VALIDATING A DECONTAMINATION PROTOCOL UTILIZING IONIZED HYDROGEN PEROXIDE (IHP)

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INTRODUCTION

Effective decontamination procedures are critical for a range of healthcare environments. These spaces vary in their layout, HVAC and engineering controls, as well as room classification (for cleanrooms). Hospital pharmacies are a notable example of spaces where aseptic conditions must be maintained; specifically, the cleanrooms designed for handling Compounded Sterile Preparation's (CSPs).

In this initial case study, we examine, implement and validate a decontamination protocol for mobile cleanroom trailers. These mobile pharmacies are housed within 53' foot (16 meter) trailers that meet all requirements for USP <797> and <800> as well as cGMP-compliance. These mobile units have integrated HVAC systems and must operate effectively in a wide variety of external environments. It is critical to provide effective sterilization protocols for each trailer that is deployed. Therefore, we require a solution that is transportable and can assure a 6-log sporicidal kill throughout all surfaces of the trailer.

Further, the process must confirm that mold and Clostridium difficile (CDF) were killed. These are both spores and can be difficult to ensure a kill. They are also pathogens in humans. Another impetus for optimizing sterilization procedures is to mitigate the potential for positive hits for mold.

BACKGROUND

There are multiple verified methods to do a low temperature sterilization of a pharmacy cleanroom space including: Formaldehyde, Chlorine Dioxide Gas, and Vaporized Hydrogen Peroxide (VHP). Because of the unique challenges associated with operating a mobile cleanroom, considerations must be made for the transportation of sterilization equipment, time required to complete the necessary operations, and the remote location of the facility itself.

Formaldehyde presents problems for remote use, as it requires longer contact time to ensure the required kill as compared to other methods. Furthermore, formaldehyde requires neutralization after decontamination. The additional time required from our team meant that this method was not a suitable solution. In recent years, Chlorine Dioxide and VHP have been emerging as leaders in the sterilization industry. VHP has been a more accepted solution due to its quicker "kill time" at the OSHA limit for 8 hours of exposure at 1 ppm. Chlorine Dioxide requires a 0.1 ppm concentration for safety. The higher exposure limit also means faster aeration. There are also high temperature sterilization methods but, due to the large volumes of solution that are required, this is impractical for any room-sized space. An additional consideration is heat sensitivity of equipment within the trailer.

VHP is one of the most widely used sterilants for laboratory and cleanroom applications. Typically, this is a solution of 35% v/v mixture of Hydrogen Peroxide (HP) and water (for reference, this is a much higher concentration than the 3% solution that is available in a common drug store). This high concentration VHP solution presents some problems as well. The U.S. Department of Transportation prohibits the conveyance of hydrogen peroxide at concentrations above 8% without a special license. The EPA also restricts the amount of the high concentration HP that can be stored in a facility and has strict guidelines on how it must be disposed.

There are several companies that claim they can achieve a kill with HP solutions below 8%. The first company we tried utilizes a misting method to disperse the HP throughout the trailer. The initial results showed that this method was not able to achieve the kill required.

Second, we found a process that utilizes Ionized Hydrogen Peroxide (IHP) solution (manufactured by TOMI Environmental Solutions). This method sprays an HP mist through an electrical arc. The electricity alters the HP chemistry so that it achieves a kill faster than conventional VHP. The reduced contact time allows the HP solution to have a lower concentration. The system was also designed with transportability in mind. These factors made this a very enticing method of decontamination for mobile cleanrooms. The main problem was that the IHP process had not been fully adopted as a validated sterilization method within the industry. Therefore, a validation study was completed by Germfree to ensure the method would be able to achieve the kill we desired.

PROPOSED SOLUTION

An initial test of the IHP solution was conducted on a Germfree bioGO™ Rx Mobile Compounding Pharmacy. A satisfactory kill was achieved, but there was some residue left over after the test was complete. After consulting with the decontamination system manufacturer, the protocol was adjusted and no residue was left after the second cycle development run.

Once the proper system setup was confirmed we began engineering level tests to validate the system. Three identical tests would have to be run in order to have the system considered validated. Approximately 40 Chemical Indicators (CIs) and 40 Biological Indicators (BIs) inoculated with 106 of Geobacillus stearothermophilus (GS) were placed throughout the trailer, including the space that is above the ceiling grid (see figure 1). This bacterium is used due to its high resistance to VHP sterilization (comparable to mold and C. Diff.); it is non-pathogenic, and it incubates at relatively high temperatures (55-60 °C). The higher incubation temperature allows there to be some leeway on how the BIs are handled after the sterilization, since most other bacteria cannot live at this temperature. The CIs are strips of paper with a dye that reacts to the HP in the air and changes color. This gives a rapid response as to how the HP is dispersed throughout the trailer, but the CIs cannot be used to validate that the system has achieved a six-log kill.

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After the IHP cycle was complete and the concentration in the trailer was below 1 ppm, the BIs were collected and then aseptically transferred to a culture media. The culture media is a vial of a liquid with a soy protein mixture and a pH indicator in it. During the incubation period, if bacteria growth is positive, the media changes in pH level, which changes the color of the media from purple to a yellow color. In addition to the exposed BIs, a positive and a negative control were incubated. The positive control is a BI that is unexposed to sterilant and placed into a media vial and the negative control is an empty media vial. These are to confirm the validity of the materials used. Each vial is also marked with the date, the test number, and location number. The location corresponds to a predetermined map of the BIs. The BIs and media were incubated for 7 days, per FDA requirements, with initial results being available after 24 hours of incubation.

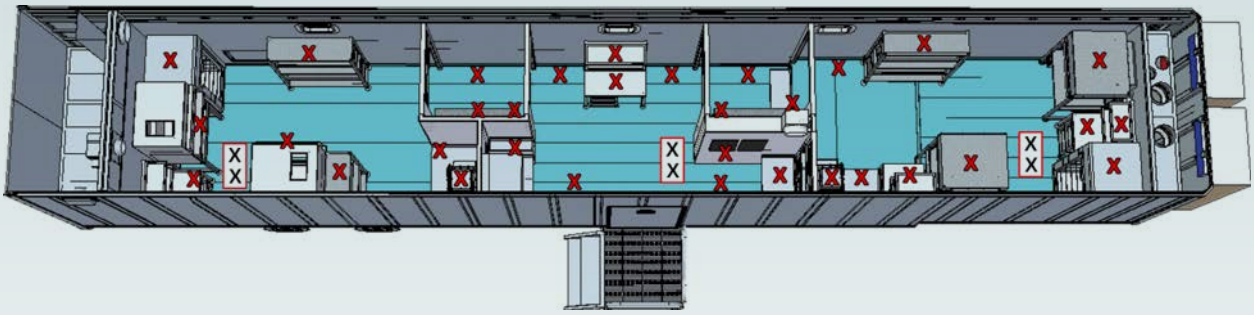

Figure 1 - Location of BIs throughout the trailer (boxed X's were above ceiling panels)

Note: The cleanroom trailer was run under normal operational conditions during the testing. The set points are 18.9 C and less than 60% RH. (55% RH is the typical RH at 18.9 °C).

CONCLUSION

After the seven days of incubation all test BIs showed no signs of growth. This validates that the Ionized Hydrogen Peroxide (IHP) process is effective for use in the pharmacy trailer systems. The process used multiple BIs in difficult to reach places. Placement of BIs was consistent for each of the three validation cycles. This demonstrates that there is repeatability in this sterilization method. Since the solution is below 8% of HP v/v we are able to service the trailers in multiple locations across the US without any restrictions on transportation. The design of the system in a portable, rugged case is another benefit. IHP is considered the preferred method for sterilization of the Germfree bioGO™ Rx Mobile Compounding Pharmacies due to its efficacy, portability and other benefits. This method should also be considered for other types of facilities including mobile, modular, and fixed laboratories and cleanrooms.

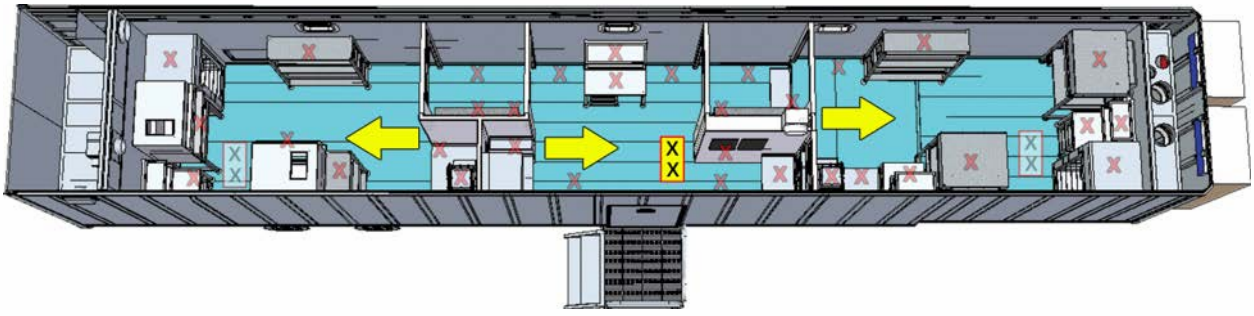

Figure 2 - Yellow rectangle shows location of the tile, arrows represent the location of the distribution heads and direction of spray