museums australia victoria

AIR POLLUTION

Museums and galleries bring together collections and the public. On most days of the year visitors enter the building. Their surroundings must be at a comfortable temperature and the air they breathe must be fresh. Fresh air enters the museum through open doors and windows or is drawn in by means of a mechanical ventilation system.

Museum objects also require a certain kind of environment, which includes an atmosphere free of dust and pollutants. Unfortunately the outdoor air, brought in for the wellbeing of visitors and staff, is often polluted. This is particularly the case in towns and industrial areas, where cars and industry produce harmful pollutants. Materials used for the construction of the building, display and storage may also give off harmful substances that pollute the air, and furnishings and visitors add to the pollution with fibres and skin flakes.

This factsheet is about the pollutants found in outdoor air. The effects of gaseous pollutants generated indoors are not discussed here, as they are outlined in a separate factsheet: *The Effects of Materials used in Storage and Display.*

GASEOUS POLLUTANTS

Outdoor air pollution is associated with towns and industry, and is almost entirely caused by the burning of fuels in power stations, factories, vehicles and heaters. When fuel is burnt, the sulphur content combines with oxygen in the air to form **sulphur dioxide** (SO_2). Sulphur dioxide, which is also naturally present in outdoor air, reacts with the ever-present water molecules in the air to form **sulphuric acid** (H_2SO_4).

Car exhaust fumes produce **nitrogen dioxide** (NO_2). It forms into **nitric acid** (HNO_3) with water from the air. Nitrogen dioxide also forms **ozone** (O_3) and **PAN** (peroxyacyl nitrate) in combination with sunlight (these pollutants are referred to as 'photochemical smog'). **Ozone** is not just a man-made pollutant but is also naturally present in the air at a height of 20-30 km, where it protects life on earth from harmful short wave ultraviolet radiation. However, the increase in ozone at ground level is such that it has become a threat to both people and objects.

All these gaseous pollutants can be divided into two main groups, according to their physical properties: substances that are acidic and substances that have an oxidising effect.

1. Acidic Substances

Acidic substances are corrosive, they affect the surface of materials such as metals and calcareous stone. They cause hydrolysis in cellulose materials: a process of decomposition by moisture, which induces the breakage of molecular chains (loss of strength) and eventually the disintegration of the affected material. Sulphur dioxide and nitrogen dioxide are mildly acidic. Sulphuric acid is a strong and corrosive acid. It does not evaporate and leave the affected material even after the source of the acid has been removed. Nitric acid is also a strong acid, but it evaporates and is therefore less likely to cause problems in the long term.

Acidic substances can have the following effects on museum items:

- limestone, marble and other calcareous materials readily dissolve ("acid rain")
- iron corrodes
- leather suffers from "red rot": it loses its strength and flexibility and is eventually reduced to powder
- cotton, linen and viscose deteriorate rapidly, they become very weak and brittle
- wool and silk are weakened
- paper objects become increasingly acidic, they become yellow and brittle
- the silver in photographic images yellows and fades
- paper and the film-base of negatives degrade

2. Oxidising Substances

Oxidising substances bring about oxidation reactions. The process involves yellowing and the formation of acids in organic materials. These acids cause cross-links in the molecular structure of the materials, making them very brittle. Double bonds in carbon molecule chains are broken, thus damaging almost all organic materials. Nitric acid, ozone and PAN are powerful oxidants. Ozone in particular is very reactive.

Oxidants can have the following effects on museum objects:

- dyes and pigments fade
- rubber cracks
- textiles become brittle
- paint binder is attacked
- the tarnish rates of metals such as silver, copper and iron are increased
- they cause pyrite decay ("fossil disease"): pyrite, present in many fossil materials, contains sulphide components. These are oxidised into sulphur dioxide. The result is yellow and white efflorescence, cracking of the specimen and, sometimes, total destruction.

PARTICULATE POLLUTANTS

Burning fuel also produces sooty and tarry **particles,** which are then dispersed into the air. Large particles are abrasive and may cause surface scratching. Some particles may be large and heavy enough to settle in still air (dust or grit). Others are

so small that they remain suspended until trapped or held down on some surface by electrostatic attraction. They can enter display cases, deposit on objects, and soil the surface. Particles are usually **acidic** due to absorbed sulphur dioxide and therefore affect all acid-sensitive materials. Acidic particles are hygroscopic: they attract water and cause corrosion of metals. They may also contain **traces of metals** such as iron, which can speed up the deterioration of organic materials.

Special attention should be paid to situations where food is prepared (restaurant or coffee shop areas). The preparation of food may produce "wet" or oily particles, which can be so small that they travel through a building before they are deposited. It is important that adequate air extraction is used in these situations.

New concrete emits **alkaline** particles. They darken oil paint films and discolour some dyes and pigments. Protein materials, such as wool and silk (and the hair in thermohygrographs), lose their tensile strength.

High levels of salt crystals in the air affect coastal areas. Salts absorb water from the air, creating droplets with high salt concentrations. These will corrode most unprotected metals. High moisture levels can also support the growth of micro-organisms even when the surrounding appears quite dry.

Textile fibres and fragments of skin can be an attractive food source for insects.

HOW TO REDUCE THE RISK OF DAMAGE DUE TO POLLUTION

First of all it is important to find out what the pollution levels in your area are. Information about pollutant levels can be obtained from the Environmental Protection Agency Victoria. Their website www.epa.vic.gov.au contains the most up-to-date information on air quality levels and common pollutants. When levels of pollution appear to be high, or it is noted that dust and dirt build up rapidly within the museum, it is necessary to take action.

The most effective solution is to **prevent any pollutants from entering the museum building**. This will only be possible when the building provides an effective envelope for the collection, so that no uncontrolled air can enter, and requires a mechanical ventilation system with filtration systems to ensure that fresh filtered air is provided for the health and safety of museum workers and visitors. This is an approach that can work very effectively. However, it is expensive to install and requires on-going maintenance, as well as on-going running and maintenance costs. It also requires the installation of ducting, which can involve substantial building work.

If this approach is one that the museum is considering, then it is important to ensure that doors and windows close properly, and that a policy is developed for the opening of doors and windows. In general, the building should be free of any leaks or drafts (but it should be noted that some sort of ventilation is necessary for the fabric of the building). The air that is brought into the building through the mechanical ventilation system needs to be filtered. This can be achieved by:

- filtering out particles (but not with electrostatic air cleaners, as they produce ozone and aid the conversion of sulphur dioxide into sulphuric acid)
- filtering out gases, either with a water spray system (not effective for

ozone) or with active carbon filters

Although it is the most comprehensive approach, it is not the first or only one that museums should consider.

The main aim should be to **prevent harmful substances from reaching the object.** There are several options that can be used that keep costs and alterations to a minimum.

- Place the objects in an enclosure. This can be a cupboard, a storage box or a display case. It is important to use only those materials that do not give off harmful substances themselves and do not create an adverse microclimate. Avoid open display and storage, and use dust covers for items that cannot be stored in boxes.

- Use materials that act as a buffer, such as acid-free paper and board. Take care not to use 'buffered' acid-free paper near items that are affected by the buffering agent, such as photographic materials and textiles. (Refer to another factsheet *The Effects of Materials used in Storage and Display* for more information on 'buffered' and 'unbuffered' acid-free tissue).
- Maintain a regular housekeeping program, to prevent the build-up of dust, dirt, fibres etc. throughout the building.

It is important to note that museum objects themselves may also give off harmful substances. Military displays often contain uniforms and metal items. The sulphur compound in the wool may affect the metals. Modern organic materials are most likely to emit harmful gases. For instance, badly processed photographs may give off acidic or sulphuric gases that cause brittleness and discolouration of the paper, and cellulose nitrate ("celluloid") objects release vapours that speed up their own deterioration. These processes particularly occur when the objects are kept in a confined space (such as a display case, polythene bag or plastic box), where a concentration of the harmful vapour is allowed to build up. For these objects an exception should be made: they are best displayed in cases that allow air exchange and should be stored together in a separate part of the storage area where there is adequate air-exchange.

FURTHER INFORMATION AND ADVICE

Further information on air pollution can be found in *Museum Methods* (Museums Australia (NSW) Inc) and in *ReCollections* (Heritage Collections Council). *ReCollections* is available on-line www.amol.org.au/recollections

Museums Australia (Vic) can provide assistance with the location of further information on collections care and conservation for small museums. Contact: 03 8341 7344 or mavic@mavic.asn.au

Further conservation information can be found on the Australian Institute for the Conservation of Cultural Materials (AICCM) website www.aiccm.org.au

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