CASE **STUDY**
Cultural Heritage

CULTURAL ARTIFACT MUSEUM

CUSTOMIZED MOLECULAR FILTER AND FILTER FAN UNIT (FFU) ELIMINATE DAMAGING CRYSTAL GROWTH ON PRICELESS ARTIFACTS DISPLAYED IN VITRINE CASES

COMPANY PROFILE

One of the world's most esteemed museums houses a unique collection showcasing examples of Native American daily life, including pottery, wood, textiles, and artworks. The curators and operations team work diligently to preserve and display these treasures, many of which are hundreds of years old.

THE SITUATION

While preserving and curating artifacts within their vitrines (custom steel and glass enclosures), museum staff observed efflorescence, a form of crystal growth, on the surfaces of ceramic, stone, and wood artifacts, plant fibers, seeds, textiles, feathers, fur, and tanned hides. The staff consulted with colleagues at other museums and found that similar issues were occurring in several vitrines.

THE ACTION

To avoid the expense of modifying or replacing multiple vitrines, the museum contacted Camfil to explore filtration solutions that eliminate harmful contaminants. Camfil's Molecular Contamination Control (MCC) team was engaged to design a solution. Drawing on a similar successful project from European colleagues, the team developed an innovative test method that samples air inside the vitrines. This allowed for the contaminants to be analyzed and the appropriate molecular filtration system to be designed.

Utilizing Camfil's proprietary simulation software, multi-layer GigaPleats (filters commonly used in highly sensitive semiconductor manufacturing facilities) and custom, UL certified filter fan units (FFUs) were designed and installed for a trial in two vitrines.

THE RESULT

After several months of operation, the priceless artifacts were reexamined, confirming that no new crystal growth had occurred in the vitrines. Due to the success of this trial, FFUs with GigaPleat filters were installed in the remaining 48 vitrines to protect the invaluable artifacts. Additionally, other museums experiencing similar issues have since adopted Camfil's solution for their vitrines.

"Camfil designed a solution and verified its effectiveness. Now we can protect other valuable artifacts in our collection."

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THE PROOF

Identifying Contaminants

Camfil installed thermal desorption tubes in five vitrines to collect air samples over a four-hour period. The samples were analyzed using gas chromatography-mass spectrometry (GC-MS) in Camfil's molecular lab to determine both the composition and concentrations of gases present. Among the contaminants identified were volatile organic compounds (VOCs), acids, and bases.

Designing the Filter

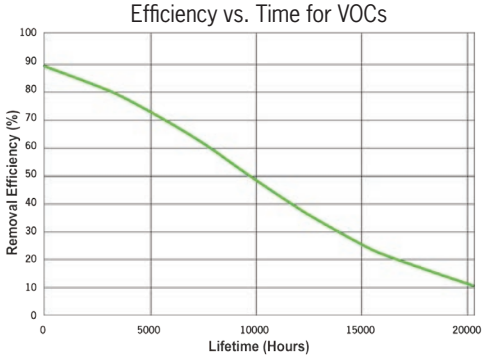
Using proprietary GigaPleat Lifetime Determination (GLD) simulation software, a multi-layer filter was designed and manufactured to remove the VOC, acid and base contaminants responsible for the efflorescence.

Contaminants Measured in Five Vitrines (ppb)

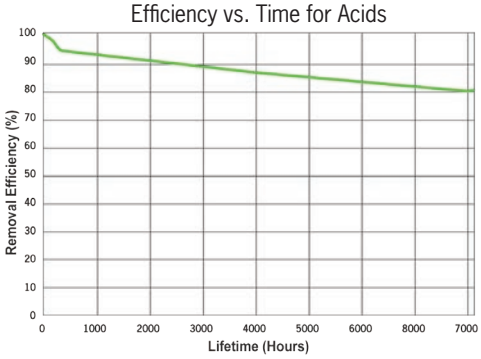
Sulfur dioxide	0.0	0.4	0.1	0.0	0.0
Butane	0.2	0.3	0.4	0.2	0.0
Nitrosomethane	0.4	0.2	0.4	0.1	0.0
Acetone	2.3	7.0	2.4	3.4	0.4
2-Propanol	3.0	0.4	0.1	0.2	0.0
1,4-Epoxy-1,3-butadiene	0.0	0.2	0.0	0.0	0.0
N-Methyl-N-nitrosomethanamine	6.5	13.1	5.8	6.4	2.3
1-Pentene	0.0	0.1	4.0	0.0	0.0
Acetic acid	0.3	0.0	1.0	0.7	0.7
Hexane	0.0	0.0	0.0	0.0	0.5

Thermal desorption tube in vitrine

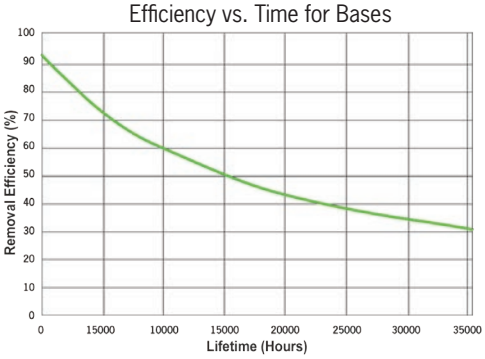
Efficiency vs. Time for VOCs



Efficiency vs. Time for Acids



Efficiency vs. Time for Bases



Validating the Solution

In general ventilation particulate air filters, growing resistance to airflow is a common indicator of remaining service life. However, for gas-phase filters, lifetime is determined either by measuring the gas upstream and downstream to monitor efficiency or by removing the filter and analyzing its remaining adsorbent capacity. In this case, filters were removed from the vitrines and evaluated in Camfil's lab using GC-MS and ion chromatography (IC) analyses. The results indicated that the filters would have a minimum service life of 18 months.