

CSI ClorDiSys Solutions, Inc.™

“The Chlorine Dioxide People”

Providing you with gaseous chlorine dioxide solutions for your decontamination needs

Chlorine Dioxide vs. “Vapor” Hydrogen Peroxide

Chlorine Dioxide (CD) and formaldehyde are the only effective decontaminating agents that are used for the decontamination of buildings, rooms, isolators and bio-safety cabinets that are “true” gases. Hydrogen peroxide is a liquid at room temperature and requires boiling or vaporization to generate the vapor. The boiling point for 35% hydrogen peroxide is 109°C while room temperature is only 21-22°C. A vapor is basically a super heated fluid that, when introduced into a room, wants to return to its original form, a liquid, as condensation. If the target chamber is a long distance from the generator (more than a few feet), heat tracing or insulation of hosing is required to REDUCE condensation in the hoses.

Chlorine dioxide on the other hand does not require condensation or lack of condensation for an efficacious process. Gaseous CD does not require tight control of Dew Point temperatures (ie. difficult to obtain uniform condensation or lack of condensation in a real world application). Gaseous CD has Quicker Aeration due to minimal absorption and lack of condensation. Additionally, CD systems from CSI can include integrated, accurate, and repeatable CD concentration measurement and control. This means that while only an *injection rate* is selected with VHP and the chamber concentration assumed, an *actual chamber concentration* is chosen and attained with CD. This greatly simplifies validation efforts and assures efficacy and repeatability.

Scalability: One single ClorDiSys CD generator can decontaminate spaces from 1 to over 60,000 cubic feet as compared to multiple Hydrogen Peroxide generators. Injection rates also do not need adjustment based on volume.

Material Compatibility: Hydrogen Peroxide is 1.9 times more corrosive than CD based on its higher oxidation potential.¹

Efficacy: CD is 250% more efficient than Hydrogen Peroxide due to CD’s higher oxidation capacity based on CD seeking 5 free electrons vs. 2.¹

Quicker Cycles: To further highlight the benefits of CD, the following documents example cycle times for both CD and VHP.

Isolator Decontamination	Volume	Cycle Time
Steris VHP	≈ 25 ft3	3-6 hours ²
Bioquell Clarus	≈ 25 ft3	3-3.5 hours ²
Chlorine Dioxide	31 ft3	1.3 hours ³

Room Decontamination	Volume	Cycle Time
Steris VHP	300 ft3	7.5 hours ⁴
Steris VHP	760 ft3	4.25 hours+overnight aeration ⁵
Bioquell Clarus	2500 ft3	10-11 hours ⁶
Chlorine Dioxide	2700 ft3	3.5 hours ⁷

References:

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4. Steris Case Study M1456, VHP Case Study #1 – Hydrogen Peroxide Gas Decontamination of A Material Pass-Through (MPT) Room, Publication ID #M1456(8/99), Steris, August, 1999.
5. Steris Case Study M1455, Case Study #3 - VHP 1000 Decontamination of a 760 ft3 room Containing Blood and Urine Analyzers, Publicaiton ID#M1455/990810 (8/99), Steris August 1999.
6. Room Decontamination Presentation to Council on Private Sector Initiatives, Washington, DC, by Henry Vance PE of Alpha Engineering, February 11, 2002
7. Lorcheim, Paul. Decontamination using Gaseous Chlorine Dioxide, A case study of automatic decontamination of an animal room explores the effectiveness of this sterilization system. Animal Lab News, Vol. 3, No. 4 , p25-28, July/August 2004.

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Additional benefits can be seen in the following table:

	“Vapor” Hydrogen Peroxide	Chlorine Dioxide
Safety	<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) 	<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"> • Pharmaceutical and Medical Device Equipment and Components • Medical Device Sterilization • Hospital 	<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 • Hospital • Removal of biofilms • Water treatment • Food sanitization (Meats and Produce) • Drinking water
Regulatory status	<ul style="list-style-type: none"> • Steris Vaprox is EPA registered for sterilization/decontamination (Including rooms) 	<ul style="list-style-type: none"> • ClorDiSys Solutions, Inc. is EPA registered for sterilization/decontamination (Including rooms)
Biocidal Activity	<ul style="list-style-type: none"> • Broad Spectrum <ul style="list-style-type: none"> ◦ Requires Low humidity • Good sporicidal activity 	<ul style="list-style-type: none"> • Broad Spectrum <ul style="list-style-type: none"> ◦ Higher humidity (>65%) • Good sporicidal activity
Mode of action	<ul style="list-style-type: none"> • Oxidation (oxidation potential of 1.78) • Oxidation Capacity of only 2e- 	<ul style="list-style-type: none"> • Oxidation(oxidation potential of 0.95) • Oxidation Capacity of only 5e- • Free radical monomer • Does not Chlorinate
Functional Conditions	<ul style="list-style-type: none"> • Use concentrations > 2.0 – 5 mg/L • Need very low humidity levels prior to starting cycle • Concentration based on loss in mass • Ideal temp > 35°C (to reduce condensation) • Boiling/Vaporization of liquid • Typical cycle time 3 hours (25ft³ chamber) 	<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 cycle time 1.3 hours (25ft³ chamber)
Advantages / Disadvantages	<ul style="list-style-type: none"> • Broad Spectrum • Good sporicidal activity • Vapors have poor penetrating ability • Cannot monitor hydrogen peroxide concentration in real time • Oxidation Capacity of only 2e- • More corrosive effects due to higher oxidation potential • Need higher operating temperatures in chamber to reduce hydrogen peroxide condensation • Cannot take into account loss of vapor concentration due to condensation • Long cycle times • If generator is a long distance from chamber (>5ft) insulation and heat tracing of hoses required to reduce condensation • Can be corrosive to uncoated ferrous metals at higher concentrations 	<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 • More efficient due to Oxidation Capacity of 5e- • 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

Additional References:

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- Joseph Knapp and Diane Battisti, “Chlorine Dioxide” in *Disinfection, Sterilization, and Preservation*, ed. by Seymour Block (2001), Lippincott, Williams & Wilkins, Philadelphia, pp 215-228
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