The Study of Microclimates within Storage Boxes of Archival Records

Hannah Clare, Rachel Farmer and Kostas Ntanos, The National Archives, UK

Introduction

The National Archives is a government department and an executive agency of the Ministry of Justice. As the government's official archive for England and Wales we hold over 1,000 years of the nation's records for everyone to discover and use.

At The National Archives, we are very concerned with mitigating the risk of mould growth on our collection. The ambient relative humidity and temperature are closely controlled with the use of a large air conditioning system, to keep them below the necessary range for mould germination and growth. The vast majority of the collection is stored in boxes, which provides additional protection against both physical and environmental factors. However, as ambient conditions naturally fluctuate on a daily and seasonally basis, a project was begun to investigate the capacity of storage boxes to shield the collection from fluctuating ambient storage conditions.

Figure 1: A typical corridor within one of the repositories at The National Archives.

Aim

The aim of this project was to investigate the relationship between the microclimate within the storage boxes and the ambient conditions in the repositories at The National Archives; In particular whether the microclimate inside the boxes can be of concern, even when ambient conditions appear to be below the required range for mould to germinate and grow.

Experiments

The experiments were carried out inside an environmental chamber with controlled relative humidity. The temperature was kept constant throughout the experiments as we were only interested in the reaction of relative humidity in the microclimate. Earlier experiments indicated that the microclimate inside the boxes responds quickly to ambient changes. However, it takes several days to reach equilibrium with the ambient conditions, especially when relative humidity was monitored in the centre of a stack of archival documents. Two data loggers were placed in a box, one on the top of the archive documents and one down the side of the box (Fig 2). This was done to examine what effect, if any, the thickness of the box walls have on the microclimate. Once the lid is on the box the side walls become double thickness while the top and bottom remain single thickness.

The boxes in the experiments were the most commonly used size at The National Archives. They were made of stapled cardboard of approximately 3mm thickness with dimensions of 35 x 25 x 10 cm. The boxes were fully filled with sample archival documents (consisting of loose mixed papers and cardboard folders) in order to replicate the same ratio of content mass to internal volume of box as found in the repositories. All experiments were duplicated.

Four relative humidity fluctuation patterns were programmed into the environmental chamber (Fig 3) to compare the responding relative humidity within the boxes. The relative humidity patterns were designed to replicate both likely ambient conditions within the repositories, and also extreme changes.

Pattern 1: Relative humidity fluctuating within 2 points.

Pattern 2: Relative humidity gradually increasing and decreasing with fluctuations between various points.

Pattern 3: Period of high relative humidity followed by fluctuations around a lower point

Pattern 4: Period of high relative humidity followed by a fluctuating decrease and then a period of fluctuating low relative humidity.

The first two patterns reflected changes in relative humidity indicative of conditions monitored in The National Archives repositories. The latter two patterns replicated extremes, which could arise in the repositories for example due to mechanical failure in HVAC system.

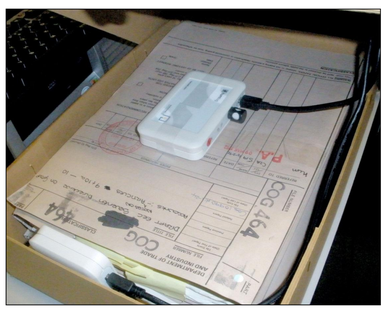


Figure 2: Position of dataloggers inside test box

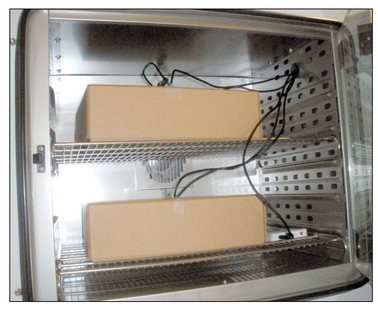


Figure 3: Test boxes inside the Environmental Chamber

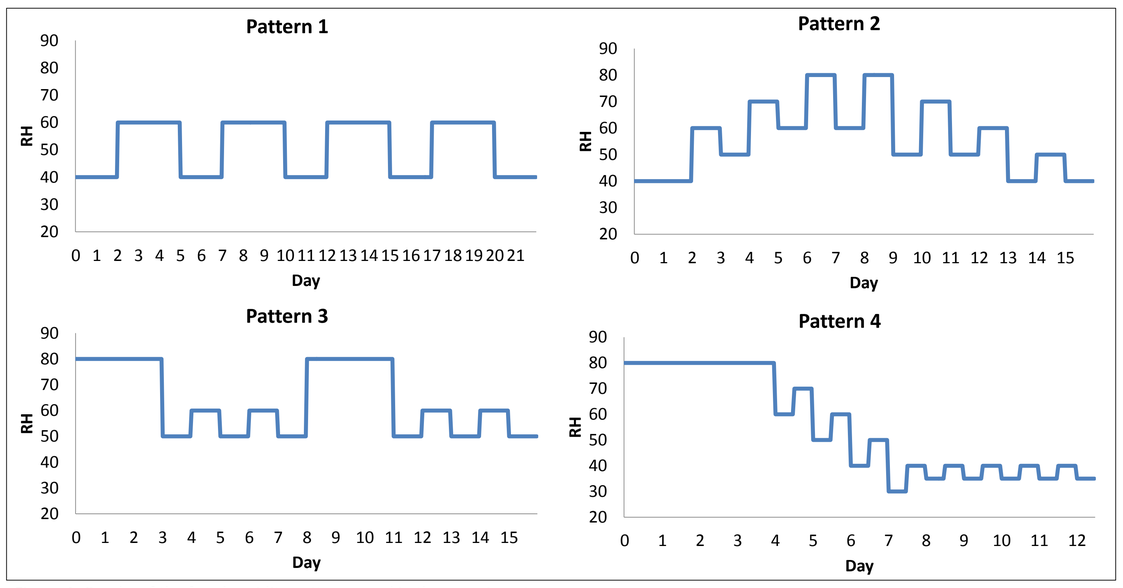


Figure 4: Graphs of the four humidity patterns used in the experiments

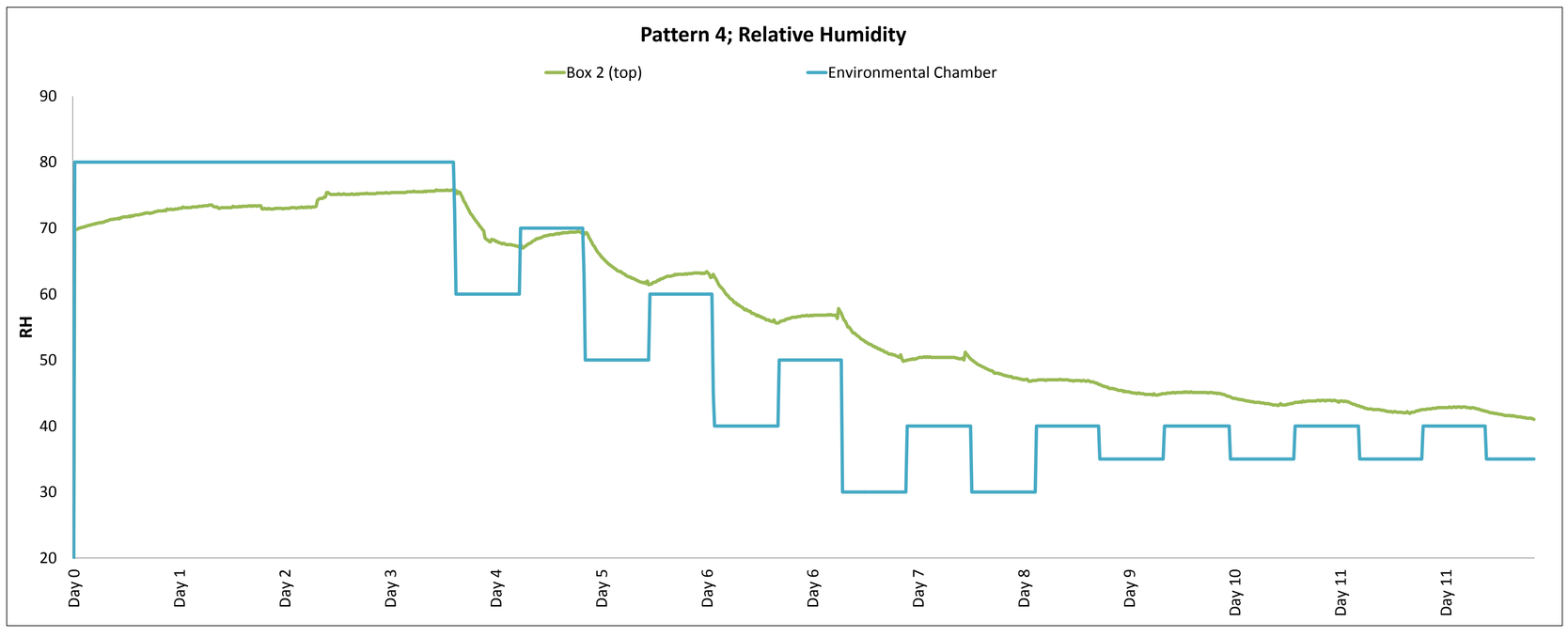
Results

Pattern 4 (Graph 1) showed that a sudden drop in ambient relative humidity followed by small fluctuations at a lower humidity results in the loss of humidity being delayed in the microclimate even if the microclimate humidity levels are higher than ambient conditions. The microclimate shows fluctuations even when it has not reached the ambient level. Pattern 2 and 3 showed similar behaviour but not as clearly as pattern 4.

Pattern 1 showed that when the ambient relative humidity fluctuates between two points the microclimate remains somewhere in the middle, as long as the fluctuations occur within 48 hours.

Patterns 2 and 3 indicate that the longer the period of new humidity the closer the microclimate will be to the ambient conditions as it has more of a chance to equilibrate. For part of the rest of the project we will be looking into determining more specific timings.

It is not possible to say that the thickness of the box walls makes a difference to the microclimate. The rate of change between the two loggers is different but not consistently enough to draw a meaningful conclusion.



Graph 1: Results from the experiment using pattern 4.

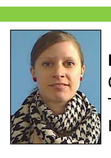
Discussion

The experiments indicate that the relative humidity in the microclimate can be significantly different to the ambient conditions. It is possible for the microclimate's relative humidity to increase beyond the ambient relative humidity under certain circumstances. As can be seen from pattern four, in cases where the ambient relative humidity falls and then continues fluctuating at a lower level, the microclimate's relative humidity can be maintained higher – forced up by fluctuations at a lower level in the ambient conditions. In repository conditions where fluctuations are small or quite slow this is not too much of a problem as the microclimate will have time to equilibrate and therefore monitors in the ambient environment will closely reflect the reactions of the microclimates within the boxes. Where more extreme fluctuations occur the ambient loggers are likely to record levels of humidity which are very different to the microclimate conditions and this needs to be considered when trying to re-establish suitable humidity levels.

Further work will investigate the effect of different box materials as well as examining what effect the storage method (where numerous boxes are pressed tightly together on a shelf, Fig 1) have on the microclimate.

We will also be examining how much time we would have to react to changing humidity before the microclimate within the storage boxes would be affected by extreme fluctuations and potentially put the collection at risk of mould growth.

Authors



Hannah Clare
Conservation Manager – Research and Development
The National Archives
Hannah.Clare@nationalarchives.gsi.gov.uk

Rachel Farmer
Trainee Preventive Conservator,
The National Archives and Tate
Rachel.Farmer@nationalarchives.gsi.gov.uk

Kostas Ntanos
Head of Conservation Research and Development
The National Archives
Kostas.Ntanos@nationalarchives.gsi.gov.uk

The National Archives