>Oxidant</th>
<th>Redox (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>O$_3$</td>
<td>2.07</td>
</tr>
<tr>
<td>HOCl</td>
<td>1.49</td>
</tr>
<tr>
<td>Cl$_2$</td>
<td>1.36</td>
</tr>
<tr>
<td>H$_2$O$_2$</td>
<td>0.87</td>
</tr>
<tr>
<td>O$_2$</td>
<td>0.40</td>
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</tbody>
</table>
Injection Methods

- **Contact Column**
  - Efficiency
    - 70% ozone dissolution
Injection Methods

- **Venturi**
  - **Efficiency**
    - 90% ozone dissolution

![Diagram of injection method](image_url)
Ozone Toxicity

Ref: Perry, Chemical Engineering, Mai 1993

Exposure Time (min)

Ozone Concentration in Air (ppm)

- No symptoms
- Non-toxic
- Toxic
- Very Toxic

0,1 1 10 100 1000 10000
# Biological Lethal Coefficients of Common Disinfectants

Ref: Hamil et Clawson, Water Technology, Avril 1997

<table>
<thead>
<tr>
<th>Disinfectant</th>
<th>Entero-bacteria</th>
<th>Virus</th>
<th>Bacterial Spores</th>
<th>Amoebic Cysts</th>
</tr>
</thead>
<tbody>
<tr>
<td>O₃</td>
<td>500</td>
<td>5</td>
<td>2</td>
<td>0.5</td>
</tr>
<tr>
<td>HOCl</td>
<td>20</td>
<td>1</td>
<td>0.05</td>
<td>0.05</td>
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<tr>
<td>OCl⁻</td>
<td>0.2</td>
<td>&lt;0.02</td>
<td>&lt;0.0005</td>
<td>0.0005</td>
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<tr>
<td>NH₂Cl</td>
<td>0.1</td>
<td>0.0005</td>
<td>0.001</td>
<td>0.02</td>
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</table>

BLC : high value = high disinfection power
**CT for Common Disinfectants**

*(pH = 6 - 9)*

Ref: Hamil et Clawson, Water Technology, Avril 1997

<table>
<thead>
<tr>
<th>Micro-organisms</th>
<th>Free Chlorine (ppm)</th>
<th>Chlorine Dioxide (ppm)</th>
<th>Ozone (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>E.Coli</td>
<td>0.034 – 0.05</td>
<td>0.4-0.75</td>
<td>0.02</td>
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<tr>
<td>Rotavirus</td>
<td>0.01 – 0.05</td>
<td>0.2 – 2.1</td>
<td>0.006 – 0.06</td>
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<tr>
<td>G. lamblia cysts</td>
<td>47 – 150</td>
<td>__________</td>
<td>0.5 – 0.6</td>
</tr>
<tr>
<td>G. muris cysts</td>
<td>30 – 630</td>
<td>7.2 – 18.5</td>
<td>1.8 – 2.0</td>
</tr>
</tbody>
</table>

*CT = Conc. O3 (ppm) x Contact Time (min)*

*Established by EPA, 99.9% neutralisation of micro-organisms*
Applications

- Residential & Municipal drinking water treatment
- Domestic or Industrial waste effluent treatment
- Agricultural waste effluent, irrigation water treatment
- Agricultural odour elimination
- Food storage and sterilisation
- Residential & commercial pool & spa treatment
- Semiconductor and electronic
- VOC destruction from gaseous or aqueous effluents
- Laundry water recycling
General O3 Treatment Configuration

Block diagram of ozone treatment process

- Compressor
- Air refrigeration
- Oil/water separator
- Filter
- Air dryer
- Oxygen concentrator
- Oxygen in
- Oxygen out
- Cooling in
- Cooling out
- Nitrogen out
- Ozone

Supplied by others

Water in

Centrifugal pump
(6 - 10 gpm)

Venturi

UV lamp

Bypass valve

Treated water out
Typical O3 Treatment plant
Air Compressors & dryers
O2 & O3 Generators
Ozone Injection
Retention Tanks
A. Carbon Filters
General O3 Treatment Configuration

Block diagram of ozone treatment process:

- Compressor
- Air refrigeration
- Oil/water separator
- Filter
- Air dryer
- Oxygen concentrator
- Oxygen
- Cooling in
- Nitrogen in (optional)
- Ozone
- Cooling out
- Nitrogen out
- Water in
- Centrifugal pump
  (6 - 10 gpm)
- Venturi
- Bypass valve
- UV lamp
- Treated water out
Some Skid mounted Ozonisers
Important Features

- Ozonator safety features
  - Emergency-off button
  - Internal lamp cooling
  - Nitrogen cooling (for explosion proof models)
  - Fan cooling
  - Thermostat
  - Flow switch for oxygen feed
  - Flow switch for internal cooling
  - Ozone monitor
  - Door switch
## Conclusions

L'Ozonation et Ozonation Catalytique se distinguent par:

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<thead>
<tr>
<th></th>
<th>Compact</th>
<th>Bas-Moyen</th>
<th>Très faible</th>
<th>Très élevée</th>
<th>Très facile</th>
<th>Minimal</th>
<th>Faible/Inexistante</th>
<th>Très élevés</th>
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<td>Espace d'Occupation</td>
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<td>Coût de capitalisation d’équipment</td>
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<td>Coût d’opération</td>
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<td>Génération de particules en suspension</td>
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<td>Rigidité /Stabilité du procédé</td>
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<td>Flexibilité du procédé</td>
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<td>Expansion</td>
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<td>Complexité</td>
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<td>Manipulation des produits chimiques</td>
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<td>Sécurités</td>
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