TECHNICAL BULLETIN

Effects of Decontamination Agents on HEPA Filters

Applying HEPA Air Filtration in applications subjected to routine bio-decontamination.

High Efficiency Particulate Absolute (HEPA) filters are widely used to provide clean air to facilities where microorganisms cannot be tolerated. HEPA filters are also used to clean the air leaving certain facilities where pathogens may be present. In these situations the facilities are routinely cleaned using disinfectant solutions and the filtration systems may be decontaminated prior to servicing. In the course of these activities the HEPA filter will be exposed to the decontamination agent.

For clarity we can divide commonly used agents into two broad groups.

1. Those that are gasses and vapors used in space decontamination including:

a. formaldehyde (gas + water vapor)

b. hydrogen peroxide (vapor)

c. chlorine dioxide (gas + water vapor)

2. Those that are solutions used for surface decontamination in the facility including:

a. bleach (sodium hypochlorite) solution (oxidizer)

b. acidic / oxidizing solutions including peracetic acid / hydrogen peroxide mixtures

c. quaternary ammonium chloride solutions

This bulletin primarily focuses on group one above where occasional direct application of the decontamination agent on the installed filter for the purpose of decontamination prior to servicing occurs. Where applicable, we will also provide information on the effect of routine exposure of the filters to ambient levels of vapors from the group two cleaning solutions used on facility surfaces.

Camfil has considered the foreseeable exposure of HEPA filters to decontamination agents. Laboratory testing and field experience related to HEPA filters produced by Camfil indicates that in general, the materials used by Camfil are suitable for these applications. Generally speaking compatibility of the filter materials used by Camfil with commonly used decontamination agents is good to excellent. Due to the hygroscopic and porous nature of wood, filters made with wood frames should be avoided where decontamination of microorganisms is required. Naturally, there is always interaction between decontamination agents and the materials they come in contact with. In fact, that is how they establish their effectiveness in controlling microorganisms. Under most conditions, Camfil HEPA filters withstand these effects without loss of required performance. Since each decontamination agent affects the filters differently we will address each one seperately below.

Formaldehyde:

General Formaldehyde Gas Decontamination Process Summary:

Formaldehyde gas is generated on-site at the point of use by heating solid paraformaldehyde in a closed space. The resulting gas is distributed throughout the space along with water vapor to achieve decontamination. The target concentration level of formaldehyde is usually theoretically set to approximately 10.5 g/m3 (0.3 g/ft3) or approximately 7800 – 8000 ppm. The duration of exposure may range from 2 to 16 hours or longer and the relative humidity is usually maintained between 60% - 95% RH during the decontamination cycle. Temperature is ambient to slightly above ambient, approximately 21 C to 35 C (70°F – 95°F). Following decontamination the space might be either ventilated to atmosphere or the formaldehyde gas is neutralized using ammonia (by heating ammonium carbonate or a similar compound to generate ammonia gas) and then ventilated.

Compatibility and Characteristics of HEPA Filters to Formaldehyde Decontamination:

Both laboratory testing (where performed) and field experience (where known) indicate that the materials used by Camfil to construct HEPA filters show excellent chemical compatibility to formaldehyde under typical decontamination cycles and generally good compatibility to short duration exposure to ammonia consistent with this process. Extended exposure of HEPA filter media and aluminum components to ammonia gas, particularly at high relative humidity is not recommended. Fraction negative decontamination studies using 106 B. atrophaeus biological indicators demonstrate the effectiveness of formaldehyde in decontamination of Camfil HEPA filters.

Hydrogen Peroxide

General Hydrogen Peroxide Vapor Decontamination Process Summary:

Hydrogen peroxide vapor is generated by evaporation or aerosolization of concentrated (30 – 35%) aqueous hydrogen peroxide solution. Some processes require initial dehumidification prior to introducing the peroxide vapor into the space. While some processes allow micro-condensation to occur, accumulation of condensation should be avoided since the condensate could be very concentrated (60% H2O2) and the concentration of peroxide in the air could drop as a result of condensation. During the exposure phase, temperature, humidity and dew point in the system should be maintained to avoid wide-spread condensation of hydrogen peroxide on HEPA filters and surfaces. Peak hydrogen peroxide concentration may range from approximately 250 ppm to approximately 1600 ppm. Duration of hydrogen peroxide exposure may vary from 30 minutes to several hours. Aeration follows the decontamination cycle until the residual hydrogen peroxide level reaches an acceptably low level to allow access to the decontaminated space.

Compatibility and Characteristics of HEPA Filters to Hydrogen Peroxide Decontamination:

Both laboratory testing (where performed) and field experience (where known) indicate that the materials used by Camfil to construct HEPA filters show excellent chemical compatibility to hydrogen peroxide under typical decontamination cycles. It is known that hydrogen peroxide over time adsorbs onto exposed surfaces and during aeration (or ventilation) desorbs over time. It is also known that different types of surfaces exhibit different levels of adsorption and retention of hydrogen peroxide. Accordingly, and due to the physics of adsorption, laboratory testing and field monitoring indicate that the presence of a HEPA filter in a system, due to the enormous surface area of the filtration media, may delay the attainment of peak concentration levels downstream of the HEPA filter. The HEPA filter will also capture droplets of aerosol in the air steam if they exist. Hydrogen peroxide in the vapor phase will pass through the HEPA filter and downstream concentration levels will rise accordingly, approaching levels similar to upstream concentration level once adsorption has occurred. After exposure, during the aeration phase, the opposite effect is observed. Downstream hydrogen peroxide levels will momentarily peak at the start of aeration due to rapid desorption from the filter media. Reduction in downstream concentration levels will initially lag that of the upstream level. The overall aeration time may or may not be extended due to the presence of the HEPA filter depending upon the type and area of other surfaces present in the system. Fraction negative decontamination studies using 106 G. stearothermophilus biological indicators demonstrate the effectiveness of hydrogen peroxide in decontamination of Camfil HEPA filters.

Chlorine Dioxide:

General Chlorine Dioxide Gas Decontamination Process Summary:

Chlorine dioxide gas is generated on-site at the point of use by either Gas-Solid Phase or by Solid-Liquid Phase methods. Regardless of the generation method, the decontamination cycles are similar. The resulting chlorine dioxide gas is distributed throughout the space along with water vapor to achieve decontamination. The target concentration level of chlorine dioxide gas is typically in the range of 1 to 5 mg/l (347 – 1735 ppm). The duration of exposure may range from 30 minutes to 2 hours or longer and the relative humidity is usually maintained between 60% - 75% RH during the decontamination cycle. The space being decontaminated is kept dark since light accelerates the break-down of chlorine dioxide. Temperature is ambient to slightly above ambient, approximately 21 C to 30 C (70°F – 86°F). Following decontamination the space is ventilated through a scrubber to capture and neutralize the chlorine dioxide gas.

Compatibility and Characteristics of HEPA Filters to Chlorine Dioxide Decontamination:

Both laboratory testing (where performed) and field experience (where known) indicate that the materials used by Camfil to construct HEPA filters show good to excellent chemical compatibility to chlorine dioxide under typical decontamination cycles. HEPA filter frames and housings constructed of aluminum or stainless steel are preferred to those constructed of coated carbon steel. Repeated exposure of welded or fabricated (machined, formed, etc) stainless steel to high levels of chlorine dioxide especially in high humidity environments will result in surface rust staining if iron impurities are present on the exposed metal surface. The formation of rust stains are superficial and do not negatively affect the integrity of the filter or housing. However, if the desire is to have a very smooth clean surface and to avoid rust stains, it is recommended that the housing be treated either by pickling or passivation or other means to remove residual iron contamination on surfaces after fabrication and prior to exposure to chlorine dioxide. Rust stains present on previously exposed surfaces may be removed in the field by application of a pickling solution or other cleaning agent that removes iron oxide. Once properly cleaned, the stains will not return upon subsequent exposure to chlorine dioxide. Careful studies indicate that while low carbon stainless steel is advantageous, the use of 316/316L alloy stainless steel offers no additional advantages in this regard compared to 304/304L stainless steel. HEPA filter potting compound made of polyurethane will show a characteristic color shift to yellow following exposure to chlorine dioxide, however tests indicate no measurable change to the bulk properties and no loss in performance of the polyurethane. Fraction negative decontamination studies using 106 B. atrophaeus biological indicators demonstrate the effectiveness of chlorine dioxide in decontamination of Camfil HEPA filters.

Exposure to decontamination agents for facility cleaning over long periods of time

Certain component materials and filter assemblies have been exposed to the cleaning agents (listed in group 2 above) in laboratory tests. These tests were intentionally designed to be harsh since practical concerns limited exposure time. Since environmental exposure and experience concerning the installed base of filters takes many years of observation, everything about long term exposure to environmental contamination is not currently known. Generally in our laboratory tests and field experience there were no severe interactions between materials of construction and exposure to these agents with the following notable observations:

- Direct application of liquid or aerosolized cleaning agents onto any part of the filters should be avoided.
- If a gel is required to be used in an application (e.g. pharmaceutical, biological, food industries) where oxidative decontamination or oxidative cleaning agents will be used, the preferred gel is silicone gel. The use of polyurethane gel will shorten the effective lifetime of the filter since polyurethane gel may oxidize on the surface and exhibit a “skinning effect” after many years of service. Prolonged and repeated exposure of silicone gel to oxidizing agents like sodium hypochlorite will result in fading of the color pigment. This color shift to clear by itself does not indicate a problem with the gel, but may indicate that the gel is being subjected to very harsh or unusual conditions. Exposure of silicone gel to chlorine and to strong acids and bases over many years may result in damage to the gel beyond color change that may compromise the performance of the gel system.

Camfil Disclaimer and End User Responsibilities:

We would like to take this opportunity to thank our customers and other parties for their interest in Camfil filters, housings and products and to remind them that each user bears the full responsibility for making its own determination as to the suitability of Camfil materials, information, products, recommendations and advice for its own particular purpose. Each user must identify and perform tests and analysis sufficient to assure that its finished parts, methods and results will be safe and suitable for use under end-use conditions. Because actual use of products, methods and information by the user is beyond the control of Camfil, such use is within the exclusive responsibility of the user and Camfil cannot be held responsible for any loss incurred through incorrect or faulty use of products or information. Further, no statement contained herein concerning a possible, safe or suggested use of any material, method, product or advice is intended or should be construed to grant any license under any patent or other intellectual property right of Camfil or any of its subsidiaries or affiliated companies or as a recommendation for the use of such information, material, product, method, service or design in the infringement of any patent, copy write, trademark or other intellectual property right.