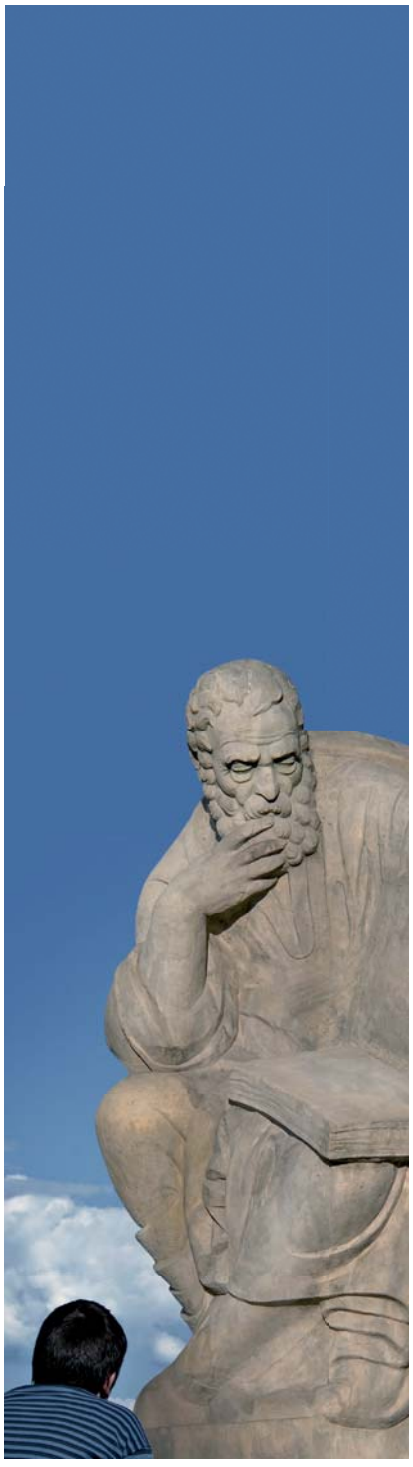
camfil FARR

molecular filtration preserves artefacts

Camfil Farr	Segment brochure
Museums, galleries, archives	
Camfil Farr – clean air solutions	

the art of artefact preservation



The primary function of museums, art galleries, libraries and document archives is to preserve artefacts for future generations. Artefacts need not be ancient; they may be comparatively recent but nevertheless sensitive objects such as government records, newspapers and microfilms.

Conservation may be applied on a remedial basis (repair of existing damage), however it is far more desirable and cost effective in the long term to prevent deterioration. This approach is called “Preventative Conservation”. Molecular Filtration has an important role to play within Preventative Conservation.

Display and storage conditions in museum, gallery and archive buildings

Inappropriate environmental conditions may cause irreversible damage to vulnerable artefacts. Critical parameters include; temperature, relative humidity, lighting, particulate pollution (dust), molecular (gaseous) pollutants and pests. The stability of temperature and humidity levels are equally important. In some cases, rapid changes can be more detrimental than a stable condition, albeit at a non-ideal level. It is also known that there is a synergistic relationship between increased temperature, increased humidity, molecular pollutants and rate of deterioration. Different categories of artefact e.g. paper, paintings, metals and wood have their own specific storage requirements.

A very high level of care and expertise should be applied in the design and construction of buildings used for the storage and display of artefacts. Interestingly, in most collections only a small proportion of the artefacts are on the display, the bulk of the items are actually in storage.

If different classes of artefact are present, it is normal to provide a cell or compartmentalised construction within the building, in which it is possible to provide different microclimates. All buildings must be ventilated to some degree. Since it is necessary to provide good breathing air, ventilation rates typically increase with human occupancy.

Forced or natural ventilation induces external or “fresh” into the building. This air will contain any particulate or molecular pollutants present in the external air. External pollutants may also enter the building via “fugitive” routes such as open windows, delivery bays and building defects. In addition to external sources, there are important internal sources of pollutants which may damage artefacts. Humans shed vast numbers of particles from skin and clothing. It is known that internal levels of particles may exceed the external street level value during daytime periods. Molecular pollution can originate from building construction and finishing materials, from storage materials and perhaps surprisingly from the artefacts themselves.

the problem: molecular pollutants

Although there are natural sources such as hot water springs and volcanoes, atmospheric molecular pollutants can be predominantly attributed to human activity such as power generation and transport. Normally they are associated with high population density, e.g. cities.

In terms of damage to artefacts, molecular pollutants fall into two broad categories

- **those with acidic chemical properties**
- **those with oxidising chemical properties**

The principal acidic precursor gases are sulphur dioxide and nitrogen dioxide. These may react with atmospheric humidity to form the stronger sulphuric / sulphurous and nitric / nitrous acids. Acids cause damage by corrosion to materials such as metals and marble. Other materials susceptible to damage include leather, wool, silk, paper and photographic items.

The predominant oxidising gases are ozone, nitric acid and other oxygen/nitrogen compounds. These gases will cause damage mainly in organic materials and the effects can be likened to premature ageing. In some cases, ozone will lead to the breakdown of the organic material, and the formation of carboxylic acids. These acids can accelerate the deterioration rate within the affected artefact and in other artefacts in close proximity. Typical visual changes resulting from oxidation include; yellowing, brittleness, fading and tarnishing of metals.

Molecular pollutants are specified in terms of the concentration of individual chemicals or groups of chemicals. The normal units of concentration are micrograms per cubic metre ($\mu g/m^3$) and parts per billion (ppb). Typical concentrations of these gases in cities are readily available from appropriate web sites. Pollutant molecules act on an individual basis and for a concentration of 10 ppb (which is an extremely low ambient level) there are 25,000,000,000,000,000 molecules per cubic metre of air which are each capable of causing damage.

A summary of molecular pollutants and their effects is given in Table One.

Particulate pollutants

Particulate pollutants arise from multiple sources including combustion processes (industrial, power generation, vehicle exhausts, cigarette smoke), vehicle tyres running on roads, building activity and human beings. Heavy particles with metallic content are abrasive and may settle on surfaces and cause scratching. Smaller particles may remain suspended and be transported by air movement to even the remotest corners in rooms and display cabinets. Here surface deposition will lead to soiling or discolouration.

Many particles, particularly those arising from combustion processes will be oily or sooty in nature and have acidic properties. These particles are particularly damaging since they are very sticky and can cause corrosion in many materials.

Particles arising from building works (concrete) have both alkaline and abrasive properties and are harmful to artefacts such as paintings, and textile fibres.

Particles are specified according to their size and frequency, i.e. number per unit volume (per cubic metre). If the level of particulate pollution is high then it may be appropriate the specify the amount in terms of weight, (mg/m^3).

Gas	Formula	Source	Susceptible artefacts	Type of damage
Sulphur dioxide	(SO_2)	External, traffic fumes, power generation	Metals, marble/limestone, paper.	Acidic corrosion
			Old paintings, particularly the natural pigments (inorganic and organic)	Blackening due to sulphide formation
Oxides of nitrogen, particularly nitrogen dioxide	(NOX), NO_2	External, traffic fumes	Metals, marble/limestone.	Acidic corrosion
Ozone	(O_3)	External, atmospheric	Paper, fabrics,	Oxidation (ageing)
Hydrogen sulphide	H_2S	External – industry, wastewater treatment Internal – leather items	Old paintings, particularly the natural pigments (inorganic and organic)	Blackening due to sulphide formation
Organic acids – formic or methanoic acid, acetic or ethanoic acid	HCOOH CH_3COOH	Internal – wooden fixtures, wooden and paper artefacts	Metals and organic based materials	
Organics e.g. phenol, formaldehyde	C_6H_5OH	Internal, construction and furnishing materials	Various	Ageing

Table One. Gaseous pollutants, their sources and effects.

Proven products fr

1

Camcarb Metal

A robust solution that can be filled with adsorbents. The product provides long contact times, long life and extremely high efficiency. The stainless steel cylindrical cartridges may be refurbished by refilling with new media. Camcarb is particularly suited to make-up air applications.

2

Camcarb Green

A robust solution that can be used with any of the adsorbents. The product provides long contact times, long life and extremely high efficiency.The Green version is a one-use product suitable for disposable by incineration. Camcarb is particularly suited to make-up air applications

3

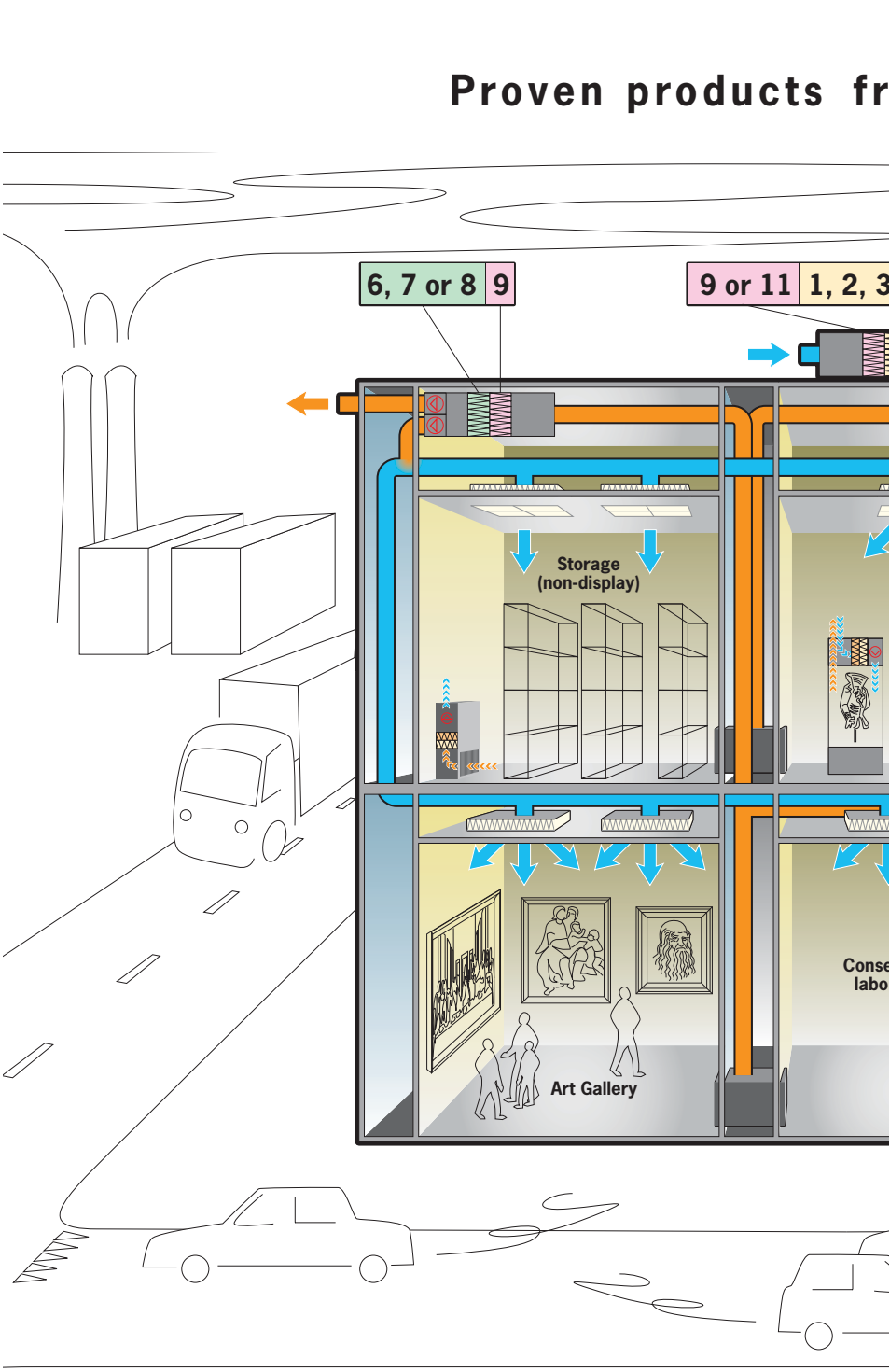
Camsure

A robust solution in flat panel/tray form that can be used with any of the adsorbents. The product provides long contact times, long life and very high efficiency.

4

GDM 300

A robust solution used with Campure medias.



5

GDM 440

A robust, low pressure loss solution used with Campure medias.

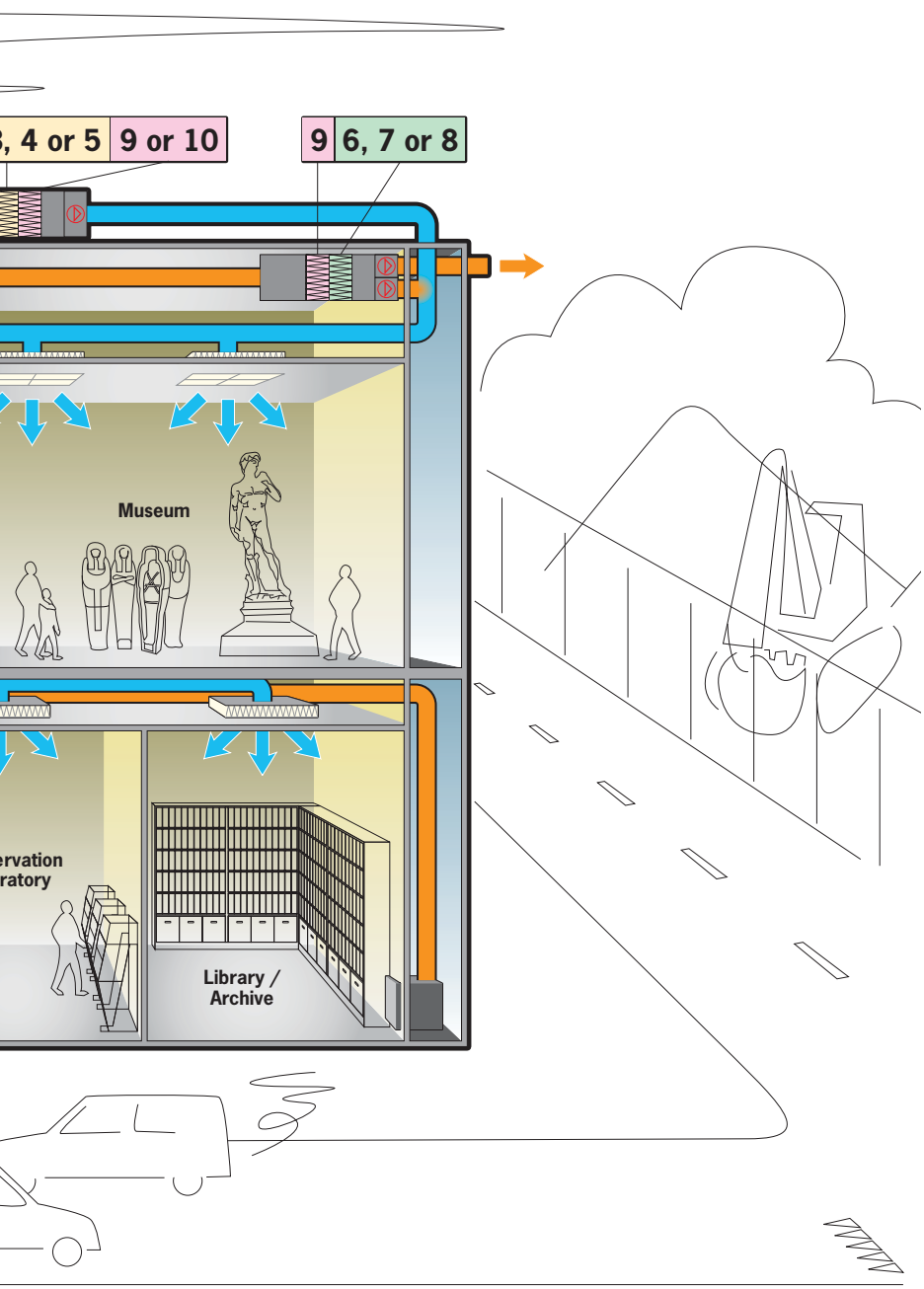
6

Citysorb

A very compact and practical solution aimed at low concentration (predominantly recirculation air applications). Citysorb uses a very finely divided adsorbent and provides Rapid Adsorption Dynamics (RAD).

Two versions are available, one with very high quality Broad Spectrum adsorbent and one with impregnated activated carbon to target acidic gases.

om Camfil Farr



Solid pollutants (particle filtration)

For effective preservation, artefacts must be protected from small, aggressive particles . Such particles, which are often also acidic in nature originate from combustion processes and are in the sub-micron size range. Molecular filters must therefore be used in conjunction with high efficiency particle filters. According to European standard EN 779:2002, it is required to use a final stage filter in the class F9. It is also required to ensure that the filter provides a high initial efficiency and also a high efficiency throughout its lifetime. See “discharged efficiency” in the EN 779:2002 protocols. Note that the penetration of fine particles through an F9 class filter is less than half the penetration through an F7 class filters!

To avoid microbial growth, the ventilation system should be designed so that the relative humidity (R.H.) always stays below 90% and so that the average R.H. for a three day period is less than 80% in all parts of the system, including the filters. If these requirements are impractical to meet, it is recommended to change filters more frequently.

Camfil Farr, who have more than 50 years of experience in comfort air filtration, strongly recommend the following particulate air filters for particle filtration in museums.

9

Hi-Flo

A high efficiency bag filter in filter classes from F5 to F9. With an optimised filter design and the use of superior material it is the ideal choice for very high levels of indoor air quality (IAQ). The Hi-Flo filter is the ideal first stage particle filter for an optimised low pressure drop and protection of the second step filters.

10

Opakfil Green

A high efficiency compact filter in filter classes F6 to H11. Oakfil Green provides the highest level of particle removal in a compact format. The ideal second stage filter, to control fine particles.

11

Ecopleat Green

This new generation of fine compact filters is the ideal filtration solution for applications with restricted space. Available in fully incinerable versions.

8

Cityflo

A member of the Hi-Flo bag filter family that includes a layer of very high performance Broad Spectrum activated carbon.

7

Citycarb

A Two versions are available, one with very high quality Broad Spectrum adsorbent and one with impregnated activated carbon to target acidic gases.

Similar product to Citysorb, with the addition of an integral F7 particle filter layer.

safe concentrations of molecular pollutants

It can be argued that because each individual molecule is potentially capable of causing change or damage in an artefact, the only safe concentration of molecular pollutants is zero. This however is an impractical proposition. Even without budget constraints, the optimum combination of all control factors is unlikely to produce the desired result. In any event, damage to artefacts is dose based behaviour. Not only is the concentration important, but the exposure time must also be taken into account. The goal of preventative conservation is to ensure that collections remain stable over reasonably long timescales (hundreds to tens of hundreds of years). There are no absolute definitions of acceptable concentrations of molecular pollutants, because the sensitivity of different artefacts varies and the harmful effects are influenced by other factors such as temperature and humidity. Nevertheless, guidelines do exist for critical gas concentrations that support an environment that is acceptable for long term storage, see Table Two.

Molecular pollutant	Acceptable concentration	Recommended control method	Source
Sulphur dioxide	<10 µg/m^3	Activated carbon or activated alumina	British Standard BS5454 2000
Oxides of nitrogen	<10 µg/m^3	Activated carbon or activated alumina	British Standard BS5454 2000
Ozone	< 2 µg/m^3	Activated carbon	International Centre for the Study for Preservation and Restoration of Cultural Property (ICCROM)

Table Two.

The solution to Molecular Pollutants

Molecular filtration provides a cost effective method of controlling the harmful pollutants, thereby ensuring safe storage and display conditions. Various types of solution are available depending on the types and concentrations of gaseous pollutants, the type of artefact to be protected and the layout of the ventilation system.

Molecular filtration may be applied in either the fresh air make-up or recirculation air units. Solutions for make-up applications need to reflect the high external concentrations and one-pass operation. Solutions for recirculation applications reflect lower ambient concentrations and multi-pass operation.

Adsorbents

Adsorbents are available to control the complete range of harmful gases. The adsorbents operate with either a “Broad Spectrum“ behaviour towards a very wide range of gases (particularly sulphur dioxide and organic vapours) or they use a Chemical Adsorption mechanism to target one specific gas or group of gases, e.g. acids or formaldehyde.

Base material	Material type	Grade name	Removal mechanism	Target gases
Activated carbon	Coconut shell activated carbon	LGS612	Broad Spectrum	Sulphur dioxide, ozone, organic vapours
	Coconut shell activated carbon	LGS048		Sulphur dioxide, ozone, organic vapours
	Coal activated carbon	CEX002		Organic vapours, ozone
	Coal activated carbon	CEX003		Organic vapours, ozone
	Coal activated carbon impregnated with copper oxide	CEX003/A4 CEX003/A5	Chemical adsorption	Sulphur dioxide (high capacity), nitrogen dioxide, ozone
	Coal activated carbon impregnated with potassium bicarbonate	CEX003/A6	Chemical adsorption	Acidic gases (high capacity)
Activated alumina	Activated alumina impregnated with potassium permanganate	Campure 8	Chemical adsorption	Acidic gases, formalde hyde
	Blend of activated carbon and activated alumina impregnated with potassium permanganate	Campure 8 / CEX003	Chemical adsorption / Broad Spectrum physical adsorption	Acidic gases, formaldehyde, organic acids

Support services and R&D

Gigacheck

Camfil Farr offer a comprehensive range of support services to ensure that users achieve the maximum benefit from the molecular filtration installation. In particular it is essential to have confidence in the air quality within the enclosed space and to be able to predict the end of the useful service life before the filter efficiency drops to an unacceptable level and eventually fails.

The Gigacheck and Campure Coupon passive sampling devices are a convenient and economic method of determining concentrations of various gases in ventilation systems or enclosed spaces.

More sophisticated measurements can be obtained continuously in real time with ISA Check.

The Gigamonitor techniques are used to analyse samples of used molecular filtration media to determine the adsorbed contamination A series of analyses at appropriate periods allows the residual life to be monitored and replacements planned in advance of a failure. This is an essential part of the preservation strategy for any artefact.

Camfil Farr operate a unique molecular filtration test facility in which full scale products can be tested at a wide range of temperature and humidity values to mimic actual application conditions. The test filter can be challenged with a wide variety of gases and vapours. Sophisticated detection equipment upstream and downstream of the filters allows realistic initial efficiency and efficiency / lifetime curves to be produced.

Campure Coupon

ISA Check

camfil FARR

On world standards...

...Camfil Farr is the leader in clean air technology and air filter production.

Camfil Farr has its own product development, R&D and world wide local representation.

Our overall quality goal is to develop, produce and market products and services of such a quality that we aim to exceed our customers expectations.

We see our activities and products as an expression of our quality.

To reach a level of total quality it is necessary to establish an internal work environment where all Camfil Farr employees can succeed together.

This means an environment characterised by openness, confidence and good business understanding.

www.camfilfarr.com

FOR FURTHER INFORMATION PLEASE CONTACT YOUR NEAREST CAMFIL FARR OFFICE.
YOU WILL FIND THEM ON OUR WEBSITE.

Artwork: Ymer Reklambyrå AB. Printer: Trosa Tryckeri AB, Sweden, ©Camfil Farr 020115/R500046. Eng. ed 1