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WHITE PAPER

Selecting Decontamination Technology: Aerosolized versus Vaporized Hydrogen Peroxide

Learn how aerosolized (or fogging) Hydrogen Peroxide differs from Vaporized Hydrogen Peroxide (VHP), and why VHP is best suited for critical applications.

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Hydrogen peroxide is a wide spectrum disinfectant and sterilant used in a range of applications in both healthcare and life sciences. Vaporized Hydrogen Peroxide (VHP) has become a well-established technology for sterilization and decontamination within the life sciences industry. Recent interest in "fogging" with aerosolized hydrogen peroxide technology has raised questions about the similarities and differences of these two distinct delivery methods.

This white paper reviews the technical aspects of aerosolized hydrogen peroxide vs. VHP technology, compares their performance across key criteria, and reveals numerous advantages in using VHP.

Aerosolized Hydrogen Peroxide versus Vaporized Hydrogen Peroxide

Hydrogen peroxide can be aerosolized or vaporized. Aerosolized hydrogen peroxide is also referred to as atomized, ionized, or nebulized These aerosolized technologies work, by passing an aqueous solution through a special nozzle, ultrasonic or other device to create airborne droplets. The droplets are relatively large and form a visible cloud like a dense fog. Use of aerosolized hydrogen peroxide is sometimes referred to as "fogging."

Vaporized Hydrogen Peroxide (VHP) differs from aerosolized technology as the vaporization process quickly heats and evaporates precisely measured quantities of aqueous hydrogen peroxide to its gas form while controlling airflow, humidity, and temperature within an enclosure. Hydrogen peroxide in its vapor form is molecular and small like water vapor in the air. Like water vapor, VHP is not visible but can be measured with sensor technology, much like water vapor is measured as relative humudity, so we know it is present in the targeted space.

The large droplet-size of aerosolized hydrogen peroxide compared to the small, vaporized H_2O_2 molecule is the underlying reason why the two approaches have very different performance characteristics. The following table outlines the differences between aerosolized hydrogen peroxide and VHP.

	Aerosolized Hydrogen Peroxide	Vaporized Hydrogen Peroxide (VHP)
Even H_2O_2 Distribution	Aerosolized H_2O_2 droplets are much larger than vaporized hydrogen peroxide (8-50 µm). They're less buoyant in still air, causing them to fall and preventing an even distribution of hydrogen peroxide in the air and on surfaces.	The small molecule size (sub-micron) of vaporized hydrogen peroxide allows it to act as a gas without gravity impeding its buoyancy and distribution. This even distribution allows for decontamination of hard-to-reach places. Vaporized hydrogen peroxide can pass through HEPA filters and be distributed through piping to different areas allowing a central unit to serve several areas in a facility.
Dry vs. Wet Process	An aerosol is more likely to oversaturate the environment. This causes wetness and potential puddling, which creates a hazardous situation, may cause material compatibility issues, and prolong the aeration process.	Vaporized hydrogen peroxide utilizes STERIS' patented "dry-process" technology avoiding condensation on surfaces. This means there's a higher level of material compatibility and the peroxide does not need to evaporate from the surface for a faster aeration.

	Aerosolized Hydrogen Peroxide	Vaporized Hydrogen Peroxide (VHP)
Better Material Compatibility	Aerosolized hydrogen peroxide often produces condensation. This condensation can cause issues, like degradation of strength, damage and discoloration, to materials (such as metals, paint and resins) after repeat exposure.	Vaporized Hydrogen Peroxide avoids condensation by controlling the environmental conditions and injection within the enclosure, while aerosolized processes can condense on material surfaces causing damage.
Better Efficacy	Atomization can theoretically achieve comparable kill levels to vaporization by injecting greater amounts of low-concentration H_2O_2 chemistry (typically 7% hydrogen peroxide) into an enclosure. In practice, even-distribution is difficult to achieve before condensation occurs.	By reaching higher concentrations faster (with 35% hydrogen peroxide), vaporized hydrogen peroxide can achieve higher levels of kill (six to twenty-four log bioburden reduction) compared to aerosolizing over the same period.
Environmental Measurement	Aerosolized hydrogen peroxide has larger droplets and condensation that is not accurately measurable by H2O2 sensors. The H2O2 sensors may have a reading; however, the accuracy is poor as there is both condensed and vapor forms of hydrogen peroxide present.	Vaporized hydrogen peroxide is noncondensing and can be measured accurately with commercially available H2O2 sensors. Relative Humidity (RH) and temperature is also measured to provide a holistic view of the enclosure conditions.
Cost-Effective Chemistry	Aerosolized or fogging technologies use a low-concentration, hydrogen peroxide solution that has the same per liter cost of higher concentration H_2O_2 but with more than double the amount of water. Customers end up paying hydrogen peroxide costs for what is mostly water.	Both fogging and vaporizing require the same concentration of hydrogen peroxide to achieve a desired log reduction. This means more of the low-concentration chemistry is required to get the same kill. Therefore, it's more cost- effective to use a higher concentration H_2O_2 solution.
Disinfectant vs. Sterilant	Some chemicals used for fogging are only EPA-registered as disinfectants, which are less effective than a sterilant in reducing a bioburden load of bacterial spores.	Vaprox Hydrogen Peroxide is an EPA registered surface Sterilant (USA Environmental Protection Agency: EPA Reg. No. 58779-4). It is also registered in the EU under the ECHA BPR directives. 6-log biological indicators are most often used to qualify the process.
Safety	Personnel should not be in the space during the process.	Personnel should not be in the space during the process.

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References

Kimura, T., Yahata, H., and Uchiyama, Y., Examination of Material Compatibilities with Ionized and Vaporized Hydrogen Peroxide Decontamination. Journal of the American Association for Laboratory Animal Science November 2020, Vol. 59 pg. 703 – 711.

Feinstein, S., Klostermyer, J., Newbould, D., Warren, W., Vaporous Biodecontamination: A Matter of Efficacy. Cleanroom Technology February 2019.

FOUR KEY TAKEAWAYS

VHP differs from fogging in these important ways:

1. VHP technology is very different from fogging hydrogen peroxide technologies that rely on aerosolization
2. VHP is a dry technology compatible with a wide range of materials and is suitable for use around sensitive electronics
3. VHP is more efficacious that aerosolized technology, with more even distribution at higher concentrations.
4. VHP is proven and used globally in life sciences to safely decontaminate rooms, materials, and medical products, making them safe for use in patient care.