

# SASKPIC

## Taking the Mystery out of Chemical Disinfection

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## Basic Facts

- Disinfectants are the backbone of Infection Control
- >8000 Products registered in the U.S. & Canada
- 50% of which are used for Healthcare Infection Control
- There are 300 different active chemistries
  - 14 are in 95% of the disinfectant products
  - 6 are the most common

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## Effects of Germicides on Microorganisms

- HCWs take for granted the action of disinfectants without fully understanding mechanism of action
- Differences in the action of antimicrobial ingredients
- Differences depending on concentration of chemical used

Infection Control Today  
Cleaning & Disinfecting: The Effects of Germicides on Microorganisms  
Feb 2004

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## Chicago Tribune (2000)

- 75% of an estimated 103 000 patient deaths linked to HAIs
- Due to unsanitary facilities, unwashed hands & dirty instruments
- Found that hospital cleaning staff were inadequately trained & cuts cleaning budgets

Chicago Tribune

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## Computer Keyboards May Harbor Harmful Bacteria

- Harmful bacteria can survive for prolonged periods on keyboards & keyboard covers (VRE & MRSA: 24 hrs, PSAE: 1hr)
- More contact with contaminated keyboard increase likelihood of transmitting bacteria to hands (MRSA: 42% - 92%, VRE: 22% to 50%, PSAE: 9% to 18%)
- Hand Hygiene important helps cut down on transmission
- Cleaning & Disinfection of keyboards & keyboard covers helps decrease contamination

Infection Control Today  
Computer Keyboards May Harbor Harmful Bacteria;  
Experts Advise to Use Disinfectant and Wash Your Hands  
April 2005

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## On the Same Page

Terminology, Definitions,  
Common Words

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# Major Groups Of Microbes

- Viruses (enveloped)
- Bacteria (*Gram +ve* & *Gram -ve*)
- Fungi
- Viruses (non-enveloped)
- Mycobacteria
- Protozoa
- Bacterial Spores




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Typically, the more resistant the pathogen, the more toxic the disinfectant needs to be...




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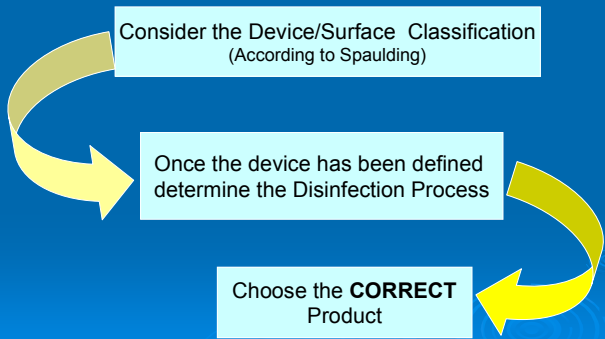
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# Process for Choosing a Disinfectant




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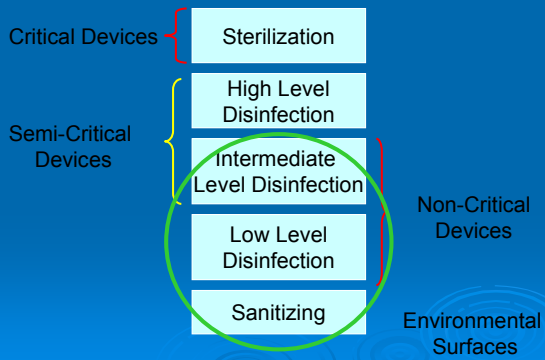
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## Process for Choosing a Disinfectant



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## Cleaning

- The removal of adherent visible soil, blood, protein substances (tissue) and other debris from surfaces by mechanical or manual process
- Generally accomplished with water and detergents
- Removes or eliminates the reservoirs of potential pathogenic organisms



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## Criteria for Sanitizing

- A process that reduces microorganisms on surfaces to a safe level
  - **Food Contact Surfaces:** reduction of surrogate bacterial strains by more than  $5\text{-log}_{10}$  in the presence of 5% bovine serum
  - **Non-Food Contact Surfaces:** reduction of surrogate bacterial strains by more than  $3\text{-log}_{10}$
- Vegetative Bacteria such as E. coli, Staphylococcus, Pseudomonas and other common food borne bacteria can be used

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## Criteria for Low Level Disinfection

- Bactericidal: effective against Vegetative bacteria:  
> 6 Log<sub>10</sub> reduction
  - *Staphylococcus aureus*, *Pseudomonas aeruginosa*,  
*Salmonella choleraesuis*
- General Virucide: effective against the Sabin strain of Polio virus Type 1 (Hydrophilic virus), criterion is > 3 Log<sub>10</sub> reduction
- Virucidal: effective against targeted viruses (enveloped or non-enveloped), criterion is > 3 Log<sub>10</sub> reduction
- Fungicidal: effective against criterion is > 5 Log<sub>10</sub>
  - *Trichophyton mentagrophytes*

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## Criteria for Intermediate Level Disinfection

- Bactericidal: criterion is > 6 Log<sub>10</sub> reduction
- General Virucide: criterion is > 3 Log<sub>10</sub> reduction against Polio
- Virucidal: criterion is > 3 Log<sub>10</sub> reduction against specific viruses
- Fungicidal: effective against *Trichophyton mentagrophytes*, criterion is > 5 Log<sub>10</sub>
- Tuberculocidal: effective against *Mycobacteria terrae*, criterion is > 4 Log<sub>10</sub>

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## Criteria for High Level Disinfection & Sterilization

- Fungicidal: effective against *Trichophyton mentagrophytes*, criterion is > 5 Log<sub>10</sub>
- Tuberculocidal: effective against *Mycobacteria terrae*, criterion is > 6 Log<sub>10</sub>
- Sporocidal: effective against *Bacillus subtilis* & *Clostridium sporogenes*, criterion is > 6 Log<sub>10</sub>

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## Disinfectants: Desired Traits & Limiting Factors



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## Marketplace overview

➤ Existing Technologies *"FAIL"* in one or more of the key decision making criteria when selecting a cleaner/disinfectant.

- *Cleaning Efficacy*
- *Disinfection Capability*
- *Personal Health & Safety*
- *Environmental Responsibility*

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## Positive Changes

➤ "It is cheaper & more effective to prevent environmental & health damage than to attempt to manage or cure it. Prevention requires examining the entire life cycle of products. It encourages the exploration of safer alternatives and the development of cleaner products, technologies & workplaces."

- Preventing Occupational & Environmental Cancer  
- A strategy for Toronto

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## Registration

- Government registered by Health Canada (DIN)
- Easy to Use with clear label instructions

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## Microbiological

- Broad-Spectrum Germicidal Activity
- Fast Acting
- Not Readily Neutralized in Organic or Inorganic Matter
- Microorganism Resistance will not develop

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## Chemical

- Safe to Transport
- Long Shelf Life
  - Improper or prolonged storage of disinfectants may lead to growth of bacteria in them
- Safe & Easy to Store
  - Improper storage of disinfectants may lead to explosions or fires
- Non-Corrosive & Material Compatible
  - Using the wrong type or level of disinfectant may cause corrosion or other damage to expensive items such as flexible endoscopes

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## Toxicological

- Non-Toxic to humans & animals
- Non-Allergenic & non-sensitizing
- Non-Hormone disruption
  - Certain microbicidal chemicals or their breakdown products can disrupt hormone function in humans & animals
- Safe for the User and Patient
  - Exposure to cleaner & disinfectant vapours may cause respiratory sensitization
  - Improperly rinsed endoscopes or other devices may release residues of disinfectants into body cavity

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## Environmental

- Environmentally sound (Biodegradable)
  - Environmentally-stable sanitizers & disinfectants can contaminate food or water (groundwater & surface water)
- No Active Residual Chemistry
- Good Air Quality
  - Free of any pungent smell
  - No Volatile Organic Compounds (VOCs)
  - Use of gaseous or volatile products may negatively affect indoor air quality
  - Fragrance Free

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## Purchasing & Training

- Cost Effective
  - Consider the Shelf-life of product once diluted (i.e. 24hrs vs 30 days)
  - Consider cost at Use Dilution (\$/L of product)
  - Decisions on purchasing disinfectants may be made entirely based on cost which can lead to choosing an inappropriate product
- Training Support
  - Personnel responsible for using disinfectants may not receive any training or inadequate instruction in the preparation, use, storage and disposal of the formulation in use

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## Factors Affecting Disinfectants

- Prior cleaning of a surface or device
  - Cleaning **MUST** precede disinfection & sterilization procedures
  - Cleaning residues can interfere with the activity of some disinfectants
  - Chemical sterilants can be relied on to produce sterility only if adequate cleaning occurs
- Organic load on the surface or device
  - Soil can provide a protection barrier for microbes
  - Soil can neutralize many of the disinfectant chemistries

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## Factors Affecting Disinfectants

- Type & level of microbial load on the surface or device
  - Mechanism of action differs for each chemistry (surface actives, cell components)
- Water Quality
  - Many chemistries can be neutralized when diluted with hard water
- Concentration of the chemical
  - Improper dilution can lead to a false sense of security

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## Factors Affecting Disinfectants

- Exposure time of the surface or device to the chemical
  - Contact time must be adhered to in order to achieve desired level of disinfection
  - Surface or device must remain wet
- Physical configuration of the object (crevices, hinges etc)
  - Difficult to remove debris or ensure disinfectant comes in contact with all areas of a surface or device

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## Factors Affecting Disinfectants

- Temperature
  - Effectiveness is enhanced or hindered by various temperature levels
  - Higher temperatures can accelerate the evaporation of volatiles which can reduce the concentration & effectiveness
- pH
  - Some products need to be activated prior to use
  - Changes to pH can decrease (neutralize) some chemistries
- Storage & Shelf-life
  - Must consider how products are stored (too cold or hot)
  - Efficacy of product decreases once diluted

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## The Chemistries



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## NAME THAT CHEMISTRY!?!

What Do the following chemicals have in common?

- N-Alkyl (40% C12, 50% C14, 10% C16) dimethyl benzyl ammonium chloride
- 3-(trimethoxysilyl) propyldimethyloctadecyl ammonium chloride
- N-Alkyl (68% C12, 32% C14) dimethyl ethylbenzyl ammonium chloride
- Benzalkonium chloride

They are all **QUATERNARY AMMONIUM COMPOUNDS!**

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## Quaternary Ammonium Compounds

### Advantages:

- Bactericidal, Fungicidal, Virucidal (enveloped) with a minimum contact time of 10 minutes
- Generally non-irritating to hands & non-corrosive to surfaces
- Usually has detergent properties
- Low Toxicity profile
- Stable in concentrate and use dilution
- Newer generations are relatively stable in the presence of organic matter

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## Quaternary Ammonium Compounds

### Disadvantages:

- Not sporicidal, generally not tuberculocidal or virucidal against non-enveloped viruses
- Not effective against Biofilms
- DO NOT use to disinfect Instruments
- Leaves Residual Active Chemistry on Environmental Surfaces

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## Quaternary Ammonium Compounds

### Disadvantages:

- Repeated uses increase residue build up on surfaces which may lead to increase resistance to susceptibility to antimicrobials inside health settings
- Formulations may contain APEs or NPEs (hormone disrupting chemicals)
- Non-Biodegradable

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## NAME THAT CHEMISTRY!?!

What do the following chemicals have in common?

- Ethanol
- Isopropanol
- Methanol
- Alcohol Anhydrous

They are all ALCOHOLS

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## Alcohols

### Advantages:

- Broad-spectrum effectiveness: bactericidal, tuberculocidal, fungicidal and virucidal
- Contact time for Ethanol is 1 to 3 minutes
- Contact time for Isopropanol is 5 to 10 minutes (generally added to Quats)
- No Active Chemical Residue
- Non Staining

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## Alcohols

### Disadvantages:

- Evaporation may diminish concentration therefore contact time is difficult to achieve unless items are immersed
- Inactivated by organic material
- Poor cleaners, not appropriate for use on Environmental Surfaces
- Not sporicidal

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## Alcohols

### Disadvantages:

- Volatile, flammable and must be stored in well-ventilated area
- Use in the OR is contraindicated
- Prolonged exposure may cause dry skin & skin irritation
- Compatibility issues with glues & plastics
- May affect indoor air quality due to VOCs

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## Quat-Alcohol Blends

- Surface products on the market that contain a combination of Quats & Alcohol (IPA)
- Addition of IPA allows for efficacy against Mycobacteria (TB Claim)
- These products have the same Advantages & Disadvantages for both Quats and Alcohols

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## NAME THAT CHEMISTRY!?!

What do the following chemicals have in common?

- Chlorophene
- Chloroxylenol
- P-tert-amylphenol Potassium salt
- O-phenylphenol
- O-benzyl-p-chlorophenol

They are all PHENOLS / PHENOLICS

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## Phenols & Phenolics

### Advantages:

- Commercially available with added detergents to provide cleaning & disinfecting
- Broad-Spectrum antimicrobial (bactericidal, tuberculocidal, fungicidal & virucidal) with a 5 to 10 minute contact time
- Stable in both concentrate and use dilutions
- Tolerance for organic load and hard water will depend on formulation
- Generally regarded as biodegradable

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## Phenols & Phenolics

### Disadvantages:

- Poor cleaning efficacy
- Not Sporicidal
- Contraindicated for use around children
- Not recommended for use on Food Contact Surfaces
- Residual disinfectant may cause tissue irritation
- Pungent Odour (Volatile)

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## Phenols & Phenolics

### Disadvantages:

- High Toxicity (listed on the Canadian Toxic Substance List & the EPA National Priority Lists)
- Phenols have limited use in Educational & Food Preparation settings because of their restrictions due to the toxicity
- Potential toxicity (skin, brain, kidneys, liver & lungs) from o-phenylphenol (listed as a carcinogen), o-benzyl-p-chlorophenol & ethylene glycol (anti-freeze, listed as a teratogen)

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## NAME THAT CHEMISTRY!?!

What do the following chemicals have in common?

- Calcium Hypochlorite
- Sodium Hypochlorite
- Chlorine Dioxide
- Sodium Chlorite

They are all **CHLORINE COMPOUNDS!**

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## Chlorine & Chlorine Compounds

### Advantages:

- Low cost, readily available, Multi-purpose
- Relatively Fast Acting (average contact time of 10 minutes)
- Broad-Spectrum Antimicrobial (bacteria, viruses, fungi, protozoa, spores)
- Effective in removing biofilms (does not kill)
- Readily available in liquid or solid
- Use for disinfection Environmental surfaces, toys, sports equipment

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## Chlorine & Chlorine Compounds

### Disadvantages:

- Unstable, Corrosive & pH dependant
- Inactivated (neutralized) by Organic Matter
- No detergent properties
- Irritant to skin & mucous membranes
- Compatibility issue with metals, rubber & fabric materials

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## Chlorine & Chlorine Compounds

### Disadvantages:

- Use in well-ventilated areas
- High Toxicity, especially on aquatic life
- Chlorine disinfection by-products cause adverse developmental & reproductive effects including spontaneous abortion

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## NAME THAT CHEMISTRY!?!

What do the following chemicals have in common?

- Dihydrogen dioxide
- Hydrogen dioxide
- Dioxidane

They are all synonymous for Hydrogen Peroxide!

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## Hydrogen Peroxide

### Advantages:

- Environmentally safe
- Broad-spectrum antimicrobial (bacteria, viruses, mycobacteria, fungi, spores)
- Effective against biofilms
- Stable in presence of organic matter
- Non-staining
- No Active Chemical Residue

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## Hydrogen Peroxide

### Disadvantages:

- Can be corrosive to soft metals aluminum, copper, brass, zinc, mild & galvanized steel
- High concentration has strong pungent odour (>20%)
- High concentration may cause chemical burns (>20%)
- Can be explosive at high concentrations (>20%)

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## Accelerated Hydrogen Peroxide

### Advantages:

- Fast acting broad-spectrum antimicrobial (bacteria, viruses, mycobacteria, fungi, spores) for environmental surfaces and instruments
- Contact times ranging from 30 seconds to 20 minutes depending on level of disinfection
- Effective against biofilms
- Excellent cleaning efficacy
- Excellent Health & Safety profile

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## Accelerated Hydrogen Peroxide

### Advantages:

- Stable in presence of organic matter
- No active chemical residuals
- Low foam & non-staining
- Stable in concentrate form
- VOC free
- Environmentally friendly (EcoLogo and Green Seal Approved formulas)
- Not manufactured using APEs (ie NPEs)

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## Accelerated Hydrogen Peroxide

### Disadvantages:

- Not recommended for use on soft metals aluminum, copper, brass, zinc, anodized aluminum and carbon steel
- Surface disinfectants do not contain solvents

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## NAME THAT CHEMISTRY!?!

What do the following chemicals have in common?

- Glutaral
- 1,5-pentanedial
- Ortho-phthalaldehyde
- Formalin

They are all ALDEHYDES!

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## Ortho-phthalaldehyde

### Advantages:

- High level disinfectant in 5 - 12 mins
- No activation required
- Non-corrosive to metals
- Non-flammable
- Excellent material compatibility, can be used on lensed instruments and flexible endoscopes

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## Ortho-phthalaldehyde

### Disadvantages:

- Slow sporicidal activity
- Stains skin, mucous membranes, clothing and environmental surfaces
- Eye irritation with contact
- Not enough information on Toxicity
- Potential material incompatibility (anodize aluminum coating dulls)

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## Ortho-phthalaldehyde

### Disadvantages:

- Restrictions to disposal (dependant on municipality)
- Instruments must be well rinsed to ensure removal of all chemical residues
- Contraindication for use on urological instruments due to anaphylaxis

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## Glutaraldehydes

### Advantages:

- Chemical sterilants in 6 - 12 hrs
- High level disinfectant in 10 - 60 mins
- Non-corrosive to metals
- Non-flammable
- Active in presence of Organic Matter
- Excellent material compatibility, can be used on lensed instruments and flexible endoscopes

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## Glutaraldehydes

### Disadvantages:

- Not suitable or safe for use as a surface disinfectant
- Pre-cleaning is essential (fixative)
- May corrode or stain high-carbon steel & leave residues on metals
- Germicidal activity is affected by pH & dilution
- Questionable ability to kill / remove Biofilms

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## Glutaraldehydes

### Disadvantages:

- Extremely irritating to skin & mucous membranes (pungent odour)
- Special ventilation is required
- Liquid & vapour are recognized as toxic can cause dermatitis (skin), conjunctivitis (eyes), rhinitis & sinusitis (lungs)
- Glutaraldehyde is a suspected mutagen & carcinogen

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## Conclusions

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## Disinfectant Selection

Consider:

- Efficacy
- Spectrum
- Versatility
- Ease of use
- Safety profile
- Cost




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## Disinfectant Selection

Remember:

- Match Product with Protocol
  - Surfaces vs Instruments
- Cleaning = 1<sup>st</sup> step
- Disinfection = 2<sup>nd</sup> step
- Contact Time is **MANDATORY!**




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Summary

| Germicide Type | Germicide Type   |           |                   |               |                  |               |                      |                           |                     |                     |
|----------------|------------------|-----------|-------------------|---------------|------------------|---------------|----------------------|---------------------------|---------------------|---------------------|
|                | Active Residuals | Volatiles | Organic Compounds | Toxic Instant | Substrate Impact | Post-Cleaning | Environmental Issues | Narrow Spectrum Germicide | Organic Neutralizer | Restrictions in Use |
| Iodine         |                  |           |                   |               |                  |               |                      |                           |                     |                     |
| Alcohols       |                  |           |                   |               |                  |               |                      |                           |                     |                     |
| Phenolics      |                  |           |                   |               |                  |               |                      |                           |                     |                     |
| Chlorine       |                  |           |                   |               |                  |               |                      |                           |                     |                     |
| Quats          |                  |           |                   |               |                  |               |                      |                           |                     |                     |
| AHP            |                  |           |                   |               |                  |               |                      |                           |                     |                     |

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| Germicide Type | Active Residuals | Volatiles | Organic | Compounds | Toxicity | Initial | Substrate | Impact | Post-Cleaning | Environment | Health | Issues | Spectrum | Neutralization | Restrictions | in Use |
|----------------|------------------|-----------|---------|-----------|----------|---------|-----------|--------|---------------|-------------|--------|--------|----------|----------------|--------------|--------|
| Peracetic Acid |                  |           |         |           |          |         |           |        |               |             |        |        |          |                |              |        |
| OPA            |                  |           |         |           |          |         |           |        |               |             |        |        |          |                |              |        |
| Glutaraldehyde |                  |           |         |           |          |         |           |        |               |             |        |        |          |                |              |        |
| AHP            |                  |           |         |           |          |         |           |        |               |             |        |        |          |                |              |        |

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## Virox Technologies Inc.

Engineering  
Revolutionary  
Disinfectants for the  
War Against  
Microbes

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