The Effect of Air Tightness on RH Control

David Thickett
Collections Conservation Team
RH measurement

- 1 pt
- 3 pt
- data failure

- 1991 THGs + 5%
- 1994 squirrel + 3%
- 1996 Shinea + 3%
- 2000 Vaisala humicap + 2%
- 2006 Rotronic hygroclip + 1%
Thomsen (1977)

\[ t_{1/2} = \frac{4MB}{N} \]

- \( t_{1/2} \) is the hygrometric half life (days)
- \( M \) is the loading of silica gel in the box (0.1 kg/m\(^3\))
- \( B \) is the specific moisture reservoir of silica gel (8 g/kg/%)
- \( N \) is air exchange rate (0.35 and 0.65 /day)

**Thermal Equilibrium between enclosure and room**
**Perfect and rapid mixing in enclosure**
Weintraub and Tetrault (2003)

\[ t_{RH} = \frac{MFB_{H}}{C_{eq}DN} \]

\( t_{RH} \) is time to reach a specified RH (days)
F is targeted range of RH fluctuation (irrelevant for this application but taken to be 16%)
B\(_{H}\) is specific moisture reservoir corrected for hysteresis (this effect is negligible for regular silica gel below 30% RH)
\( C_{eq} \) is equilibrium concentration of water vapour (calculated g/m\(^3\))
D is decimal difference between external RH and chamber (0.59)

Perfect and rapid mixing in enclosure
Dryer than Room
Stewart Boxes for Archaeological Metals

Thickett & Odlyha, Conservation Arch Materials, 2007
t_{1/2} = 4MB/n
M = 10kg/m3, B = 8, t_{1/2} = 187 days
Thickett & Luxford, *Metal 07, 2007*
Wetter than Room
Above and Below Room
Werner Collection, Rangers House London

Thickett et al, *Conservator, 2005*
Mechanical Conditioning

- Dehumidifiers
- Humidifiers
- Mixed
- Flow Through, Hahn RK2,
- Recirculation, Miniclima
Dehumidifier Performance
Bronzes, 42%

![Graph showing dehumidifier performance](image-url)
Dehumidifier Specification

The graph shows the water vapour output (g/hr) over time (days) for a dehumidifier. The data fluctuates significantly throughout the monitored period.
$y = -0.31x + 8.6582$
Dehumidifier Performance
Bones, 70%
Tapestry Case RH

The graph shows data from 21/08/2006 to 04/09/2006. The y-axis represents RH (Relative Humidity) values ranging from 0 to 65, with peaks around 35-40. The graph indicates fluctuations in RH levels over time.
Tapestry Case RH

Date

21/08/2006 00:00 26/08/2006 00:00 31/08/2006 00:00 05/09/2006 00:00 10/09/2006 00:00 15/09/2006 00:00 20/09/2006 00:00

Graphical representation of data.
Conditioning Failure
Ethanoic acid

![Graph showing concentration of ethanoic acid](image-url)
Conclusions

- Modelling internal RHs fairly well, well enough
  - Temperature effects
  - Wood
- Predict performance of cases
- Specify AER required, cost implications
- Methanoic acid, equation works well
- Ethanoic (sealed MDF), apparent ‘threshold’
  \[0.5\text{day}^{-1}\]
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