Cost-effective human comfort manikin with realistic thermal load for convection-driven ventilation systems

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The thermal environment in interior spaces (e.g. cars, trains, aircrafts and office buildings) is often very inhomogeneous. Under such conditions, the human thermal sensation is influenced by a variety of thermal parameters, which renders the determination of the thermal comfort into a complex task. Especially the acquisition of single, pointwise quantities, such as air temperature, air velocity or surface temperatures, is insufficient for robust evaluation of the thermal comfort. The equivalent temperature, which combines several comfort-relevant quantities into a single integral quantity, is considered a mature quantity for the evaluation of passenger thermal comfort.

Nowadays, only a few solitary systems exist to assess the thermal comfort based on equivalent temperatures experimentally. These are either very expensive or suitable for pointwise measurements only. However, simultaneous data acquisition at many different locations in the interior space is highly desired, generating the need for cost-effective yet precise systems. These systems are supposed to provide access to local equivalent temperatures and further, especially if convection-driven ventilation systems are considered, to simulate the heat impact of real passengers as well.

To accomplish this task, thermal passenger manikins of the German Aerospace Center (DLR) have been turned into thermal comfort manikins. In order to enable the measurement of equivalent temperatures for several body parts, the thermal manikin is calibrated in a thermally isolated, temperature-controlled test chamber. Herein, the surface temperature of the manikin is measured using high-definition infrared thermography. This offers the possibility to calculate local equivalent temperatures at a spatial resolution of 10 cm and with a precision better than ±0.5 K.

At the conference we are going to present the thermal manikin and the whole technical procedure regarding the calibration in detail. The performance of the manikin is going to be demonstrated for dedicated ventilation cases in aircraft, car and train cabin models.