Safer Sanitizers and Disinfectants: A Look at San Francisco’s Latest Alternatives Analysis

BizNGO Webinar, May 7, 2014
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San Francisco Department of the Environment
Topics

- The problem
- Definitions
- Methodology
- Recommendations
- Regulatory challenges
Problems with disinfectants
Prions* (CJD, BSE) → Coccidia (Cryptosporidium) → Spores (Bacillus, C. difficile) → Mycobacteria (M. tuberculosis, M. avium) → Tuberculosis → Cysts (Giardia) → Small non-enveloped viruses (Polio virus) → Trophozoites (Acanthamoeba) → Gram-negative bacteria (non-sporulating) (Pseudomonas, Providencia) → Fungi (Candida, Aspergillus) → Large non-enveloped viruses (Enteroviruses, Adenovirus) → Gram-positive bacteria (S. aureus, Enterococcus) → Lipid enveloped viruses (HIV, HBV) → E. coli → Norovirus → Athletes Foot → Influenza

FIG. 1. Descending order of resistance to antiseptics and disinfectants. The asterisk indicates that the conclusions are not yet universally agreed upon.

Source: McDonnell & Russell, 1999
Definitions

- Non food contact sanitizers

- Staph
  - AND
  - Klebsiella pneumoniae OR Enterobacter aerogenes
  - 99.9% in 5 minutes
Definitions

- **Disinfectants**
  - **High-Grade, or Hospital-Grade**
    - *Staph, Salmonella, and Pseudomonas*
    - 99.9999% in 10 minutes
  - **General**
    - *Staph AND Salmonella*
    - 99.999% kill in 10 minutes
  - **Limited**
    - *Salmonella OR Staph*
    - 99.999% kill in 10 minutes.
Attributes assessed in this AA

- Hazard*
- Fate
- Physical-chemical properties
- Functional use
- Product performance*
- Technical feasibility
- Exposure potential*
- Cost and availability*
- Life-cycle impacts
- Social impacts
- Stakeholder input
- Comparison of materials and/or processes.

Assessment factors: Active ingredients

- Cancer
- Reproductive toxicity
- Respiratory sensitization
- Skin sensitization
- Aquatic toxicity
- Persistence
Assessment factors: Products

All of the above, and…

- Dwell time
- Efficacy for various microorganisms
- Acute toxicity
  - Skin
  - Eye
  - Respiratory
- Eutrophication potential
- Surface compatibilities
- Availability as a concentrate (carbon impacts)
- Potential for exposure reduction (dispensing systems)
Active ingredients considered

- Chlorine “bleach” (sodium hypochlorite)
- Hydrogen peroxide (regular and AHP)
- Organic acids (citric/lactic/caprylic)
- Ortho-phenylphenol
- Pine oil
- “Quats”
- Silver + citric acid
- Thymol

Other alternatives
- Electrolyzed water
- Microfiber cloth
- Soap and water
- Steam
# Sodium hypochlorite (bleach)

<table>
<thead>
<tr>
<th>PROS</th>
<th>CONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEAP, widely available</td>
<td>pH 11.5 = severe eye damage</td>
</tr>
<tr>
<td>Kills wide variety of microbes, versatile; some products kill Tb and/or NoroVirus</td>
<td>Respiratory irritant; Cl₂ and HCl are Asthmagens (AOEC)</td>
</tr>
<tr>
<td>Leaves no residue</td>
<td>Reacts with organic molecules – environmental hazards</td>
</tr>
<tr>
<td></td>
<td>Corrodes metals and floor polish</td>
</tr>
<tr>
<td></td>
<td>Not stable – loses potency</td>
</tr>
<tr>
<td></td>
<td>Reacts with other chemicals to form toxic gas</td>
</tr>
</tbody>
</table>
$1.79 (60 oz)  $2.00 (10.1 oz)
# Quaternary ammonium compounds

<table>
<thead>
<tr>
<th>PROS</th>
<th>CONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Widely available, inexpensive</td>
<td>Found in sewage outfalls</td>
</tr>
<tr>
<td>More stable than bleach</td>
<td>High aquatic toxicity, “persistent*”</td>
</tr>
<tr>
<td>Broader efficacy claims than most other products</td>
<td>Asthmagens; concentrates corrosive</td>
</tr>
<tr>
<td>Not as sensitive to organics as bleach</td>
<td>Forms toxic chloramine gas when mixed with bleach</td>
</tr>
<tr>
<td>Surfactant – cleans also</td>
<td>Dev &amp; repro toxicity observed (but not weight of evidence)</td>
</tr>
<tr>
<td>Available in neutral pH formulations</td>
<td>Requires rinsing – leaves residues</td>
</tr>
</tbody>
</table>
# Thymol

<table>
<thead>
<tr>
<th>PROS</th>
<th>CONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low environmental hazard</td>
<td>Strong smell</td>
</tr>
<tr>
<td>Rapidly breaks down</td>
<td>Skin sensitizer</td>
</tr>
<tr>
<td>Long shelf life</td>
<td>Possible repro effects ('weak’ studies)</td>
</tr>
<tr>
<td>Not an asthmagen</td>
<td></td>
</tr>
</tbody>
</table>
# Peroxide compounds

<table>
<thead>
<tr>
<th>PROS</th>
<th>CONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low human toxicity</td>
<td>Eye hazard from concentrates - corrosive</td>
</tr>
<tr>
<td>Low environmental hazard</td>
<td>Irritating vapors from concentrates</td>
</tr>
<tr>
<td>Rapidly decomposes to $\text{O}_2 + \text{H}_2\text{O}$</td>
<td>Animal carcinogen &amp; mutagen?</td>
</tr>
<tr>
<td>No residues</td>
<td></td>
</tr>
<tr>
<td>Effective on full range of microbes</td>
<td></td>
</tr>
<tr>
<td>Shorter dwell time than quats, pine oil</td>
<td></td>
</tr>
<tr>
<td>Whitens grout; removes stains</td>
<td></td>
</tr>
</tbody>
</table>
## Active ingredient review

<table>
<thead>
<tr>
<th>ACTIVE INGREDIENT</th>
<th>CANCER</th>
<th>REPRO TOX</th>
<th>ASTHMA</th>
<th>SKIN SENS</th>
<th>AQUATIC TOX</th>
<th>PERSIST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caprylic Acid</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Med acute</td>
<td>Low</td>
</tr>
<tr>
<td>Citric Acid</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>None</td>
<td>Low</td>
</tr>
<tr>
<td>Hydrogen Peroxide</td>
<td>No¹</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>High acute</td>
<td>Low</td>
</tr>
<tr>
<td>Lactic Acid</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>None</td>
<td>Low</td>
</tr>
<tr>
<td>Ortho-Phenylphenoll</td>
<td>Known</td>
<td>Suspected</td>
<td>No</td>
<td>No</td>
<td>Very high acute</td>
<td>Low</td>
</tr>
<tr>
<td>Peroxyacetic Acid</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Very high acute</td>
<td>Low</td>
</tr>
<tr>
<td>Pine Oil</td>
<td>No²</td>
<td>No</td>
<td>No³</td>
<td>Yes</td>
<td>None</td>
<td>Low</td>
</tr>
<tr>
<td>Quats</td>
<td>No</td>
<td>Suspected</td>
<td>Yes</td>
<td>One compound⁴</td>
<td>High acute, med chronic</td>
<td>Very High</td>
</tr>
<tr>
<td>Silver</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>High acute</td>
<td>Very High</td>
</tr>
<tr>
<td>Chlorine Bleach</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Very high acute</td>
<td>Low</td>
</tr>
<tr>
<td>Thymol</td>
<td>No</td>
<td>No⁵</td>
<td>No</td>
<td>Yes</td>
<td>High acute</td>
<td>Low</td>
</tr>
</tbody>
</table>
Recommendations-ingredients

• Hydrogen peroxide
• Citric acid
• Lactic acid
• Caprylic acid
• (Silver/citric acid)
## Sample product review

<table>
<thead>
<tr>
<th>Active Ing.</th>
<th>Dwell</th>
<th>Efficacy</th>
<th>(Bact, Virus, Fungi)</th>
<th>Health</th>
<th>Env</th>
</tr>
</thead>
<tbody>
<tr>
<td>H2O2</td>
<td>1</td>
<td>BB</td>
<td>VVV</td>
<td>FF</td>
<td>L</td>
</tr>
<tr>
<td>CAPRYLIC ACID</td>
<td>10</td>
<td>BBB</td>
<td>VVV</td>
<td>F</td>
<td>L</td>
</tr>
<tr>
<td>CITRIC ACID</td>
<td>10</td>
<td>BB</td>
<td>V</td>
<td>0</td>
<td>L</td>
</tr>
<tr>
<td>SILVER/CITRIC</td>
<td>1</td>
<td>BBB</td>
<td>VVV</td>
<td>F</td>
<td>L</td>
</tr>
<tr>
<td>LACTIC ACID</td>
<td>10</td>
<td>BB</td>
<td>V</td>
<td>0</td>
<td>L</td>
</tr>
<tr>
<td>THYMOL</td>
<td>10</td>
<td>BB</td>
<td>VV</td>
<td>F</td>
<td>H</td>
</tr>
<tr>
<td>QUATS</td>
<td>10</td>
<td>BBB</td>
<td>VVV</td>
<td>FFF</td>
<td>H</td>
</tr>
<tr>
<td>CHLORINE</td>
<td>1-10</td>
<td>BBB</td>
<td>VVV</td>
<td>FFF</td>
<td>H</td>
</tr>
<tr>
<td>PINE OIL</td>
<td>10</td>
<td>BB</td>
<td>0</td>
<td>F</td>
<td>M</td>
</tr>
<tr>
<td>H2O2 + PAA [ ]</td>
<td>10</td>
<td>BBB</td>
<td>V</td>
<td>FF</td>
<td>H</td>
</tr>
<tr>
<td>OPP</td>
<td>10</td>
<td>BBB</td>
<td>VVV</td>
<td>F</td>
<td>H</td>
</tr>
</tbody>
</table>
Recommendations - disinfectants
(for complete list, see report)

**Hydrogen Peroxide**

- **Accel** (Concentrate: 1:128, 3-minute dwell time)
- **Alpha HP** (Concentrate, 1:128 dilution, 3-minute dwell time)
- **Alpha-HP Multi-Surface Disinfectant Cleaner** (Concentrate, 1:128 dilution, 3-minute dwell time)
- **Carpe Diem Concentrate Five 16** (Concentrate: 1:128, 3-minute dwell time)
- **Envirox Concentrate 118/H2Orange2 117** (Concentrate, 5-minute dwell time)
- **Envirox H2Orange2 Superconcentrate 112** (Concentrate: 5:23 dilution, 5-minute dwell time)
- **G-Force H2O2 Bathroom Cleaner Disinfectant** (Concentrate, 1:128 dilution, 3-minute dwell time)
- **Oxivir Five 16** (Concentrate, 1:128 dilution, 3-minute dwell time)
- **Ramsey Bathroom Cleaner Disinfectant** (Concentrate, 1:128 dilution, 3-minute dwell time).
Recommendations - disinfectants
(for complete list, see report)

**Citric Acid**
- **Comet Disinfecting Bathroom Cleaner** (Concentrate, 1:4 dilution, 5-minute dwell time)

**Caprylic/Octanoic Acid**
- **Ecolab 65 Disinfecting Heavy-Duty Acid Bathroom Cleaner** (Concentrate, 1:40 dilution, 5-minute dwell time)
**Recommendations-specialized**

**Bloodborne pathogens HIV + HBV**

- **RTU**
  - 30 sec: Clorox Healthcare Peroxide Cleaner (1.4% H₂O₂)
  - 1 min: Oxivir Tb (0.5% AHP)
  - 1 min: Pure Hard Surface (Silver + Citric Acid)

- **Concentrate**
  - 5 min: Oxivir Five 16 (4.25% AHP; 1:16)
Recommendations-specialized

**Locker Rooms (Athletes Foot Fungus)**

- **RTU**
  - 5 min: H2Orange 120 One (1% H202)
  - 3 min: Clorox Healthcare Peroxide Cleaner (1.4% H2O2)
  - 10 min: Oxivir Tb (0.5% AHP)
  - 10 min: Clean-Cide (0.6% Citric acid)
  - 10 min: Quantum Tb (0.138% Caprylic acid)
  - 5 min: Limited: Pure Hard Surface (Silver + CitAcid)

- **Concentrate**
  - 5 min: Oxivir Five 16 (4.25% AHP; 1:16) 5 min.
Recommendations-specialized

Norovirus

- RTU
  - 1 min: Oxivir Tb (0.5% AHP)
  - 1 min: Clorox Healthcare Peroxide Cleaner (1.4% \( \text{H}_2\text{O}_2 \))
  - 5 min: Clean-Cide (0.6% Citric acid)
  - 1 min: Pure Hard Surface (Silver + Citric Acid)
    24-hr residual efficacy

- Concentrate
  - 5 min: Oxivir Five 16 (4.25% AHP @1:16)
Electrolyzed water devices
Microfiber
(an important part of an effective disinfection program)
Regulatory challenges

- Meaningful registration of devices
- Full ingredient disclosure
- Verifying manufacturers’ claims
- Confusion over market claims vs. label claims
Safer Products and Practices for Disinfecting and Sanitizing Surfaces

http://www.sfapproved.org/
Acknowledgements

- Susan Kegley – Pesticide Research Institute
- Kelly Moran – TDI Consulting
- Ann Blake – Ann Blake Consulting
- Justine Weinberg – Calif Dept. of Public Health
- Luz Agana – SF Dept. of Public Health
- Karen Cohn – SF Dept. of Public Health
- Bridget Williams - USEPA DfE
- Cal Baier-Anderson - USEPA DfE