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What's the Worst That Can Happen?

Accelerated Testing of Conserved Waterlogged Wood

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Introduction

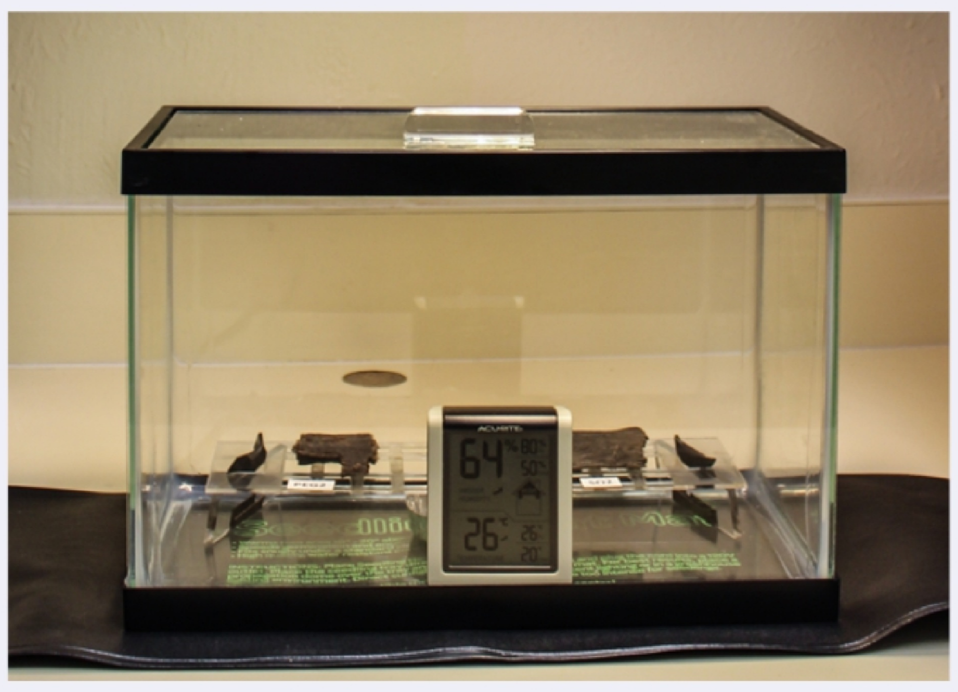
Accelerated degradation testing is a method of materials testing that simulates and exaggerates the environment in order to observe the processes by which a material will degrade in a fraction of the time, thus saving companies both time and money. At its most precise (and most expensive), accelerated testing provides information that allows companies to provide warranties to consumers; however, even tests that lack that level of precision can provide valuable qualitative data that is useful to conservation laboratories and museums.

Methodology

Provenience of the wood: Two oak staves from La Belle (wrecked in 1686 in Matagorda Bay, Texas). Oven drying determined both contained over 400% water.

12 samples (53 x 10 x 5 mm) were divided into three groups of four and were treated using silicone oil (10% MTMS crosslinker), 75% polyethylene glycol in water, and 25% polyethylene glycol in water followed by freeze drying.

Treated samples were placed on acrylic stands inside 5-gallon glass containers with removable lids. Temperature and relative humidity were monitored in each container using a digital thermometer and hygrometer.



Accelerated Testing Scenarios

~Chamber 1 (Control): Museum with full environmental control
Temperature: 20–22°C (68–71.6°F) RH: 16-20%

~Chamber 2: A museum with variable environment
Temperature: 28–30°C (82.4–86°F) RH: 16-84% (5mL water added weekly)

~Chamber 3: Warehouse storage with no environmental controls
Temperature: 35°C (95°F) RH: 27-93% (5mL water added weekly)

~Chamber 4: Cool storage
Temperature: 4–6°C (39.2–42.8°F) RH: 16-20%

*Silica gel was used to regulate relative humidity in Chambers 1 and 4
*Fluorescent lamps were cycled (5 days on, 2 days off) to simulate museum lighting in Chambers 1 and 2
*Pests and pollutants also greatly affect artifacts in museums, labs, and storage facilities; they could have an effect on this study, but these were not monitored in order to limit variables.

Results

Chamber 2 (Variable Environment)

PEG-treated samples at 2 weeks (left) and 6 weeks (right). In addition to a slight darkening in color, the surface of the sample is slightly tacky from the PEG beginning to leach out of the wood.

Freeze dried samples at week 8 (left) and week 12 (right). At week 8, the sample is the same color as at the beginning of the study, but the surface is beginning to delaminate. A slight change in color is more obvious at week 12.

Chamber 3 (Warehouse Storage)

PEG-treated samples at week 2 (left), week 6 (center), and week 10 (right). Almost immediately, the sample began to darken and develop a tacky surface as PEG leached from the wood. By week 6, some PEG was left behind on the acrylic stand when the sample was removed. When no water was added for one week to maintain the high humidity (week 10), the sample underwent an immediate lightening in color and became dry to touch and slightly friable.

Freeze dried samples at week 6 (left), week 8 (center), and week 12 (right). Small spots began to appear at week 6, and became more visible at week 8 due to a color change of the wood. No water was added to Chamber 3 for the week 10, which caused a color change that was maintained through week 12; spots are still visible.

*Chamber 1 (Control), Chamber 4 (Cool Storage) and silicone oil samples are not pictured here due to lack of visible change
*Though no visible changes occured to samples in Chamber 4 (Cool Storage), the sample treated with PEG did become very dry to touch and lost small pieces when handled

CONCLUSION

All samples reacted to the accelerated environments as expected. With some refinement, this chamber setup could be used by conservation laboratories or museums in order to:

~Test new treatments against a variety of conditions in a short timespan
~Determine the best environmental settings for treated artifacts
~Determine the best treatment for artifacts, given the institution's environmental controls
~Determine the effect of natural disasters, especially hurricanes and flooding, on artifacts
~Develop methods to prevent and treat the damaged caused by natural disasters

Notes

For a full discussion and bibliography of this study see:
Martindale, Karen E. 2015. The Accelerated Testing of Conserved Waterlogged Wood. Thesis.Texas A&M University: College Station, TX.

For additional information on accelerated degradation in conservation, see:
Zervos, Spiros. 2010. Natural and Accelerated Ageing of Cellulose and Paper: A Literature Review. In Cellulose: Structure and Properties, Derivatives and Industrial Uses, A. Lejeune, and T. Deprez, editors.

Porck, Henk J. 2000. Rate of Paper Degradation: The Predictive Value of Artificial Aging Tests. European Commission on Preservation and Access, Amsterdam, Netherlands.

For additional information on accelerated testing, see:

Schulz, Ulrich. 2009. Accelerated Testing: Nature and Artificial Weathering in the Coatings Industry. Vincentz Network, Hannover, Germany.

For additional information on treatment methods, see:
Hamilton, Donny L. 1999. Methods of Conserving Archaeological Material from Underwater Sites. <http://nautarch.tamu.edu/CRL/conservationmanual/ConservationManual.pdf>