Vaporized Hydrogen Peroxide Bio-Decontamination in Isolators, cRABS, and Transfer Hatches

Hydrogen peroxide bio-decontamination is often used inside isolators in, for example, pharmaceutical industry.

Isolators, closed restricted access barrier systems (cRABS), and transfer hatches (TH) are used in applications like pharmaceutical manufacturing, pre-clinical and clinical trial testing, the preparation of cell-based treatments, and the creation of tissue banks. Although this article focuses mainly on isolators, the same principles also apply to other safety and purity units.

An isolator is a device supplied with air meeting a minimum of ISO 5 classification standards that provides uncompromised, continuous isolation of its interior from the external environment. Isolators are used in a variety of life science applications, such as the manufacture of pharmaceuticals and vaccines, aseptic filling, sterility testing, and pharmacy compounding. Isolators must be treated regularly with disinfection agents in order to ensure they are free of microorganisms. These agents need to be effective against all possible forms of microbes: viruses, bacteria, yeast, mold, and fungi, including highly resistant forms like mycobacteria and bacterial spores. A minimum 6-log bioburden reduction in microorganisms needs to be achieved when treating an isolator with bio-decontamination agents.

Vaporized hydrogen peroxide (H_2O_2) is a commonly used disinfection agent for this purpose. Vaporized H_2O_2 is non-toxic, works at low temperatures, and destroys the full spectrum of biological contaminants. It is compatible with a wide variety of materials. Because it decomposes to water vapor and oxygen, it leaves no residue on surfaces, meaning they do not have to be wiped down after bio-decontamination. It is therefore no surprise that vaporized H_2O_2 is widely used in place of other agents (chlorine dioxide, formaldehydes, and ethylene oxide) to kill microorganisms.

Isolator cycle development is dependent on reliable measurements

When performing isolator bio-decontamination cycle development studies, accurate, stable, and repeatable measurement values for H_2O_2 ppm content, humidity (referring to both relative humidity and relative saturation), temperature and time of exposure are crucial.

Theoretically, reproducible cycle development can be divided into seven separate steps (all steps are not mandatory):

1. Dehumidification study

2. Smoke pattern studies (smoke penetration), temperature and vapor study (mapping temperature and humidity)

3. Preliminary lethality study (with chemical or enzyme indicators)

4. Worst case lethality studies (with biological or enzyme indicators)

5. Aeration study

6. Process validation

7. Regular revalidation

Reliable measurements of environmental conditions and their distribution inside an isolator are needed in order to perform all of these steps and to validate bio-decontamination cycles quickly and easily.

Bio-decontamination: Control & Monitor

Once an isolator's qualification steps have been performed and the bio-decontamination cycle validated, bio-decontamination with vaporized H_2O_2 is repeated according to the needs of the manufacturing processes. The bio-decontamination cycle interval depends on the product being manufactured and types of processes being performed in an isolator. Depending on the process in question, bio-decontamination may be performed as often as several times per day, or as infrequently as once per year. Disinfection is a critical process and often a time consuming one. Bio-decontamination can be divided into four separate steps, all of which must be carefully controlled and monitored. The four steps (see Figure 1) are described below.

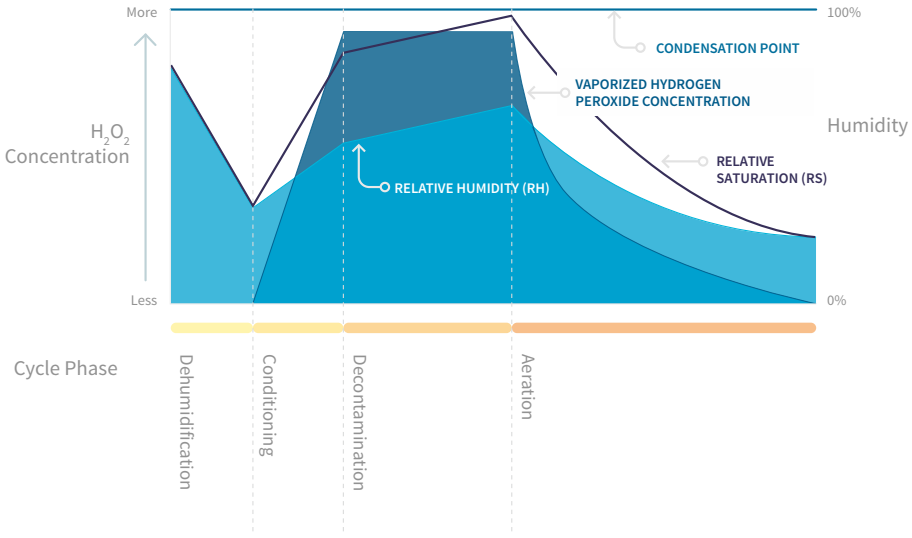

Figure 1. An example of the four steps in a typical non-condensing isolator bio-decontamination process.

1. Dehumidification phase (average target humidity level 5–40%; this step may be omitted if the bio-decontamination phase includes micro-condensation/condensation)

2. Conditioning phase (to achieve correct conditions for decontamination)

3. Bio-decontamination phase (average target values: H_2O_2 600–1000 ppm, humidity 50–100%)

4. Aeration phase (to remove H_2O_2, which is typically catalyzed into water vapor and oxygen with the help of a catalytic converter)

Rigorous control and monitoring of the environmental conditions (H_2O_2 ppm, RH, RS and temperature) helps guarantee the safety of the products produced in the isolator and decreases the amount of time and money spent during decontamination.

The Vaisala PEROXCAP® Hydrogen Peroxide, Humidity, and Temperature Probe HPP270 series fulfills several isolator measurement needs. For more information visit www.vaisala.com/HPP270.