

Questions should be of general interest and be about temperature measurement techniques and/or heat transfer.

QUESTIONS? ANSWERS!

QUESTION: One day last year I visited an old castle from the 1500s. Inside the large hall of the castle it felt really chilly even though all the windows were open and the outdoor temperature was over 20 °C. The weather was cloudy and it was slightly windy so the air temperature inside the castle should have been about the same as outside. Inside the castle I felt really cold but I wasn't cold in the park outside. Why?

Margareta J

ANSWER: The air temperature was probably about the same inside the castle hall as outside, since it was slightly windy and the windows were open. However, the heat flow from your body to your surroundings was different inside the castle hall than outside in the park. Heat transfer from the body to its surroundings occurs in this case via convection and radiation. Heat flow via convection is about the same indoors and out but heat radiation in the two environments is different. Old uninhabited castles are usually not heated in the winter and the thick stone walls are therefore cold all winter. When the spring warmth comes it heats the walls but this occurs very slowly and the walls are therefore considerably cooler than the spring air. If we assume that the skin surface temperature of the body is 30 °C, the air temperature is 20 °C and the ambient temperature inside the

Chilly castles


castle hall is the same as the air temperature, the heat flow from the skin surface can be estimated at 70 W/m² (watts per square metre). If the temperature of the walls inside the castle hall is 15 °C instead of 20 °C, the heat flow becomes 95 W/m² and if the wall temperature is 10 °C the heat flow is 120 W/m². The colder the walls, the greater effect radiation has on the heat flow from the body. When the heat flow increases as the result of radiation, the temperature distribution in the skin is affected and the surface temperature drops. This temperature drop is registered by the body's "temperature sensors" and we start to feel cold.

The estimate of the heat flow is based on a number of assumptions with regard to geometry, material data and heat transfer. One example of such a assumption is that the ceiling and floor have the same temperature



as the walls. Another assumption is that natural convection is occurring. If the conditions change then the heat flow will naturally be different but the same tendency remains.

EASY TO MEASURE WRONGLY

If we were to measure the air temperature in the castle hall with an ordinary thermometer without a radiation shield, our measurement of the air temperature would be too low. This is because the thermometer's temperature adjusts itself so that the radiation from the thermometer to the cold walls is equal to the convective heat flow from the air to the thermometer. If we equip the thermometer with a radiation shield we will measure a temperature that better corresponds to the actual air temperature. 

To express viewpoints or ask questions, contact Professor Dan Loyd, Linköping University by e-mail to: dan.loyd@liu.se

This is Dan Loyd



Dan Loyd is a professor at Linköping University, Sweden. His field is industrial thermodynamics and fluid mechanics and he also solves complex issues to do with temperature measurement

– a subject that coincides with Pentronic's interests. For the past nine years he has also answered readers' questions in Pentronic's Swedish customer magazine. 