

IIC International Training Centre for Conservation

Inaugural Programme

20-25 Sep 2015 The Palace Museum, Beijing

Scientific Approaches to Preventive Conservation



Energy saving in museum and heritage organisations

- 1 - Passive environments
- 2 - Display cases

24 September 2015

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Energy saving in museum and heritage organisations

- In recent years the options of creating passive environments for museum collections (and buildings) has been studied from a conservation perspective. As supplement or alternative to traditional museum airconditioning.
- In this presentation I will introduce two areas of research:
 - 1 - Passive environments - buildings
 - 2 - Display cases

Historic museum building, airconditioned



Statens Museum for Kunst (Danish national art gallery),
19th century, Copenhagen, DENMARK

Museum buildings

- Older and newly built museums often rely on some kind of air conditioning.
- Depending on how air tight (low ventilation rate) the building is, climate is usually regulated with people comfort in mind:
 - For example heating if in cold winter regions, perhaps humidifying, cooling and de-humidifying in the summer season if in hot and humid regions
- If (since) most older buildings have high ventilation rate, then: \$\$\$
- Sustainable?

Historic palace, only "conservation heating"



Rosenborg Castle, built circa 1610, Copenhagen, DENMARK

Passive environments – historic buildings

- Sarah discussed aspects of how to be energy efficient and smart in the climatization of historic buildings that are heritage objects themselves.
- Avoid comfort temperature regulation for staff/visitors out of visitor season
- Whenever possible avoid conventional air conditioning. Use "conservation heating" in the winter to avoid too high RH

Museum storage

- In most museums – purpose build museums or heritage buildings re-used as museums – some or much of the collection is not on view, but kept in storage facilities.
- Often kept at internal locations, taking up space, and in not-suitable conditions (basement / attic).
- In other museums, storage facilities are in buildings away from the main museum, sometimes climatized with a kind of air conditioning, and not very energy efficient

Museum storage

- Studies indicate that purpose-build low-energy storage is a possibility.
- Such already existing storage-buildings have been studied and a new type has been introduced based on field work by conservators and scientists from the National Museum of Denmark*. They studied relevant Danish buildings' indoor climate, energy consumption, building physics, air quality

* Ryhl-Svendsen, Padfield, Jensen, Aaberg, et al

Low-energy storage buildings



Danish low energy storage locations (cities):
Ribe, Randers
& Vejle



Photos courtesy M.Ryhl-Svendsen, KADK

Low-energy storage buildings

- Cooling takes energy, but provides a high preservation index
- Dehumidification is cheaper than heating – and provides a higher preservation index
- Two of the storage buildings hardly use heating, obtain stable climate by use of thermal mass (un-insulated floor) and highly insulated walls and roofs.

Low-energy storage buildings

- According to the studies it is possible to reach a preservation index >100 without mechanical cooling, by applying the correct building design
- The temperature is moderated by heat storage in the ground below the floor while a highly insulated superstructure and good airtightness shield against variation in weather.
- The relative humidity is kept moderate by solar heating of the attic space through a roof window.

Low-energy storage buildings

- Fine humidity control can be achieved by use of moisture reactive wall surfaces, such as clay in the form of unfired bricks.
- If necessary the studies suggest solar energy driven de-humidification for further fine humidity control
- Reactive wall surfaces may also be used to absorb possible, internally generated pollutants, but studies have shown that the described type of building in general has a good air quality

Cross section of low energy storage building

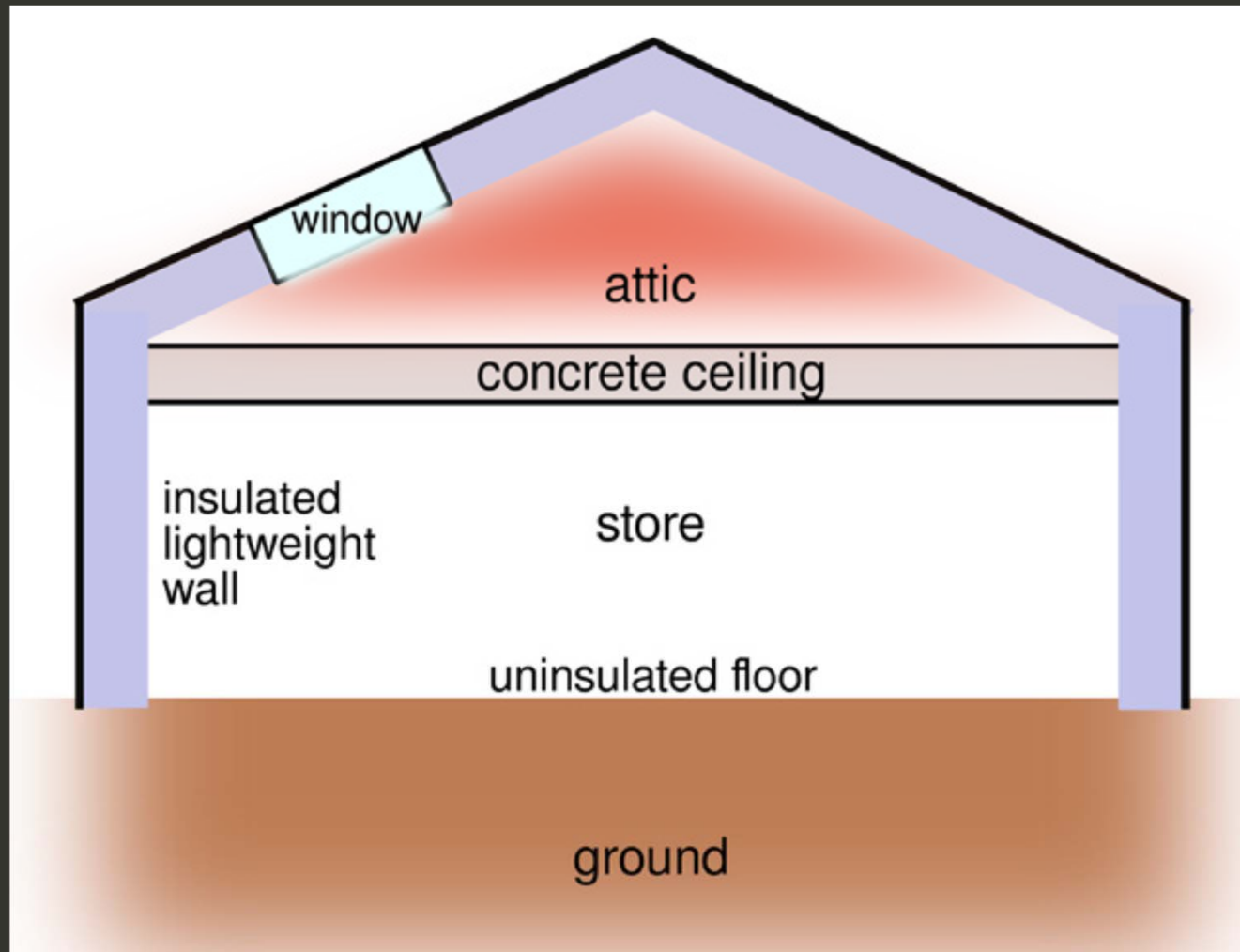


Illustration from Ryhl-Svendsen, M., et al. (2012) "A museum storage facility controlled by solar energy", *Climate for collections | standards and uncertainties*, Munich

T & RH stabilization in storage

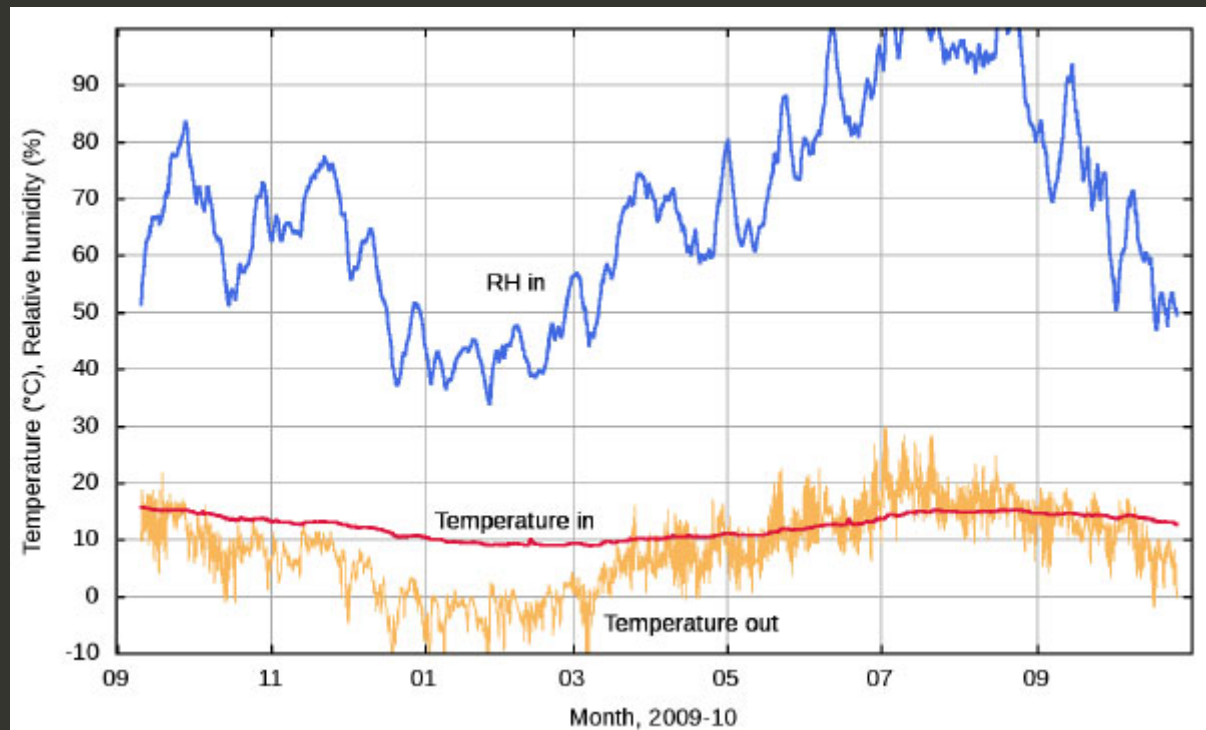


Image from lecture: "Low energy Museum Stores" by Jensen, Padfield, Ryhl-Svendsen, Klenz Larsen, Bøhm – cited from Padfield web-site "Conservation Physics"

Display cases

- Display cases has been regularly used in museums for a long time for different reasons.
- They are used to organize exhibits in an structured way, they are used to be able to exhibit objects in a context with other objects, or used to protect exhibits from various risks as discussed by Rob earlier
- Theft, wear, fragility, valuables, dust, etc

Display cases

Display case, itself a heritage object mounted inside a larger display case, at the Summer palace



Display cases

- More recently display cases were introduced as a means to provide and establish a more stable climatic environment – being build with low air exchange rate (airtight).
- Display cases were build very airtight but even in airtight display cases air would be exchanged slowly with surrounding (more fluctuating) environment

Display cases

- In order to obtain/ensure an even more stable RH inside various materials has been introduced, such as types of silica gel.
- Choosing the right type of e.g. silica gel (depending on materials inside), the proper amount and how often to conditioning the internal climate to the proper RH are aspects to include in display case design

Display cases

- Negative aspects of display cases:
- Possibility of pollutants building up inside the display-case
- Need of adding a balanced ventilation/valve system
- Need of adding pollutant absorbing materials like a carbon filter or specialized products
- The need to regularly regenerate buffer and scavenger materials

Internal stabilization in display cases

- Some objects/materials can stabilize themselves against RH (and thus AH) fluctuations inside the display case given that the ratio between the object and the volume in the case is low
- [A rule of thumb, object-air ratio: 1:5]
- With sufficient mass of an object (containing water, AH) in a narrow display case the object itself will overall stabilise the internal fluctuations and minimize dimensional changes

Micro-climate frames

- This ability has been used in a special kind of display cases referred to as "micro-climate frames"
- Such cases are partly build to protect paintings against attacks (e.g. tool and/or spray-paint attacks) and partly to establish a closed, self-contained stable environment
- For example when preparing for the loan of an object – in some cases for more permanent use.

Micro-climate frames

- Assume a painting, painted on a 1 kg board of wood. Using the previous estimate the wood will contain 100 g water if in equilibrium with 50% RH and 20°C
- The air in a display case of 1 cubic meter will contain approx 9.0 g water @ 50% and 20°C

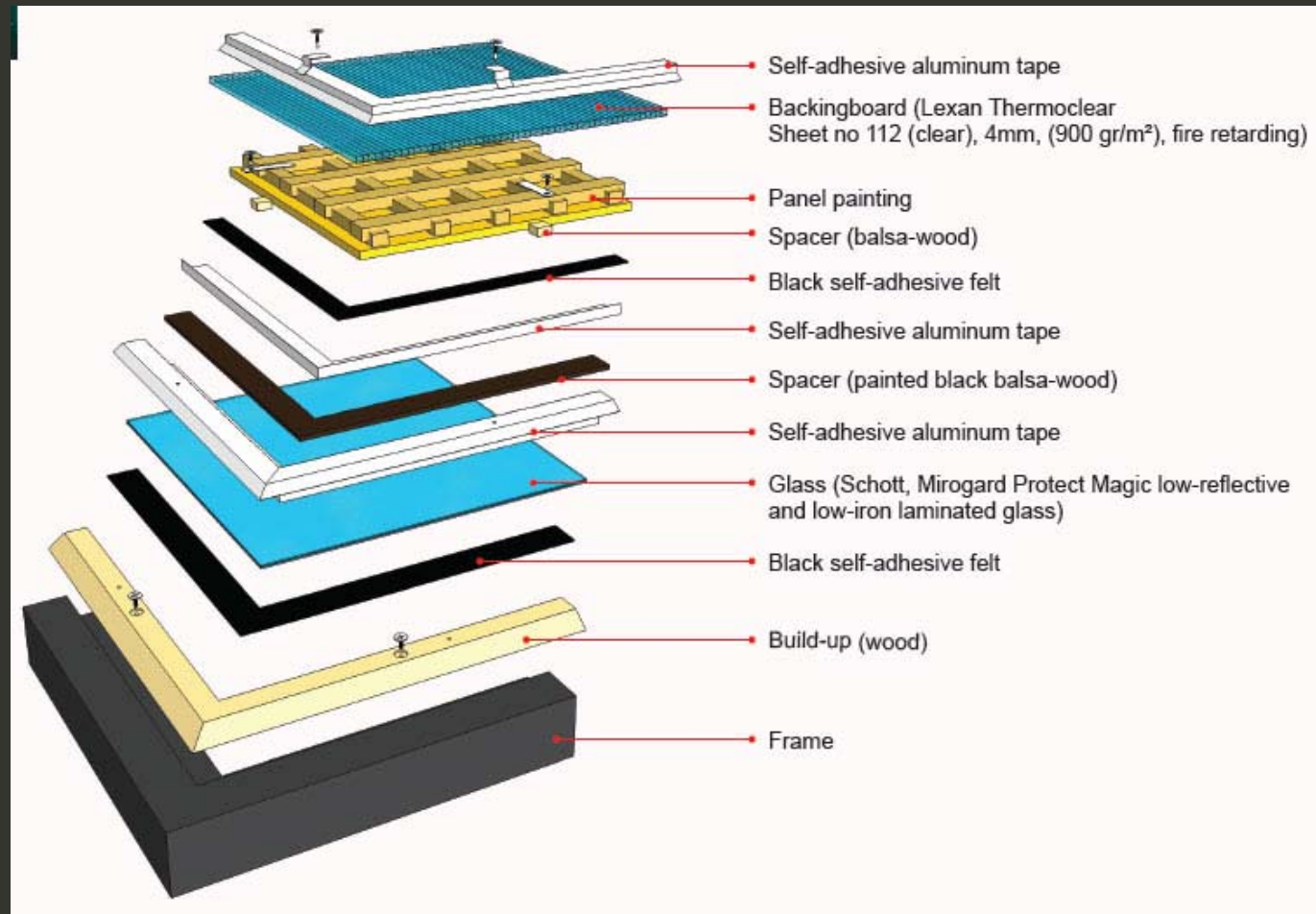
Micro-climate frames

- A display case (eg microclimate frame) of 1/20 cubic meter will hold approx 0.45 g water at 50% RH and 20°C (0.68 g @ 70%, 0.25 g @ 30%)
- Water (AH) being exchanged between the air and the object will be small and cause very little dimensional change.
- No energy consumption used to re-condition buffer materials
- Negative: possible pollutant build-up inside

Examples of display and micro frames

- The Propaint* project (2007-2010) examined various designs to re-build existing frames into microclimate frames around paintings, testing properties and suggesting suitable designs and decision models to follow in the design process.
- In a follow-up project (MEMORI) the study continued.
- In the following we will see one of the examples, a construction used at SMK, the Danish national Gallery.

Microclimate frame design



Microclimate frame design

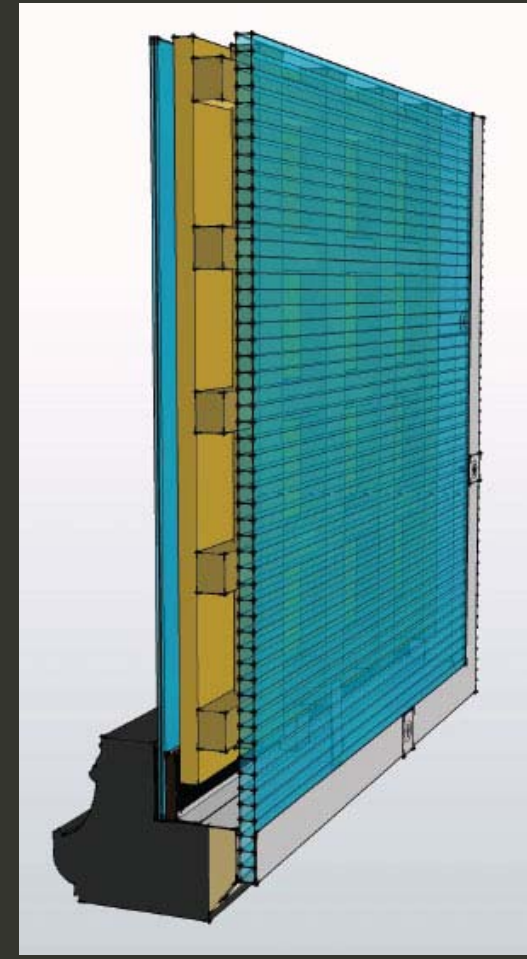
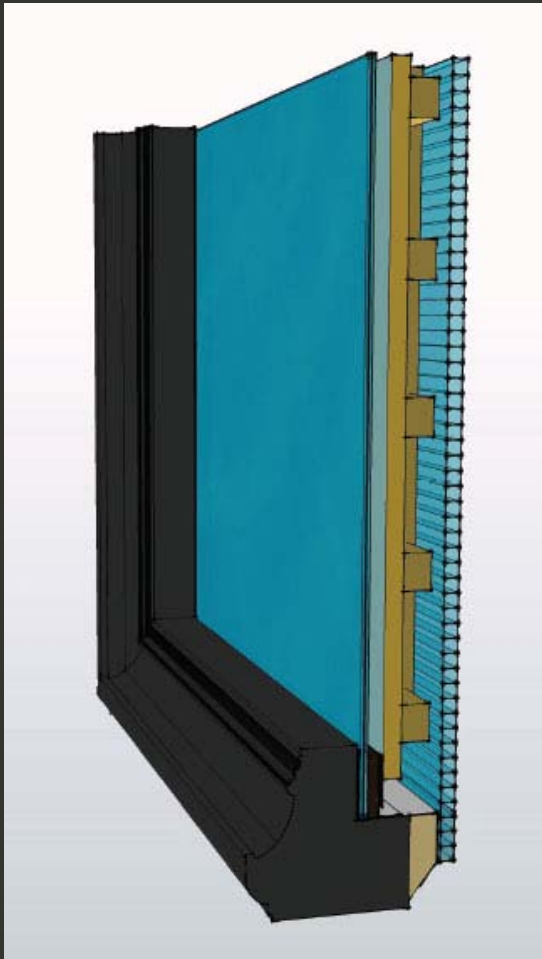


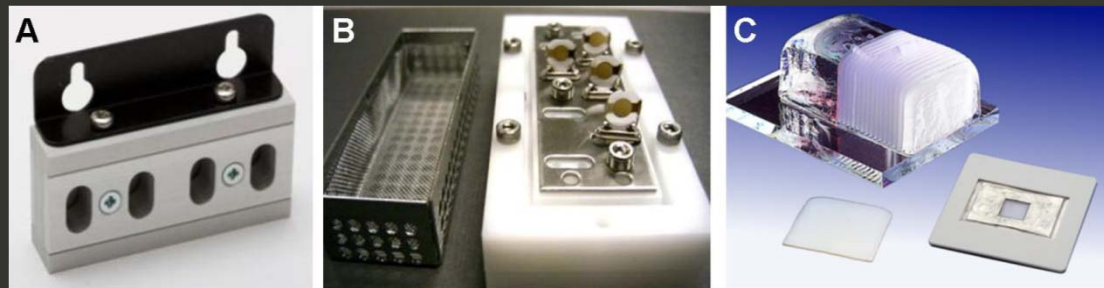
Illustration from PROPAIN: EU FP6 Supported Research Project, SSPI-044254

Display-cases and internal pollution

- Internally generated pollution is a well-known/studied phenomenon e.g.:
- Surface of lead objects corrodes in display-cases containing acetic-acid releasing objects (or display-case construction materials) like oak wood (= the Oddy-test)
- In European Union supported research projects Propaint and MEMORI the effect of common pollutants in confined spaces has been studied as well

Dosimeters measuring pollutants

- Small dosimeters, fitted into a micro-climate frame was tested to determine if the dosimeters were usable and if so, if build-up of pollutants could be traced.
- Results were compared with other types of dosimeters, passive gas samplers and RH & T loggers.



The main dosimeters used in the PROPAIN project: A. The NILU EWO (Early Warning dosimeter for Organic materials). B. The Birkbeck PQC (Piezoelectric Quartz Crystal) dosimeter and C. The Fraunhofer ISC GSD (Glass Slide Dosimeter).

Performance of microclimate frames

- Microclimate frames with low ventilation rate (airtight) performed well
- Excluding exterior pollutants from entering and effectively stabilized the climate inside (very little exchange of water = dimensional stability)
- Internally generated pollutants (e.g. from the wooden support or wooden stretcher of the painting or from solvents from recent treatments) were detected, suggesting a need for minimal ventilation or buffering

Conclusion

- Purpose built low-energy use storage buildings offer a cost-effective (and sustainable) alternative to the rationale of using airconditioning (regulating temperature, using humidification or de-humidification).
- Studies of museum objects (i.e., paintings) in narrow display cases – microclimate frames – has proven succesful in stabilizing the internal climate and thus minimizing dimensional change. However, possible internal pollution needs ventilation or use of buffering materials

End

- **Literature:**

- **Passive environments**

- Ryhl-Svendsen, M., Aasbjerg Jensen, L., Klenz Larsen, P., Bøhm, B., Padfield, T. (2012) "A museum storage facility controlled by solar energy", Climate for collections | standards and uncertainties, Munich
- Ryhl-Svendsen, M., Aasbjerg Jensen, L., Klenz Larsen, P. (2014) "Air quality in low-ventilated museum storage buildings". ICOM-CC 17th Triennial Conference, Melbourne, Australia.

- **Display cases (microclimate frames)**

- <http://propaint.nilu.no/Portals/23/PROPAIN-T-Final%20Report.pdf> (Propaint Final Report accessed 22 September 2015)

- **Acknowledgements:** thanks to M.Ryhl-Svendsen, Bent Eshøj (both KADK) for use of text examples and illustrations

- Non-credited illustrations/photographs by M.Scharff