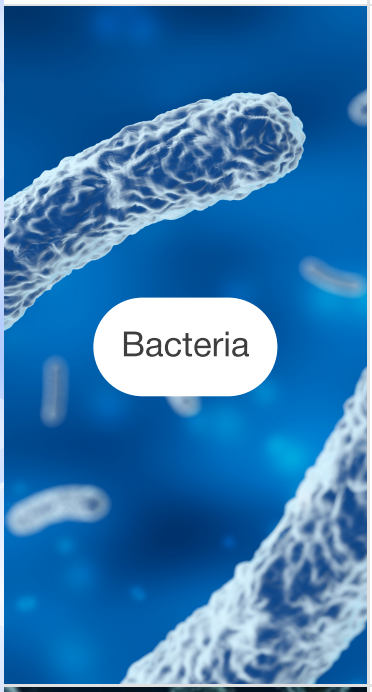
Hydrogen Peroxide Evaporation efficacy

Hydrogen Peroxide Evaporation technology (Hydrogen Peroxide Vapor) used in Evapolar evaPURE personal antibacterial air purifier and oxygenizer is a well-established medical grade technology with a broad spectrum efficacy and the ability to inactivate the most resilient microorganisms rapidly. The residue-free nature of hydrogen peroxide vapor (it breaks down to oxygen and water vapor) and vapor-phase application increases the practicality of the process. This technology has been tested against many organisms and classes of organisms. However, since many ‘common’ microorganisms exist, efficacy testing remains an ongoing process.

This document outlines the most significant current knowledge that can be attributed to qualified sources, as well as Evapolar laboratory tests. This information can be used not only to look at specific organisms but also at the efficacy of hydrogen peroxide vapor against types and groups of organisms.

Efficacy of vapor hydrogen peroxide technology

Please find the list of tested organisms and source references below.

Type of organism	Disease	Etiology	Reference
	Tuberculosis Pulmonary anthrax	Bacillus anthracis Mycobacterium tuberculosis Stenotrophomonas maltophilia Salmonella Typhimurium Staphylococcus epidermidis	(1) (2) (8) Evapolar test 1 (3) (9) Evapolar test 2
	Influenza Common cold Measles	Orthomyxovirus Rhinovirus Morbillivirus Adenovirus Phi6 pseudomonas virus	(5) (6) (11) (11) (11) (10) Evapolar test 3
	Coccidiodomycosis	Coccidioides immitis Blastomyces dermatitis Candida parapsilosis	(7) (7) (8)

References

(1) J P Wood, M W Calfee, M Clayton, N Griffin-Gatchalian, A Touati, S Ryan, L Mickelsen, L Smith, V Rastogi. A simple decontamination approach using hydrogen peroxide vapour for Bacillus anthracis spore inactivation

AIM: To evaluate the use of relatively low levels of hydrogen peroxide vapour (HPV) for the inactivation of Bacillus anthracis spores within an indoor environment.

METHODS AND RESULTS: Laboratory-scale decontamination tests were conducted using bacterial spores of both B. anthracis Ames and Bacillus atrophaeus inoculated onto several types of materials. Pilot-scale tests were also conducted using a larger chamber furnished as an indoor office. Commercial off-the-shelf (COTS) humidifiers filled with aqueous solutions of 3 or 8% hydrogen peroxide (H2 O2) were used to generate the HPV inside the mock office. The spores were exposed to HPV for periods ranging from 8 h up to 1 week.

CONCLUSION: Four- to seven-day exposures to low levels of HPV (average air concentrations of approx. 5-10 parts per million) were effective in inactivating B. anthracis spores on multiple materials. The HPV can be generated with COTS humidifiers and household H2 O2 solutions. With the exception of one test/material, B. atrophaeus spores were equally or more resistant to HPV inactivation compared to those from B. anthracis Ames.

Read the article ↗

(2) L Hall, JA Otter, J Chewins, NL Wengenack. Use of hydrogen peroxide vapour for deactivation of Mycobacterium tuberculosis in a biological safety cabinet and a room.

Mycobacterium tuberculosis is an important human pathogen that is routinely cultured in clinical and research laboratories. M. tuberculosis can contaminate surfaces and is highly resistant to disinfection. We investigated whether hydrogen peroxide vapor (HPV) is effective for the deactivation of M. tuberculosis on experimentally contaminated surfaces in a biological safety cabinet (BSC) and a room.

Biological indicators (BIs) consisting of an approximately 3-log10 inoculum of M. tuberculosis on stainless steel discs and a 6-log10 inoculum of Geobacillus stearothermophilus were exposed to HPV in BSC time course experiments and at 10 locations during room experiments. In three separate BSC experiments, M. tuberculosis BIs were transferred to growth media at 15 min intervals during a 180 min HPV exposure period. No M. tuberculosis BIs grew following 30 min of HPV exposure. In three separate room experiments, M. tuberculosis and G. stearothermophilus BIs were exposed to HPV for 90, 120, and 150 min, respectively. BIs for both microorganisms were deactivated in all 10 locations following 90 min of HPV exposure. HPV provides an alternative to traditional decontamination methods, such as formaldehyde fumigation, for laboratories and other areas contaminated with M. tuberculosis.

Read the article

(3) K Back, J Ha, D Kang. Effect of hydrogen peroxide vapor treatment for inactivating Salmonella Typhimurium, Escherichia coli O157:H7 and Listeria monocytogenes on organic fresh lettuce.

In this study, the efficacy of hydrogen peroxide vapor (HPV) for reducing Salmonella Typhimurium, Escherichia coli O157:H7 and Listeria monocytogenes on lettuce was investigated as well as its effect on lettuce quality. Lettuce was inoculated with a cocktail containing three strains of each pathogen then treated with vaporized hydrogen peroxide for 0, 2, 4,6, 8 and 10 min. The concentrations of hydrogen peroxide used were 0, 1, 3, 5 and 10%. With increasing treatment time and hydrogen peroxide concentration, HPV treatment showed significant ($P < 0.05$) reduction compared to the control (0%, treated with vaporized distilled water). In particular, vaporized 10% hydrogen peroxide treatment for 10 min was the most effective combination for reducing the three pathogens on lettuce. The reduction levels of S. Typhimurium, E. coli O157:H7 and L. monocytogenes on lettuce were 3.12, 3.15 and 2.95 log10 CFU/g, respectively. Furthermore, there were no significant ($P > 0.05$) quality changes (color and texture) of lettuce among all tested samples, and hydrogen peroxide residues were not detected after 36 h storage time in any of the treated samples. These results suggest that HPV treatment could be an alternative method for reducing S. Typhimurium, E. coli O157:H7 and L. monocytogenes on fresh produce.

Read the article

(4) S M Goyal, Y Chander, S Yezli, J A Otter. Evaluating the virucidal efficacy of hydrogen peroxide vapour

AIM: To evaluate the in-vitro efficacy of hydrogen peroxide vapour (HPV), a vapour-phase disinfection method, for the inactivation of a number of structurally distinct viruses of importance in the healthcare, veterinary and public sectors. The viruses studied were: feline calicivirus (FCV, a norovirus surrogate); human adenovirus type 1; transmissible gastroenteritis coronavirus of pigs (TGEV, a severe acute respiratory syndrome coronavirus [SARS-CoV] surrogate); avian influenza virus (AIV); and swine influenza virus (SwIV).

METHODS: The viruses were dried on stainless steel discs in 20- or 40-µL aliquots and exposed to HPV produced by a Clarus L generator (Bioquell, Horsham, PA, USA) in a 0.2-m(3) environmental chamber. Three vaporized volumes of hydrogen peroxide were tested in triplicate for each virus: 25, 27 and 33 mL.

FINDINGS: No viable viruses were identified after HPV exposure at any of the vaporized volumes tested. HPV was virucidal (>4-log reduction) against FCV, adenovirus, TGEV and AIV at the lowest vaporized volume tested (25 mL). For SwIV, due to low virus titre on the control discs, >3.8-log reduction was shown for the 25-mL vaporized volume and >4-log reduction was shown for the 27-mL and 33-mL vaporized volumes.

CONCLUSION: HPV was virucidal for structurally distinct viruses dried on surfaces, suggesting that HPV can be considered for the disinfection of virus-contaminated surfaces.

Read the article ↗

(5) S N Rudnick, J J McDevitt, M W First, J D Spengler. Inactivating influenza viruses on surfaces using hydrogen peroxide or triethylene glycol at low vapor concentrations.

BACKGROUND: Surfaces in congregate settings, such as vehicles used for mass transportation, can become contaminated with infectious microorganisms and facilitate disease transmission. We disinfected surfaces contaminated with H1N1 influenza viruses using hydrogen peroxide (HP) vapor at concentrations below 100 ppm and triethylene glycol (TEG)-saturated air containing 2 ppm of TEG at 25°C.

METHODS: Influenza viruses in aqueous suspensions were deposited on stainless steel coupons, allowed to dry at ambient conditions, and then exposed for up to 15 min to 10 to 90 ppm of HP vapor or TEG-saturated air. Virus assays were done on the solution used to wash the viruses from these coupons and from coupons treated similarly but without exposure to HP or TEG vapor.

RESULTS: After 2.5 min, exposure to 10 ppm HP vapor resulted in 99% inactivation. For air saturated with TEG at 25 to 29°C, the disinfection rate was about 1.3- log10 reductions per hour, about 16 times faster than the measured natural inactivation rate under ambient conditions.

CONCLUSION: Vapor concentrations of 10 ppm HP or 2 ppm TEG can provide effective surface disinfection. At these low concentrations, the potential for damage to even the avionics of an airplane would be expected to be minimal. At a TEG vapor concentration of 2 ppm, there are essentially no health risks to people.

Read the article ↗

(6) L Hall, J A Otter, J Chewins, N L Wengenack. Deactivation of the dimorphic fungi Histoplasma capsulatum, Blastomyces dermatitidis and Coccidioides immitis using hydrogen peroxide vapor.

Hydrogen peroxide vapor (HPV) has been proposed as an alternative to formaldehyde fumigation for the decontamination of biosafety level (BSL) III laboratories. The aim of this study was to evaluate the efficacy of HPV against the dimorphic fungi Histoplasma capsulatum, Blastomyces dermatitidis and Coccidioides immitis. Working inside a class II biological safety cabinet (BSC) within a BSL III laboratory, inocula containing approximately 5-log10 CFU/ml from the mold form of each organism suspended in RPMI medium were deposited on stainless steel discs and allowed to air dry. The organisms were exposed to HPV inside a BSC using a Bioquell Clarus S HPV generator. In three replicate experiments, individual discs were transferred into liquid media at timed intervals during a 105 min HPV exposure period. Control and HPV exposed discs were incubated in RPMI media at 30oC for 6 weeks to determine if any viable organisms remained.

Positive cultures were confirmed using specific nucleic acid hybridization probes. Results indicate that H. capsulatum, dermatitidis and C. immitis were killed within 30 min of HPV exposure.

Read the article

(7) G McDonnell, G Grignol, K Antloga. Vapour-phase hydrogen peroxide decontamination of food contact surfaces.

Decontamination of food contact surfaces, equipment and general work areas is important for the prevention of transmission of food borne microorganisms. Many liquid-based disinfectants that are widely used for this purpose may not be appropriate for electrical equipment and for relatively large areas. Fumigation with vapour phase hydrogen peroxide (VPHP) is an option in these cases and is discussed in this report. VPHP is a dry and rapidly effective antimicrobial vapour. A typical decontamination cycle consists of four phases in a one-step process that is documented and can be validated for a given application. VPHP has been shown to have potent antimicrobial activity against bacteria, viruses, fungi and bacterial spores. Recently, efficacy has been confirmed against known food borne pathogens, including Listeria monocytogenes and E. coli O157:H7. Because the VPHP process is dry, it is compatible with many materials, including electronics. In the case study presented, VPHP was shown to be effective in decontaminating a simulative room, including an electrical appliance, in an automated, validated process. VPHP is a possible alternative to liquid-based disinfectants for decontamination of food contact surfaces and equipment.

Read the article

(11) E Berrie, L Andrews, S Yezli, J A Otter. Hydrogen peroxide vapour (HPV) inactivation of Adenovirus.

AIM: Adenovirus contamination can be problematic in various settings including life science laboratories and during pharmaceutical manufacturing processes. Stringent and effective decontamination procedures are necessary to minimise the risk of personnel exposure or product cross contamination in these settings.

Hydrogen peroxide vapour (HPV) is sporicidal, tuberculocidal and fungicidal with proven efficacy against some viruses. We investigate the efficacy of HPV for the inactivation of recombinant Adenovirus.

METHODS AND RESULTS: In this study, the survival of a dried recombinant Adenovirus (Ad5GFP) was tested before and after HPV exposure to determine the efficacy of HPV at inactivating Adenovirus. A >8- log10 TCID50 reduction resulted from 45 min exposure to HPV in a microbiological safety cabinet.

CONCLUSION: HPV is effective for the inactivation of a recombinant Adenovirus.

SIGNIFICANCE AND IMPACT OF THE STUDY: The results suggest that HPV may be useful for Adenovirus decontamination in life science laboratories or in manufacturing facilities.

Read the article ↗

(8,9,10) Evapolar tests

The following studies were all performed in similar environments using similar methods.

- CFU Colony Forming Unit — is a unit commonly used to estimate the concentration of microorganisms in a test sample. The number of visible colonies (CFU) present on an agar plate can be multiplied by the dilution factor to provide a CFU/ml result.

Type of organism	Method		Results
Stenotrophomonas maltophilia (test 1)	The Stenotrophomonas maltophilia was aerosolized into a sealed environmental bioaerosol chamber containing the Evapolar evaPURE air purifier device.	 Samples were taken every 10 minutes from the chamber in order to quantify the reduction speed and capabilities of the device.	The reduction of colony forming units is more than 99.34% in 20 minutes, from 640 to 4 CFUs.
Staphylococcus epidermidis (test 2)	The Staphylococcus epidermidis was aerosolized into a sealed environmental bioaerosol chamber containing the Evapolar evaPURE air purifier device.		The reduction of colony forming units is more than 99.5% in 20 minutes, from 600 to 3 CFUs.
Phi6 Pseudomonas syringae phage (test 3)	The Phi6 Pseudomonas syringae phage was aerosolized into a sealed environmental bioaerosol chamber containing the Evapolar evaPURE air purifier device.		The reduction of colony forming units is more than 99.34% in 20 minutes, from 600 to 3 CFUs.

Conclusion

The bioaerosol trial with evaPURE showed a quick reduction of CFUs over time. This should be considered a minimum reduction speed as the reduction from minute 0 to 20 is estimated to be significantly higher than between minute 10 and 30.

The bioaerosol control run proved to play a vital role in the Evapolar evaPURE antibacterial air purifier and oxygenizer's reduction of CFUs over time and its undeniable efficiency.