Chlorine Dioxide Gas: The Safest Fumigant

This paper highlights some of the reasons why gaseous chlorine dioxide (CD) is the safest of all the gas or vapor decontamination agents. To be clear, all decontamination agents are deadly. If they were not, then they would not be useful for decontamination.

Safety Warnings (Self Alerting): The best safety feature with CD is that it is self-alerting. CD has an odor threshold at or below the 8 hour Time Weighted Average (TWA), so the user is self alerted to exposure at a low level and the reliance on external equipment is not as imperative as with VPHP. This alone makes CD safer since the user is self-alerted before unsafe levels are achieved. With VPHP, odor does not provide a warning of exposure. The user becomes aware of a harmful exposure when choking occurs. The user cannot detect VPHP until the safe levels are exceeded and *must* rely on external equipment to alert of possible exposure. This makes it extremely important to place personal safety detection devices all around the area when using VPHP. With CD, this reliance upon external equipment is not a necessity because of the odor. Minimal area monitors are all that is required when using CD.

Shorter Cycle Times: Chlorine dioxide is the fastest acting decontaminating gas or vapor. For the various decontaminating agents the cycle times can range from 3-1/2 hours to over 12 hours in decontaminating a 2500 cubic foot room. With normal aeration exhaust rates, a CD cycle would be about 3-1/2 hours or less, formaldehyde would be about 12-1/2 hours, and VPHP could be 10 to 12 hours when you include the aeration times. This means that a potentially unsafe condition exists for a far shorter time when using chlorine dioxide for room decontamination.

The reason for the long cycles with VPHP is because of the longer aeration times because of vapor condensation and absorption issues that do not apply with a true gas. The reason for the long cycle times with formaldehyde are the long exposure times and neutralization times required.

Lower Concentration Levels: Chlorine dioxide is typically used at lower concentrations for room decontamination. VPHP concentrations are typically 1000-2000 ppm. Formaldehyde concentration is typically 10,000 ppm. CD concentration is typically only 360 ppm. If something goes wrong, the higher concentration of formaldehyde and VPHP poses a greater risk due to the higher concentrations in the room.

Quicker Emergency Aeration: Chlorine dioxide is quicker to aerate down to the 8-hour TWA compared to VPHP and formaldehyde so the room returns to a safe condition quicker when CD is used. If something goes wrong during the CD cycle, aeration can be started and in 30-45 minutes there will be no CD left (below the 0.1ppm TWA). If something goes wrong with VPHP cycle, then the catalytic conversion starts and this can take hours (typically 12 hours). If direct aeration is utilized, this also takes hours to remove the VPHP from the room (typically 6 hours). The reason for the long aeration times with VPHP is that it is a vapor with condensation and absorption issues and not a true gas. If something goes wrong during the formaldehyde cycle, aeration can be started and in 50-75 minutes there will be safe formaldehyde levels (below the 2ppm TWA) except for subsequent off-gassing. If neutralization is required, aeration can be approximately 120 minutes. Therefore the unsafe levels of a sterilant are present for much longer with VPHP than CD and provide a greater risk due to having hazardous concentrations present longer. CD can be down to safe levels much faster than VPHP. In fact, based on the 6 hours VPHP aeration, CD can be removed from the room 12 times faster that VPHP. Another way of describing this is that it will take hours for VPHP to aerate from a room to reach safe levels. For example, it takes 4 hours for VPHP to be reduced from 300 ppm to 1.0 ppm. As a contrast it takes 45 minutes to aerate CD from 300 ppm to 0.1 ppm. So even though the TWA for CD is 0.1 vs. 1.0 for VPHP, CD gets to the safe levels much quicker and therefore is much safer.

Non-carcinogenic: Chlorine dioxide gas is not carcinogenic unlike formaldehyde.

Complete Decontamination: Chlorine dioxide and formaldehyde are gasses and gasses reach and penetrate all areas that vapors have trouble reaching. If the decontaminating agent cannot reach ALL of the dangerous organisms in a BSL-3/4 facility, at the proper concentration, for the prescribed amount of time, then a complete decontamination will not occur and worker safety is compromised.

Summary: Chlorine dioxide provides a better safety measure when compared to VPHP and formaldehyde because of many important reasons. The cycles are shorter limiting the “unsafe” time when the decontaminating agent is present. It is far quicker to aeration to its TWA level if an emergency does occur. The actual concentration levels are significantly lower. And, most importantly, CD is self-alerting. CD has an odor threshold at or below the 8 hour Time Weighted Average (TWA), so the user is self alerted to exposure at a low level, which is not the case with VPHP.