Final report on comparing pollution levels in ventilated and non-ventilated display cases at the Museum of London and a progress report on leak detection and air exchange measurements in practice

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ABSTRACT

From 1976 until recently the Museum of London had a policy of naturally ventilating display cases, primarily to reduce the concentration of internally generated pollutants. In the last decade the trend elsewhere has been towards display and storage enclosures without any ventilation and low air exchange rates often less than 0.1 air changes per day. As the Museum policy seemed to be at variance with current practice it was decided to determine what the effect, if any, the ventilation the display cases had when compared with unventilated or well sealed cases.

While the primary aim was to reduce the concentration of potentially damaging organic compounds emitted by display case construction materials, such as wood and wood composites, more recently concern has focused on objects that release undesirable compounds. Pollution studies have shown several archaeological objects from waterlogged sites produce gaseous sulphur compounds, which have been shown to promote the tarnishing of silver objects housed in the same case.

The primary method of providing ventilation has involved variously sized vents located at the top and bottom of the case. The vents are fitted with particle filters to reduce dust ingress. The results from carbonyl monitoring of several ventilated and unventilated display cases in 1997 led to the conclusion that the ventilated cases had significantly lower levels of carbonyl compounds and were thus a success. However, no visible effects were observed in the cases without ventilation and there was some concern that the ventilated cases were becoming very dusty inside. A re-examination of the data suggested that the conclusions previously drawn were not supported by the results.

In 1999 the museum was beginning to embark on a major gallery redevelopment scheme and it was felt that the existing display case specifications and the practice of ventilation should be reviewed. A project was set up in conjunction with Dr Lorraine Gibson at the University of Strathclyde to investigate whether the practice of ventilating cases, had any measurable benefits for preservation.

Rather than examining different ventilated and unventilated display cases it was decided to measure a selection of cases with the vents open and then to seal the ventilation ports and retest. Levels of acetic acid, formic acid, acetaldehyde, formaldehyde, hydrogen sulphide and carbonyl sulphide were measured internally and externally using diffusion tubes in the ventilated mode and then again after the vents had been sealed to reduce the air exchange rate.

It had been assumed that the vents in cases increase the ventilation rate by a significant factor but until this work no measurement were undertaken to verify this. Thus a measurement technique was required that could be utilised in existing dressed display cases. A modified tracer gas technique using compact and self-contained Nitrous Oxide and Carbon Dioxide data loggers was developed to allow in-situ monitoring. It was found that in some instances sealing the ventilation ports had little impact on the ventilation rate, suggesting that air was entering elsewhere and by-passing the particulate filters – a hypothesis that was supported by the large amount of dust evident in some cases. Further work has been undertaken to refine the air exchange measurement technique to allow a protocol to be published that will allow other users to reliably measure air exchange for research purposes or as part of display case performance testing and assembly. Alongside this work refrigerant gas leak detectors and ultrasound leak detectors have been tested to determine the location of leakage paths in situations where traditional smoke techniques are not safe to use.

It has often been assumed that there is direct linear relationship between the ventilation rate of an enclosure and the internal pollution levels – double the ventilation rate and halve the concentration. This has often been questioned and our results and those of others, including co-workers at ICN seem to suggest a more complex relationship. For instance in a display case which had a ventilated air exchange rate of over 30 ac/d compared with a unventilated air exchange rate of 3 ac/d the measured levels of acetic acid seems to suggest a decrease in concentration of a factor of 2 rather than 10. Yet ventilation may still be effective in some cases, there is increasing evidence to suggest the damage caused by carbonyl compounds such as acetic acid on susceptible materials may only occur above certain concentrations. If this is the case then control by dilution could still be a simple and effective mitigation technique that can be retrofitted to many types of traditional case and storage enclosure. The results have also shown that in for some materials the

emission continues for a very long time without a measurable decrease whereas for some there is a rapid decrease. For example the levels of acid in a ventilated display case fabricated from plywood were very similar when measured in 1997 and 2002 at around 1000 ug/m^3. However, a prototype glass display case assembled, in error, with acetic acid curing silicone sealant had internal acetic acid levels above 30,000 ug/m3 when measured two weeks after assembly but these reduced to below detection levels after 6 weeks of ventilation.

The work has demonstrated that ventilation rate can have an impact on internally generated pollutants in practice but that very high rates are required to make a significant difference. Any reduction in internal pollutant levels needs to be balanced against the loss of relative humidity buffering and a potential increase in externally generated pollutants such as the nitrogen oxides and hydrogen and carbonyls sulphides.