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The Influence of the Indoor Air Quality of the Microclimate Box on the Material Degradation of Historic Objects

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Abstract

The paper gives an assessment of the Indoor Air Quality (IAQ) within a microclimate box and its influence on the material degradation. IAQ is concerned with maintaining acceptable temperature, humidity and oxygen levels and low pollutant levels in the rooms, cabinets or other enclosed spaces, for humans to live and work, while meeting legal guidelines. In the microclimate box it is concerned with maintaining an acceptable environment for the conservation of historic objects.

As a reference we should first consider the composition of outside air. This is contains approximately 78% nitrogen, 21% oxygen and 1% argon, and varying amounts of water vapour depending on local climate. Further it contains smaller quantities carbon dioxide, sulphur dioxide, nitrous oxides and small particles depending on local pollution levels. Temperature varies by season, time of day and location. Historically records have been kept of some of these parameters of more than 100 years as part of weather monitoring and prediction. The indoor climate in a room in a house, office or museum is modified by the building construction, heating and cooling, and by occupants and objects within the building. An unheated building is buffered from the outdoor climate by the insulation effect of the building itself, but may contain localised microclimates due to airflow (draughts) and solar radiation through the windows. Heating and cooling may be passive, by natural convection and conduction, or active airflow of heated or cooled air. Occupants and objects within the building interact with the Indoor Air Quality, for example breathing in oxygen and expelling carbon dioxide, or outgassing of volatile materials, such as paints.

An IAQ engineer has a range of instruments to monitor the indoor climate. Temperature and relative humidity (RH) can be measured using electronic sensors and if necessary logged at regular intervals over a longer period. Airflows from a heating and ventilation air conditioning (HVAC) system can be measured with an anemometer. Several anemometer types exist and they can measure air velocity and if the aperture size is known, air volume per hour. Air volume per hour allows the calculation of room air changes per hour, which is related to the dilution of pollutants in the air by the HVAC system. Examples of pollutants which can be measured include carbon monoxide (CO), carbon dioxide (CO_2) and particulates e.g. PM10s, bacteria, moulds and yeasts. Gaseous particulates, such as CO and CO_2 follow an exponential dilution curve due to the air changes and particulates follow a greater that exponential dilution curve as settling of particles also plays a role.

In a sealed microclimate, these air changes are not present, so the buffering effect is enhanced, but the active dilution of pollutants is not present. Published studies have focussed mostly on the buffering effect, while some recent studies, for example at the Metropolitan Museum of Art, measure the gaseous pollutants present. Further there is a lot of information in the literature about the influence of pollutants in outside air causing an enhanced rate of material degradation on historic buildings. This study will bring together these sources of information to assess how the air within microclimate boxes could cause an enhanced rate of chemical degradation of historic objects.