

	Formaldehyde	Chlorine Dioxide
Functional Conditions	<ul style="list-style-type: none"> • Use concentrations > 50mg/L • Concentration based on loss in mass • Need > 70% RH (hydration critical to sporicidal properties) • Ideal temp > 35°C (temps between 70-80°C reduce condensation of paraformaldehyde) • Typical exposure time 10-12 hours 	<ul style="list-style-type: none"> • Use concentrations used typically 0.2 - 5 mg/L • Need > 65% RH (hydration critical to sporicidal properties) • Effective at ambient temperatures (15-40°C) • In situ generation • Typical exposure time 1 hour
Advantages / Disadvantages	<ul style="list-style-type: none"> • Used for many years • Broad spectrum biocidal • Must neutralize with ammonia gas generated via ammonium carbonate • Bacterial spores inoculated onto stainless steel are most resistant to decontamination • Formaldehyde has poor penetrating ability • Formaldehyde not as effective on non-porous surfaces • At the higher concentrations needed, paraformaldehyde will form a film that outgases over time • There are legal concerns over the use of paraformaldehyde as a fumigant • Cannot monitor formaldehyde concentration in real time • Need higher operating temperatures to reduce paraformaldehyde re-formation(> 35°C) • Cannot take into account loss of gas concentration due to condensation • Concern over using equipment differently than specified (fire hazard) • 15 hours at concentration • All people leaving the area must be decontaminated 	<ul style="list-style-type: none"> • Broad Spectrum • Good sporicidal activity • Chlorine Dioxide is a true gas (Boiling point 11°C) • Gas concentration is continuously monitored during process • No neutralization of the gas is needed • Can vent to atmosphere or scrub • Gas penetrates dead legs and hard to reach places • Broad spectrum biocidal properties • Used to sanitize equipment in food industry • EPA approved sterilant • Novartis validated filling line using Chlorine Dioxide • Does not Chlorinate environment and equipment • Does not have effect on wide range of plastics • Does not have effect on stainless steel surfaces • Does not have effect on anodized aluminum • Can be corrosive to uncoated ferrous metals at higher concentrations

Applications for chlorine dioxide:

Building Decontaminations
Pharmaceutical Facilities

Room Decontaminations
Bio-Safety Cabinets

References:

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- Jeff MacIntyre and John Mason, Sabre Technical Services (Bio-remediation) <http://www.sabretechnologies.com/>
- Alternative Disinfectants and Oxidants, EPA Guidance Manual, <http://www.epa.gov/>
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- Akzo Nobel Chlorine Dioxide Comparison <http://www.purate.com/>
- Observations and Comments on the Use of Chlorine Dioxide for the Decontamination of the Hart Office Building, Gilbert Gordon, Department of Chemistry and Biochemistry, Miami University
- Successful Sterilization Using Chlorine Dioxide Gas (Parts I and II), Amnon Eylath
- Inactivation of Bacillus Anthracis spores, Emerging Infectious Diseases, <http://www.cdc.gov/>
- Controlled Formaldehyde Fumigation System, Applied and Environmental Microbiology, Mar. 1980, p. 480-487

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“The Chlorine Dioxide People”

Providing you with gaseous chlorine dioxide solutions for your decontamination needs

Chlorine Dioxide vs. Formaldehyde

Chlorine Dioxide (CD) and formaldehyde are the only effective decontaminating agents that are used for the decontamination of buildings, rooms, and bio-safety cabinets that are “true” gases. They are used because they are the only decontaminating agents that are truly effective in areas that are difficult to reach such as in floor drains, ceiling grids, the underside of components, in cabinets, hinges, and other difficult to reach areas. Other decontaminating methods such as sprays, mists, foggers, vapor generation systems, and manual wiping are not as effective because they do not reach all areas at an effective concentration.

The two process share many similarities such as the degree of sealing required as well as the area humidification requirements and the air distribution requirements.

Today, more and more businesses are making the change and upgrading to Chlorine Dioxide. CD offers many advantages over formaldehyde such as it is non-carcinogenic, it does not require neutralization, and it leaves no residues that require manual wiping. A fully integrated chlorine dioxide monitor is available to accurately monitor and control the decontamination cycle. Additional benefits can be seen in the following table:

	Formaldehyde	Chlorine Dioxide
Safety	<ul style="list-style-type: none"> • Carcinogen Suspect • Exposure to Bleach or HCl may form bis-chloromethyl ether (carcinogen) • Allergen • Inhalation Hazard • Decontamination needed when exiting area • Flammable solid • Explosive between 7% and 73% • People entering area need to be in self contained breathing apparatus (SCBA) 	<ul style="list-style-type: none"> • Not Carcinogenic • Mucus membrane irritant • No decontamination needed upon exiting facility • People entering area need to be in self contained breathing apparatus (SCBA)
Current uses	<ul style="list-style-type: none"> • Dialysis sterilization (liquid) • Biological safety cabinets 	<ul style="list-style-type: none"> • Bio-remediation (Anthrax- Hart Building, Trenton Post Office, AMI building) • Pharmaceutical and Medical Device Equipment and Components • Medical Device Sterilization • Removal of biofilms • Water treatment • Meat • Produce • Swimming pools
Regulatory status	<ul style="list-style-type: none"> • Not registered as fumigant 	<ul style="list-style-type: none"> • EPA registered for pharmaceutical sterilization (Including clean rooms)
Biocidal Activity	<ul style="list-style-type: none"> • Broad spectrum <ul style="list-style-type: none"> ○ High concentration (~10.5 g/m³) ○ High humidity (>70%) ○ Higher temperatures (>35°C) ○ Long exposure (10-12 hours) • Mixed sporicidal activity 	<ul style="list-style-type: none"> • Broad Spectrum <ul style="list-style-type: none"> ○ High humidity (>65%) • Good sporicidal activity
Mode of action	<ul style="list-style-type: none"> • Alkylating agent 	<ul style="list-style-type: none"> • Oxidation • Free radical monomer • Does not Chlorinate

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