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ENVIRONMENTAL CONTROL FOR SPIRIT SPECIMENS

Introduction

There are various external influences that can act on a liquid preserved specimen. Various texts have discussed the properties, monitoring and control of these influences in considerable detail [see refs]. The conditions required for optimum stability of a particular specimen are determined by its current sensitivity to these influences. In turn, this sensitivity is a complex function of response of the individual components and their subsequent interactions when exposed to the external influences. Relatively little research has been carried out into the effects and relative importance of these influences. Although recommendations for standard conditions have been made (MGC 1992), these must be regarded as provisional.

The present state, both physical and chemical, of a specimen is the result of its original state and the changes undergone. This response to external influences is of course superimposed on, or modified by, the internal interactions already occurring between the specimen's components. Frequently the specimen will have reached an equilibrium with the external conditions which it would be unwise to disturb without being prepared for the possible damaging effects of change.

Each of these external influences can be characterised by both its absolute value and by the change in this value. Sometimes the change in a value may cause a shift in equilibrium. Alternatively the absolute value of an environmental influence is inappropriate. The significant external influences on spirit collections are:

* Temperature
* Relative humidity
* Light and UV radiation
* Pollutants
* Mechanical stress
* Oxygen

The influence of oxygen is one of the main factors which fluid storage is designed to remove. The container is usually assumed to act as an oxygen barrier so reducing oxidation of the specimen. This assumption breaks down when the seal breaks down. Effects and control of oxygen concentration will be ignored for the rest of the paper.

Temperature

The absolute value of temperature is not usually considered important when environmental controls are considered. Few museum materials change their properties rapidly or dramatically at different temperatures. Those that do usually involve a change in state. One example is the melting of chocolate (Cox 1993) at about 320C. At about 320C crystals of washing soda (sodium carbonate hexahydrate) decompose to form the monohydrate. It involves a change of crystal form, resulting in the dissolution of the sodium carbonate in the released water of crystallisation.

Similarly, spirit undergoes a change of state, from liquid to vapour. This is encouraged by an increase in temperature leading to an increase in vapour pressure. If one sealed a spirit container at 150C and heated it to 250C, the internal vapour pressure would rise by around 24mm of mercury, or 3200 Pa. On a 4" square container this would be ca. 0.3 N or, 30 gf, pushing the top off.

The typical spirit jar has at least 3 significant components, thermally speaking: the glass jar, the spirit and the air. These have different thermal expansion rates. Like a bimetallic strip, a change of temperature will result in stresses or strains, ie increased fragility or distortion.

Take 1l glass jar with 100ml of space in it. Heat up from 15 to 250C. The glass expands and the liquid expands, so compressing the air which would also like to expand. This results in an increased air pressure of 4% ie about 4000 Pa. If this jar has 2ml of air, heating it up to 15 to 250C increases the air pressure rises by 12% ie 13,000 Pa. To this of course should be added the effect of the increased vapour pressure.

An increase of temperature leads to an increase in internal pressure that is likely to put the seal at considerable tension stress, which is the most damaging stress for the "battery jar" type of seal. It is apparent that the jars are best filled at a slightly warmer temperature than they will be stored subsequently. This will cause the seal to be sucked on tighter, i.e. compression stress. If the seal is airtight a partial vacuum will be maintained which will reinforce the top against knocks. The vacuum will also be improved by the reaction of oxygen, in the air bubble or dissolved in the spirit, with the contents of the jar.

Recommendations for temperature control for storage and examination should therefore include good stability of temperature at a fairly low level, preferably below that of the temperature of the jar when sealed. The MGC *Standards* recommend a value of less that 180C.

Relative Humidity

Assuming that the jar and seal are impervious and unaffected by water in the atmosphere, there should be no interaction between the external atmosphere and the contents. If the seal on the jar is tight, there is no interchange between the external air and the internal bubble. Unfortunately, as any visit to a spirit store will confirm, the smell of alcohol and the cost of its replacement demonstrate the failure of the seals. If there is a leak in the seal, alcohol vapour will leak out and air leak in.

70% alcohol will tend to evaporate ethanol or absorb water, so driving the concentration towards a more dilute solution. The higher RH, the more likely that water will condense in the spirit. Gradually the liquid will become less and less of a preservative. The lower the RH the less likely is condensation to occur, or conversely the more likely water is to evaporate alongside the ethanol. The vapour pressure of water in a 70% spirit solution is equivalent to around 35% RH. So this RH will ensure that the ethanol and H20 will evaporate at the same rate. Although the level of the liquid in the jar may be dropping, at least the preservative properties will remain the same. A low RH will also contribute to the lack of rusting of metal clips on bottles etc., though it will not reduce the internal rusting of metal lids due to the contained water and acids. Keeping the RH this low in a storeroom requires the use of a dehumidifier.

Light

All the components of the specimen will be affected by the energy in radiation to some extent. The effect of light on the water and any dissolved oxygen will tend to produce radicals which react rapidly with susceptible groups in the specimen. This is the principle of bleaching by light used for linen and in paper conservation. Various components of the specimen will react, the colouring agents, dyes and pigments, being particularly reactive because both of the absorption of radiation and of the presence of unsaturated chemical groups, such as double bond sequences, which are easily oxidised.
The ultra violet radiation is of course more energetic and damaging than visible radiation. The glass of jars will absorb the most energetic wavelengths of UV but will still allow through quite a bit. Also the liquid itself will absorb some of the UV. However about half the fading of (textile) colours is caused by the UV component of sunlight. The rest is caused by the visible component. Only a small proportion of this is absorbed or reflected by the glass and liquid. The most accessible reactants are those in solution, so light will encourage the degradation and discolouration of the fluid. This is probably one reason for the staining of jars as the degrading materials react nearest the light source.

Light also supplies energy in the form of heat to the jar, which might act as an effective greenhouse. Light will go in but infra-red radiation cannot come out. Care must be taken to limit the exposure of jars to strong light for this reason. The MGC *Standards* recommend a maximum of 200 lux and the complete elimination of UV radiation. In general it is sensible to prevent light exposure, except when viewing is required. This can be achieved simply by switching off the lights in blacked out store rooms. Alternatively one can use storage cupboards whose doors are shut and opaque.

Pollutants

Dust and grime are the most obvious pollution problems, especially in major cities. This can obscure labels and make handling unpleasant - or even dangerous. Preventing, by filtration, the dust from entering the store room can be expensive. High levels of pollutant gases, sulphur and nitrogen oxides will affect the labels, but can also diffuse into the jars, though less readily than H2O and O2.

Controls

Air extraction is usually necessary in spirit stores. The seals on jars are seldom good enough. Leakage of alcohol and formaldehyde into the air creates hazards, mostly toxic. If people are working in the room, the levels must be kept down to the Occupation Exposure Standards, OES for ethanol 1000 ppm (HSE 1991), and preferably lower for comfort reasons. We were advised (F. Howie) that 70% ethanol was not a fire risk, though it is of course sensible to take precautions against build-up of vapour, sparks etc. In practice in our spirit store room, we find that an air change rate of ca. 5-7 changes/hour is the minimum to keep the atmosphere tolerable. This means sucking in air at a rate faster than could be practically filtered or dehumidified. As a result, the shelves and jars become dirty. Fortunately, the RH in the building is already fairly low throughout the year. We are addressing this problem by a programme of rebottling into more secure jars, as finances allow.

References

Cox, H. 1993. *The deterioration and conservation of chocolate from museum collections.* Studies in Conservation 38, 217-223.

HSE 1991. *Occupational Exposure Limits.* EH40/91, Health and Safety Executive.

MCG 1992. *Standards in the Museum Care of Biological Collections.* Museums and Galleries Commission.

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WHAT FLUID IS IN THIS BOTTLE?

One of the most tedious and necessary chores of museum curators is the maintenance of fluid-preserved collections which involves a great deal of topping up. Although museum jars are being developed to reduce evaporation it still occurs. Polythene acrylic tape (PEA tape) wrapped around the junction of jar and lid has been found to reduce evaporation even further (Steigerwald and Laframboise, in press - SPNHC *Collections Forum*).

None the less curators are faced with daunting rows of jars containing (normally) colourless fluids and either resort to:

1 Nasal analysis - Health & Safety Officers get very twitchy as the results can eventually be disastrous to the health of the curator.

2 Filling the jars with museum spirit and never mind if the specimens are in formalin - disastrous for the specimens.