

Efficient room temperature control for Stralsund Museum

Relative humidity acts on the set value for room temperature

(Introduction)

5 Four renovated rooms of Stralsund Museum, previously known as the
Museum of Cultural History, in Stralsund in Northern Germany are now
being heated with skirting heaters. One special feature is the thermocyclic
individual room control with integrated humidity sensor which raises or
lowers the air temperature with an adjustable ratio of air temperature to
10 humidity. This easy and economically interesting solution now also allows
delicate exhibits to be presented.

(Text)

15 Conservators often have high requirements for the room climate in museums
which usually can only be implemented with air conditioning systems. But
not all museums can afford this expensive technology. Historic listed
buildings present the added problem that changes to the existing structural
fabric for the installation of air ducts are virtually impossible to implement,
both from a technical and from a conservation perspective.

20 For the renovation of four exhibition rooms in Stralsund Museum in the
former Dominican monastery St Katharina in Stralsund, Joachim Ludewig
(Ribnitz-Damgarten, specialist HVAC planner) assumed from the outset that
an air conditioning system with air ducts was out of the question for
structural and economical reasons. Instead he recommended removing the
25 monstrous Gamat automatic outer wall gas heaters, which still dated from
GDR times, and replacing them with a room temperature control system
based on skirting heaters with individual room controls.

To stabilise the humidity within the range stipulated by the conservators, the
planner chose controls with humidity-dependent temperature compensation
30 in a definable set value field. Ludewig's choice of this system combination
relies on his long-standing experience with heating technology renovation
projects for religious buildings, museums and other listed buildings. His

decision is based on the current state of the art in addition to VDI 3871, sheet 1, Technical Building Installations in Listed Buildings, the Guidelines
35 for Heating Churches from 8 October 1979 (OJ 1979, page 202) as well as the current publications by the Fraunhofer Institute for Building Physics on the problems of heating (temperature control) in historic buildings.

As some of the museum rooms are intended for flexible use, Ludewig specified the following temperatures for the rooms:

- 40 - Design temperature 16 - 18 °C
- Maximum heating and cooling speed 1.0 to 1.5 K/h
- Lower limit value for relative humidity 45 per cent
- Upper limit value for relative humidity 75 per cent
- Maximum humidity fluctuation in the daily cycle 10 per cent
- 45 - Maximum humidity fluctuation in the annual cycle 30 per cent

For public placement of the job, the building owner followed the recommendations from the HVAC planner and selected Radia-Therm for the skirting heater system and Thermozyklus (Gauting near Munich) for the individual room controls. The sales partner for the two systems, Perry
50 Schmuck from Rostock, comments on this decision: "Skirting heaters are the ideal solution for historic buildings like the Museum of Cultural History in Stralsund. Installation of the skirting heaters requires hardly any interference with the historic structural fabric as the flow and return lines, and optionally also electrical and data lines, can be housed in the purpose-made panels." He
55 states that an average flow temperature for the heating of only 38 °C with approx. 28 °C return temperature produces a slightly convective lift with Coanda effect directly in front of the wall. Schmuck elaborates: "We use this to primarily bring the wall surface up to temperature and only then the air in the room, so it is a kind of envelope surface temperature. This distributes the
60 heat very evenly and efficiently in the room. This means the circulated air volume is low which is an advantage from a conservation point of view." And further: "The precise control from Thermozyklus allows us to generate precisely the desired conservation room climate."

The low air speed with a low level of turbulence also means that dust
65 movement in the room is low – an important aspect for the conservators.
And what is more: The low average flow temperature of the system
generates a very mild radiation across the affected wall surface without any
negative impact on the exhibits. It is well known that the relatively high
70 surface temperatures of radiators in museums create thermal tensions on the
surfaces of delicate exhibits which can lead to cracks and premature ageing.
“What is interesting is the low penetration depth of the heat into the solid
brick wall as well as the quick drying effect from the skirting heaters,”
Schmuck adds and continues: “This drying function leaves us with brick
walls with excellent insulation properties.”

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Correct humidity more important than constant room temperature

From a conservation point of view, managing the relative humidity in a
museum is far more relevant than constant air temperature. It is important to
dampen the speed at which both values change. Perry Schmuck explains:
80 “The thermocyclic individual room controls react directly to deviations from
the programmed set value field for temperature/humidity. The calculation
model stored in the control limits the temperature hysteresis to
 $\pm 0,15$ degrees.” In reality, temperature deviations as small as 1/100 Kelvin
in the room are detected and processed by the control. Perry Schmuck's
85 experiences show that a combination of skirting heaters and thermocyclic
individual room controls can save up to 50 per cent energy compared to
conventionally controlled radiator heating.

Each of the four rooms is equipped with an independent control loop which
acts on a zone valve with a proportional actuator. To record a representative
90 humidity measurement value, a humidity sensor is mounted on the wall of
each room at a height of approximately 3 m. All devices are wired to avoid
interferences. The control connections to the upstream boiler control are
hydraulic, i.e. the heating control in the boiler uses changes in pump pressure
to detect when a zone valve opens and then supplies the corresponding heat.
95 This ensures that heat is available even during the non-heating period in

order to provide the heat required for stabilising the relative humidity in the rooms. This heat requirement is defined in the control software via an hx diagram.

Due to the high heat retention level of the surrounding solid brick walls,
100 ventilation can be achieved by opening the windows as required. The ideal time for free ventilation is indicated by a ventilation “traffic light” which measures the inside and outside climate and uses this to generate a recommendation. The diffusion-open wall paint allows the walls to act as a buffer for the room temperature as well as for the humidity. Optionally,
105 a decentralised humidifier or dehumidifier can be integrated into the control strategy using a socket which is switched via the room device. This could, for instance, be the case for loan exhibits where the owner stipulates stricter set limit values for the humidity in the room. For reasons of conservation, the temperature and humidity values in the four rooms are recorded
110 continuously and transferred periodically to the upstream building control system for evaluation and documentation.

In future, the Hiddensee gold treasure from Viking times and the gold rings from Peenemünde will be on display in one of the rooms. The St Katharinen monastery is located at the heart of the city area “historic old towns of
115 Stralsund and Wismar” which is a recognised UNESCO World Heritage Site.

Conclusion

The patented thermocyclic temperature control process, coupled with the implemented software for humidity-dependent temperature compensation in
120 combination with a skirting heater system, allows room temperature control that meets sophisticated conservation requirements. The structural impact on the listed building is minimal. The mild wall heating effect allows the air temperature in the rooms to be kept relatively low without compromising on comfort. Experiences from other projects show that the combination of
125 skirting heaters and thermocyclic control can save up to 50 per cent energy compared to conventionally controlled radiator heating.

Image captions (selection)

Fig. 1 (museum building, MG 5428, 5418,)

130 The St Katharina monastery in Stralsund is one of the most important
buildings of the Brick Gothic style typical for Northern Germany. To
improve the conservation environment, four rooms were recently renovated
and the existing outer wall gas heaters were replaced with skirting heaters
with individual room controls.

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Fig. 2 (room with skirting, selection Ms Springub, photo 1, MG 4723)

The heat from the skirting heaters is now distributed evenly across the entire
outer wall. The Coanda effect creates a mild veil of warm air in front of the
wall. This means that even low room temperatures are perceived as quite
140 comfortable.

Fig. 3 (skirting heaters, selection photo 6, MG 4802)

The Radia-Therm heating elements can be modified for each application and
the design of the panels can be adapted to the interior design.

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Fig. 4 (panel detail, selection photo 3, MG 4789)

The customised panels for the skirting heaters matches the style of the plain
rooms with the groined vaults. Flow and return lines are hidden behind the
panels, optionally also the electric cables.

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Fig. 5 (control, RG.PDF from 15/06/2015, 7:27 a.m.)

Known for its particularly high level of control accuracy: the thermocyclic
individual room control system. Integration of a humidity sensor and an
additional software in the operating device allows the set temperature to be
155 varied according to the set limit values for relative humidity in the room.

Fig. 6 (humidity sensor, selection image 2, MG 4757)

The humidity sensor mounted at a height of approximately 3 m provides the basis for calculating the correct set value for the room temperature with regard to conservation.

Fig. 7 (valve, selection image 8, MG 4855)

Zone valve with proportional actuator. The calculation model stored in the control limits the temperature hysteresis to $\pm 0,15$ degrees.

165 Fig. 1 - 7: Thermozyklus

Fig. 8 (Hiddensee gold treasure)

The Hiddensee gold treasure and the gold rings from Peenemünde will be presented to the public in one of the renovated rooms in the future.

170 Fig: Stralsund museum