A Novel approach to HEPA Housing decontamination for PC3/4 Laboratories using Chlorine dioxide gas and an Automated Mini Chlorine Dioxide Generator.

Authors: Mr Brett Cole[1], Mr Winston Lim[2], Mr Cameron Welch[1] and Dr Allan Heckenberg[1]

1. Biosafety Pty Ltd, Ferntree Gully Victoria Australia
2. Linair Australia, Singapore & Berwick Victoria Australia

BioSafety
Hygiene Consulting
Decontamination
Contamination Control

INTRODUCTION

Since the mid 1980s, the use of Chlorine dioxide as a disinfection chemical has been well established (1,2). The reasoning for the wide-spread acceptance, was partially driven by the overall high level of effectiveness. Older treatment chemicals, like formaldehyde had proven effective disinfectants, however, exposure and safety concerns were steadily increasing for Formaldehyde (3).

The added advantages that drove acceptance, were the lack of residue after disinfection, the absence of potentially harmful residues and the penetration ability of a "true-gas" in HEPA filter media, hidden surfaces and difficult to eradicate contaminants/infestations and eggs from species such as Syphacia muris - Pinworm (6,8).

Currently, broad scale disinfection of rooms, decontamination chambers and entire facilities is comparatively routine, using commercially available equipment for chlorine dioxide generation and monitoring (5,7,9,10).

Generally, the physical size, largely manual operation steps, cost and complexity of the equipment, has made the use of this technology the domain of highly trained technicians or commercial services.

This poster outlines a compact, automated system that is ideally suited to use by trained facility users, to decontaminate BSCs and HEPA housings, with the convenience of operation, at any time the facility needs to decontaminate these units and compares them with existing methods.

METHOD

EQUIPMENT

The system used in this study, consisted of a 1.1m3 decontamination chamber, to replicate a typically large BSC or HEPA housing.

The chambers' Chlorine Dioxide concentrations were monitored throughout the study with a calibrated tuned wavelength spectrometer (EMS System; Clordisys NJ USA). Data on concentration levels were recorded over time and presented as concentration (mg/L) over time and cumulative exposure (ppm-hrs).

Chlorine dioxide was generated with a compact, automated gas generator and scrubber (Mini-CD System (MCS), DRS Laboratories, Lehigh Valley, PA. USA).

Biological indicators for use with Chlorine Dioxide Processes, Bacillus Stearothermophilus. Crosstex Rush NY USA

Figure 1 - Experimental units, concentration monitoring (EMS) image left, MCS system to generate and scrub, image right.

PROCESS

The setup of the MCS, followed safe connection to the test chamber with two 1" gas tight tubing assemblies with camlock terminations (supply and return). The required PPE was arranged and checked for appropriateness and condition. Safety glasses, an appropriate respirator, gloves and lab coat are minimum requirement for the operator, who has had appropriate training in the systems use. Chlorine dioxide gas detection sensors were deployed (ATI portasense). A clear area of at least 2m was created using safety tape and appropriate signs. Biological indicators (pair) Bacillus Stearothermophilus were deployed in the chamber, and a control was deployed outside the decontamination zone.

Reference to the MCS manual (11), indicates the quantity of CD generation tablets to be used, based on the volume of the chamber to be treated. In this case, 8 tablets were indicated to be appropriate for the chamber volume of 1.1m3 (0 to 1.1m3 requires 8 tablets). The tablets are a commercial formulation supplied in foil wrappings to maintain effective storage life, and appropriate performance in terms of gas release when mixed with water.

Wearing appropriate PPE (gloves, gown, respirator-mask), a chlorine dioxide gas sensor was enabled then the MCS unit was powered up, through the simple-to-understand, user interface, then the generation vessel was filled with 1 litre of room temperature, laboratory tap water. The chamber was then threaded to the MCS unit and hand tightened to provide a sealed vessel.

Process chemicals were then added to separate chambers in the MCS system, the pre-packaged neutralisation chemical was added to the appropriately indicated holding chamber. Eight CD tablets were added to the CD dispensing cylinder.

The system was then reviewed for correct set-up and sealing. As chlorine dioxide is degraded by light (visible and UV) the chamber was covered with a light blanket material.

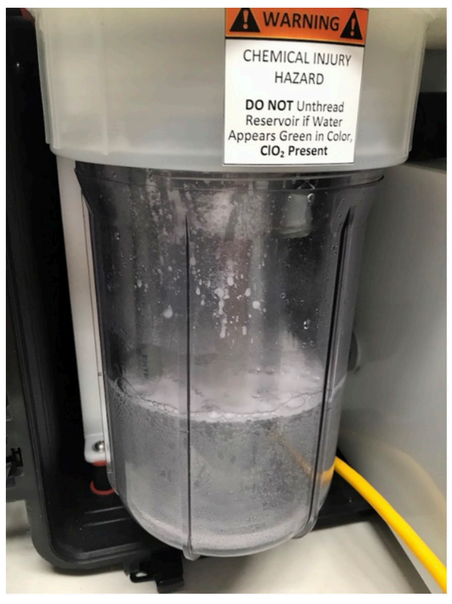

Figure 2 - Gas generation cylinder.

The CD generation switch on the MCS was depressed, activating humidified air-flow through the system (target of 60-85% RH). This preconditioning stage allows a visual inspection, to assure there are no significant leaks in the chamber or connection points. A brief test of the scrubbing blower is to confirm readiness is done by depressing the manual scrubbing button.

Having verified all important functions, the Auto Start button is depressed, initiating an automated and timed process of decontamination, including gassing and scrubbing. The system deploys the CD generation tablets into the water containing chamber, generating a controlled charge of Chlorine Dioxide gas. This is circulated to the chamber via the inbuilt air-flow blower fan.

Gas sensors are used at this time to check for minor cabinet and connection leaks. Correction of leaks if they occur is generally done by application of tape. In this study, data collection regarding concentration and total exposure was done through the cycle, by use of a Clordisys EMS unit. .

Figure 3 - Simple User Interface Panel.

Part way through the gassing exposure, the system re-activates the blower pump to "bump" the chamber to assure good gas distribution.

Once the predetermined exposure time is completed, the system activates the scrubbing cycle. Drawing chamber gas through a MCS installed carbon cartridge, effectively trapping the generated Chlorine Dioxide gas. After an appropriate period of scrubbing, the cycle is completed and the unit pauses. The operator then releases the neutralisation chemical into the generation chamber and allows 15 min for full neutralisation.

Gas sensors are used to verify the treated chamber and connection lines are free of Chlorine Dioxide (<0.1ppm), before disconnection the system and sealing components. The packaging, and neutralised aqueous waste are disposed of appropriately and PPE is discarded.

The entire sequence of events takes less than 150 minutes, with the display representing the status and time remaining at any time the user requires the information. At any time the sequence can be aborted and the scrubbing cycle initiated.

RESULTS

The chamber decontamination was biologically successful as indicated by the Biological indicators (2) Bacillus Stearothermophilus compared to the control indicator.

Figure 4 - Greater than 6-Log decontamination. Paired test BI's – negative to growth (left and centre) Control - positive to growth (right).

Concentration over time is shown in figure 5. Graph indicates that the gas is generated and deployed comparatively swiftly, with a stable period of exposure above 2mg/L, then a sharp drop to zero values when the scrubbing phase is automatically initiated by the system.

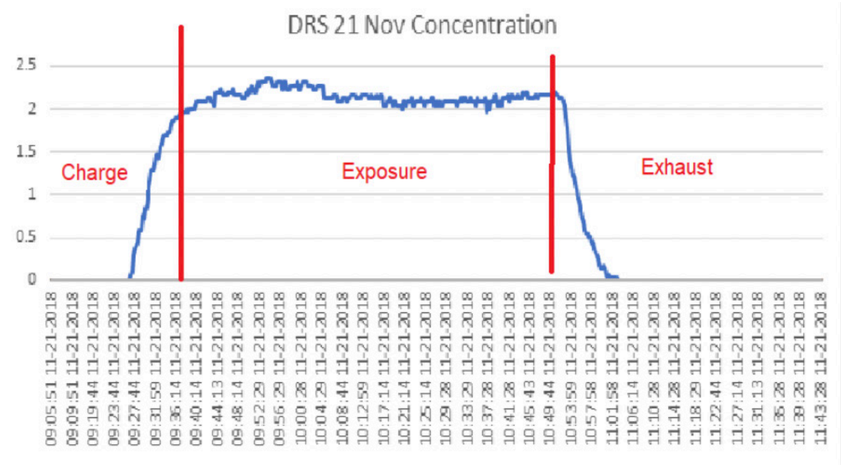

Figure 5 - Chlorine Dioxide Concentration during the automated decontamination sequence.

Total exposure is demonstrated in figure 6. Total exposure of in excess of 1100 ppm-hrs is demonstrated for the 1.1m3 chamber volume. Generally, values of above 720 ppm-hrs would be regarded as more than sufficientto allow effective decontamination of most commonly encountered contaminants.

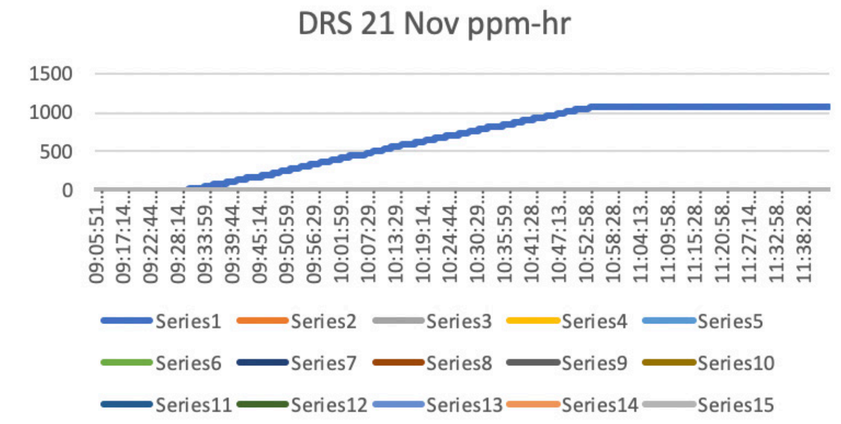

Figure 6 - Exposure values over time recorded for the 1.1m3 chamber.

DISCUSSION

The use of a fully automated, compact, gas generation and scrubbing system was successfully demonstrated. The controlled generation of chlorine dioxide gas, coupled with pre-packaged chemicals is a viable alternative to more manual, somewhat uncontrolled, open bowl generation processes. A significant user safety factor is added by the inclusion of a scrubbing system, that may be initiated at any time in the sequence of decontamination. The rapid time frame of operation, comparative mobility, freedom from residue, penetration power of the gas and clear ease-of-use features of the system, permit facility users an effective and accessible disinfection by chlorine dioxide.

The decontamination chamber is an appropriate model to replicate BSCs and HEPA housings. The connections and processes for these devices is identical. Calculations of tablet load are done on the basis of the volume of the devices, as was the case for the decontamination chamber. If present, HEPA filter materials will be decontaminated, as the gas is fully capable of penetrating the filter media. The use of MDS units for BSCs and HEPA housings has been done and shown to have comparable results to this systematic study.

Chlorine Dioxide is widely regarded as the most effective disinfection treatment available at present, with demonstrated efficacy for challenging species such as Syphacia muris.

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