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# UPDATE:
# WHY ANTIMICROBIAL TREATMENTS ARE UNNECESSARY FOR PALL CABIN AIR FILTERS

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## UPDATE: Why Antimicrobial Treatments are Unnecessary for Pall Cabin Air Filters

Joe Lundquist, Bill Needelman and Dr. Glenn Howard


## ABSTRACT

Periodically, the question arises as to the possibility of microbial growth on high efficiency cabin air filters and the subsequent transmission of these microbes through an airplane's ventilation system. In the past, Pall Corporation has asked its microbiologists to assess this purported concern. They have tested and examined numerous new and returned filters, run extensive tests, and have concluded that the use of antimicrobial treatment is both unnecessary and unwarranted for our cabin air filters. This paper summarizes the rationale for this decision.


## Introduction and Background

### Proof That the Filtration Medium Used in Pall Cabin Air Filters Does Not Support Microbial Growth:

***Testing of Used Cabin Air Filters for Microbial Growth***

Once captured within the cabin air filter, the survival rate of microorganisms is very low. In air, most microbes die within a few minutes. Bacteria require fairly high relative humidity, moderate temperatures and nutrition to survive. Conditions within a cabin recirculation system are too dry and cool and the filter itself lacks the nutrients necessary for bacteria to remain viable for long. While viruses survive somewhat longer in the low humidities experienced in flight, they need to invade living cells to survive and these are not present on the filter.

Over many years we have examined hundreds of cabin air filters returned after service for both contaminant type and distribution and have not observed any evidence of microbial growth on them. This is true even after a totally used filter was in long-term storage in significantly higher relative humidity conditions than experienced in flight.

In a test run by DaimlerChrysler Research Center Ulm, Organic Coatings Department in 1995, two used Pall cabin air filters, one of which was stored for six months, were compared for microbial content on the downstream side of the filter media.

Figure 1 (Far Right)

No microbial growth was found on either filter. Boeing's Airliner magazine, October-December 1993 issue, in an article entitled "Cabin Air Quality," while discussing microbial aerosols, reported "A biology lab at Boeing has analyzed HEPA filters for organic particulate content. Of the filters tested, virtually all organic material was on the surface of the filter..." Again, this means no microbial growth, or grow-through, was noted. Figure 1 shows the downstream side of a cabin air filter return after

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a C-check, or about 14 months of service. Like all the filters we have evaluated, it shows no traces of microbial grow-through.

### *Lab Testing of Filter Medium for Microbial Growth*

In a third-party controlled test, Pall cabin air filter medium was exposed to a myriad of bacteria and fungi in a high humidity chamber. Even after long-term exposure, no growth of microbes occurred.

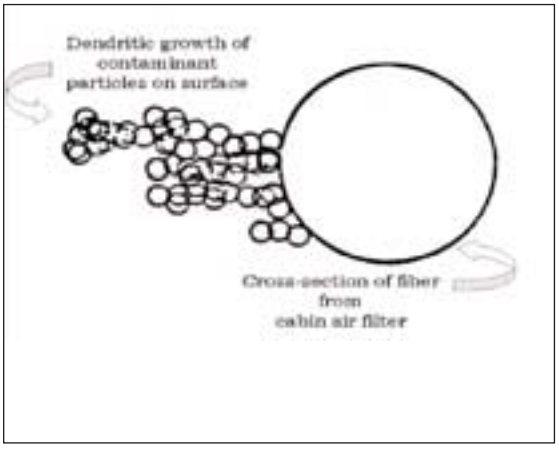
### *Microbial Challenge Testing*

Once captured within the cabin air filter, the microbes do not proliferate nor do they migrate or pass downstream. Unlike some purported HEPA rated filters, results for Pall filters demonstrate very high microbial efficiency, exceeding 99.99% removal when tested at rated flow rate with both live bacterial and virus challenges. We have run these live microbial challenge tests on our "true HEPA" cabin air filters at rated flows both on new and filters returned from service after a C-check and the efficiencies on the used filters were found to be even slightly higher than on the new filters. Pall cabin air filters are unaffected by either the rigors of service or the amount or type of contaminants captured.

### *Why Antimicrobial Treatment is Not Effective*

Biocides kill by direct contact. This type of treatment is therefore not effective at killing microbes which do not reach a treated surface, such as those that are grouped together in clumps, captured on dust particles or on fibers located upstream of the filter media, or those that form dendritic chains on the surfaces of fibers. In aerosol filtration, small particles tend to adhere to surfaces and stay there (attractive forces are greater than the drag forces trying to separate them). Typically, another particle will adhere to the first particle and so on, eventually forming a fairly

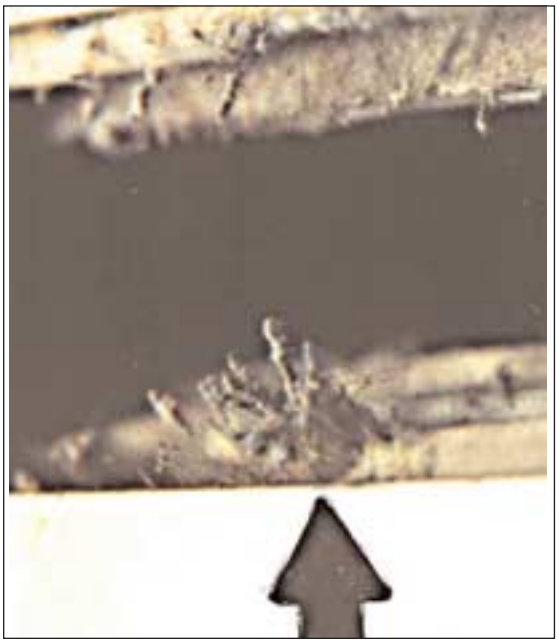
Figure 2 (Far Right)




long, tree branch-like chain, or dendrite. This is shown in the sketch in Figure 2 and in the photo in Figure 3.

We have noticed a light, continuous dust layer forming upstream of the filter media on cabin air

Figure 3 (Far Right)



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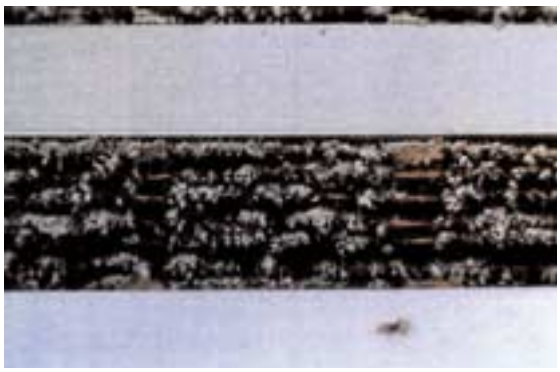
filters aboard new aircraft delivered to airlines. Even after only a few hours of flight trials some of the microbes will be captured by this dust layer and not reach the filter media. This buildup continues until a ridge of contaminants forms on the crests, or outer folds, of the pleats in a filter. Figure 4 shows a photo of a filter removed after a half C-check, or about six months service. The photo in Figure 5 shows a nearly continuous fibrous mat of contaminants collected on the upstream side of a cabin air filter after service for a full C-check, or about 14 months. You can see that the filter pleats themselves are nearly totally blocked from view and therefore you can understand why few if any of the microbes reach the filter surface once a filter begins loading with contaminants. An antimicrobial treatment applied on the surface of the filter media would be totally ineffective at killing microbes collected upstream of the media on the fibrous mats shown in both Figure 4 and Figure 5.

Figure 4

Figure 5



Antimicrobial agents might be somewhat useful in preventing staining or odors in some household products, such as water-saturated kitchen sponges. However, even in these products their effectiveness in killing a high percentage of microbes is questionable. In fact, a major disinfectant manufacturing company has rejected the idea of an antimicrobial sponge after finding large quantities of viable microorganisms on treated sponges. Additionally, these agents are ineffective at killing viruses.

The Environmental Protection Agency (EPA) disallows public health claims for any products impregnated or treated with biocides unless the products themselves have been approved and registered and the treated product demonstrates effectiveness for the claims [2].

Lastly, although some biocides might be approved for use in contact with humans (in a world with growing sensitivity to chemicals and the overuse of biocides, antimicrobial agents and antibiotics), we feel it prudent not to add a chemical compound to our media without establishing its valid need. Even issues such as user liability for disposal and consideration for chemicals created during combustion make us consider very carefully the benefits versus drawbacks associated with adding any chemical compound to our products.

### Health Care Industry Experience

HEPA filters used in the pharmaceutical and electronics industries have successfully maintained cleanliness levels in downstream air for years, even under considerably more humid conditions than exist in cabin air. These filters are used in clean rooms where particle and microbial con-

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trol is extremely critical and any grow-through or shedding would be quickly noticed downstream. These systems are routinely monitored as part of standard operating procedures and this does not occur.

In addition, hospitals and the pharmaceutical industry are well aware of the shortcomings of some HEPA filters and insist on validating performance by live agent testing. Pall has successfully validated our cabin air filters and has even validated filters returned from service. In fact, we have measured microbial efficiencies on used cabin air filters that were higher than on new filters. This includes bacterial and viral contaminants.

### Summary and Conclusions

Pall cabin air filter media does not support microbial growth, even after storage at humid conditions.

Tests prove that the bacteria, viruses and fungi, which are very effectively captured by Pall cabin air filters, die off fairly rapidly and are not released downstream.

Biocides kill by direct contact and most microbes would not even reach the potentially treated surface of the media after even slight contaminant loading.

Even though biocides might reduce staining or odors on very moist surfaces, they are ineffective at killing viruses.

The EPA disallows claiming health benefits for products impregnated with biocides where no data exists.

HEPA filters used for years in more humid environments for critical non-aerospace applications, such as hospitals and for the manufacturing of pharmaceuticals and semi-conductors, have successfully maintained cleanliness levels that would be impossible if microbial grow-through were problematic.

Chemicals should be prudently used only where their use is justified, not solely for sales promotional purposes.

Realizing that there has been a recent groundswell of discussion on this subject, we wanted to quickly answer any questions our customers may have and that is the reason for this paper. It is extremely important that Pall customers feel confident our products will perform as they are intended and be aware of our rationale with regard to what can otherwise be a fairly sensitive issue. As you can clearly see from the above, the excellent microbial efficiency and overall performance measured for Pall cabin air filters prove they effectively mitigate the transmission of infectious microbes in the cabin air ventilation system. Armed with this knowledge, we can all breathe a little easier.

## References


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3. "Pall Cabin Air Filters. . . Helping Protect Passengers From Infectious Diseases", 1998. Pall Corporation brochure PAC-CAF-M7/98.

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