The New Climate Room for transient investigations of thermal comfort

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Criteria of thermal comfort are very important to evaluate different heating and cooling systems for buildings. But the criteria given in ISO 7730 [1] or EN 16798-1 [2] are based on stationary boundary conditions. Real heating and cooling systems operate transient which means we can detect a lot of heating up and cooling down periods during one day. To evaluate these periods in the contents of thermal comfort, a new climate room was built at the Technical University of Dresden. The climate room is the final part to complete the "combined energy lab 2.0" which depends of an electrical test facility to change the parameters of the local electrical grid, the thermal test facility which is a hardware in the loop test rig for different heating and cooling devices and the new climate room. All the different parts of the combined energy lab 2.0 are connected to each other. **Figure 1** shows a principal view of the different test facilities.

With these test facility, it is possible to investigate complex technical systems in the building (generation - distribution - emission) and, also, the connection from the building to the upstream energy supply system.

The climate room consists of a special design. The main focus during the design phase was to create a system with a very low response time. The climate room should also be able to cover a lot of practical applications. Therefore, the test facility consists of 28 different wall elements. Each side wall element is separated in three segments which can be tempered separately. The top and bottom wall elements are each composed of one segment. The construction of the wall elements depends on a metal plate on the inside, a water based capillary system directly on the metal plate and an isolation. Between the capillary tubes temperature sensors are implemented for measuring the surface temperature. Figure 2 shows the construction details of the test facility. The uniform temperature control of the segments ca be demonstrated with

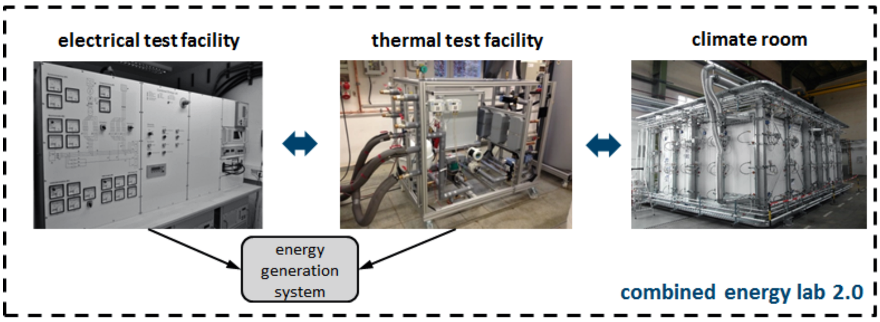

Figure 1. Combined Energy Lab 2.0 at the TU Dresden.

the help of thermography and it is shown in **Figure 2** (right).

The physical behavior of the climate room is extremely flexible. The climate room has an inner dimension of 4m x 5m and a high of x 2,5m. The surface temperatures of the walls, ceiling and floor can be regulated in a range from ϑ=10°C to 50°C. The climate room is connected to a ventilation and air conditioning systems. This is necessary to fulfill the hygienic criteria of the air in the room (e.g. CO_2 -level). Furthermore, the air temperature can be changed in a range of ϑ=10°C to 35 °C and the air humidity from ϕ=20% up to 90%. With this system, a maximum volume flow rate of 600 m^3/h can be generated which results in an air change of n=12 h^{-1}. **Figure 3** shows a view inside the room.

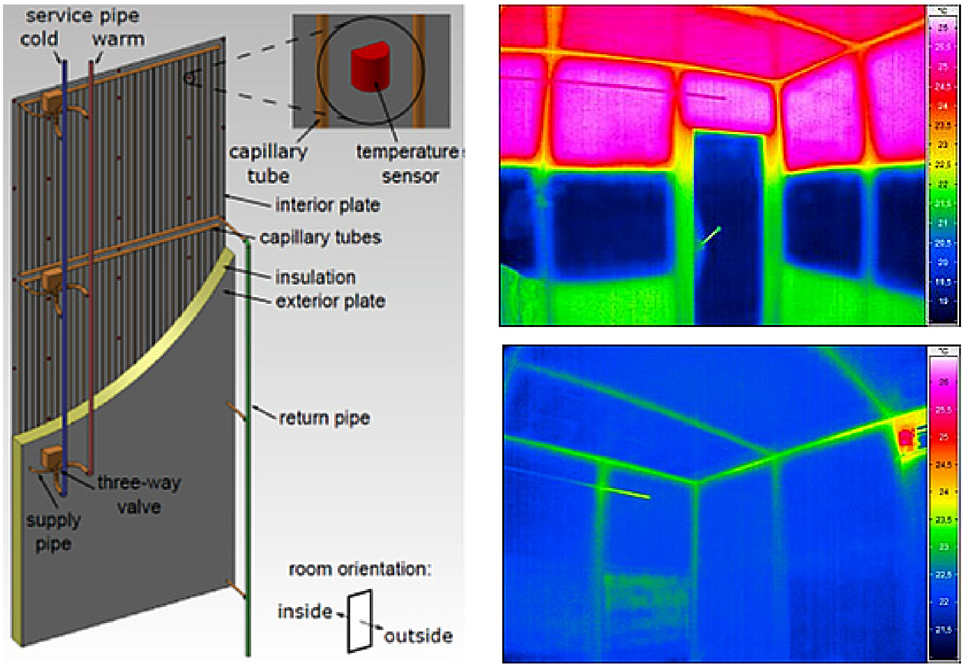

Figure 2. Construction details of the climate room.

In the occupant area, the operative temperature is measured with different sensors. The first one is a classic globe thermometer with a dimension of d=150 mm. For steady state condition this measurement device can be used. For transient conditions a modified globe thermometer is used with a very small diameter of the globe. Additionally, different velocity sensors, combined temperature humidity sensors and CO_2-sensors are used.

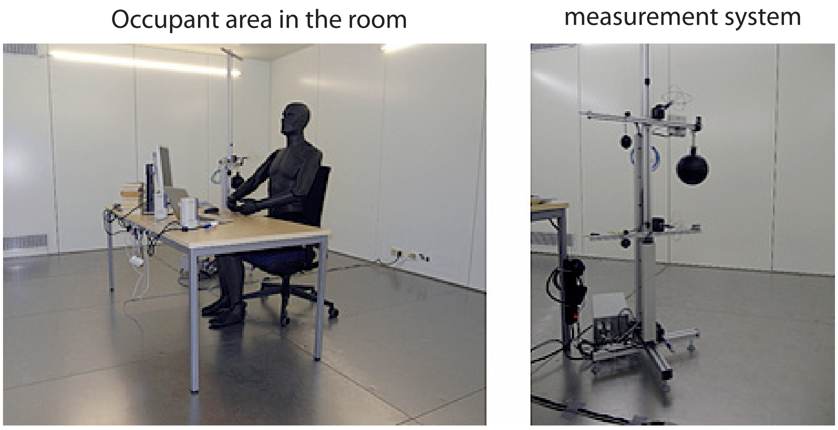

Figure 3. Inside view of the climate room.

The quality of the climate room can be detected with a transient measurement. Therefore, some initialization tests were carried out. Based on a constant operative room temperature the set point of the operative temperature was changed with gradient of 2 K/h. **Figure 4**

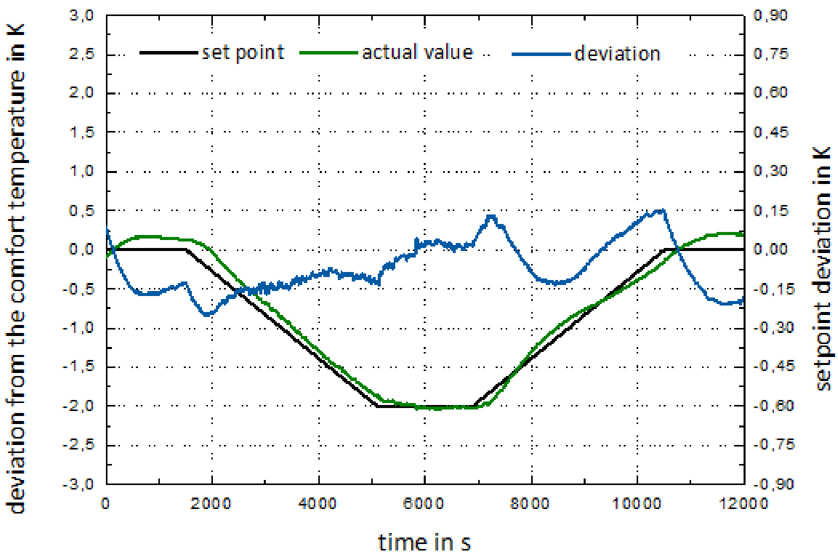

Figure 4. Set point temperature / actual temperature and derivation of the temperatures during the initialization experiment.

shows the results of the initialization test.

Based on documented results it can be determined, that the actual temperature can follow the set point very well. The differences between the set point and the actual values is lower than $\Delta\vartheta$=0,2K. Especially the air temperature fluctuate in a small range. The reason therefor is that the flow pattern in the climate room is like not complete stable.

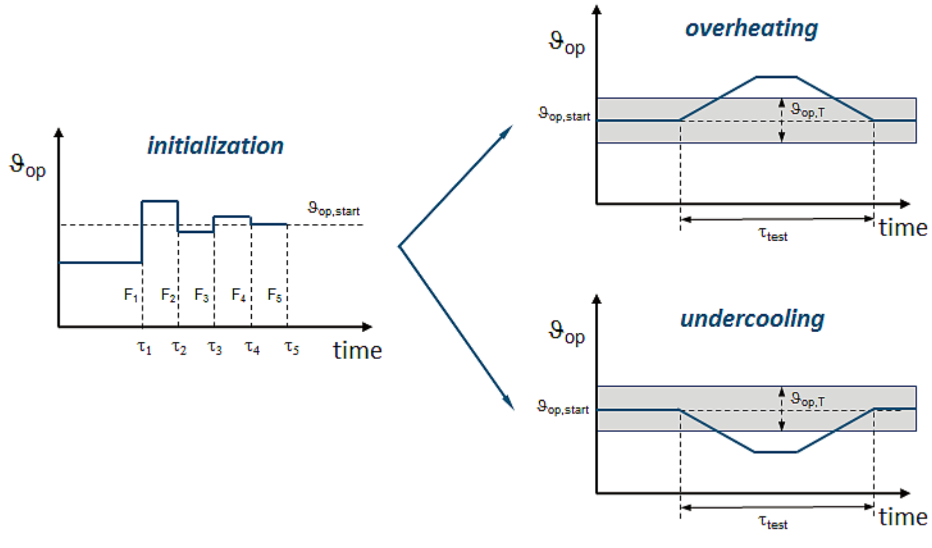

Figure 5. Initialization / overheating and undercooling investigation.

At the moment, the climate room is used to investigate transient thermal comfort aspects. For this purpose, a test program was established, which was carried out with 85 test persons. The investigation procedure begins with an adaption phase. In this adaption period, each test person selects its own comfort temperature. After this period the measurement period closes. Two periods are distinguished. The first one symbolized an overheating of the room and the second one a down cooling. **Figure 5** shows the principle of the analyses.

The results of these investigations were presented in the near future in different papers[1]. This publication should be intended to describe the test facility. But the test facility can not only be used for scientific work in the contents of thermal comfort experiments. Also, product investigations for new heating and cooling systems or control systems can be carried out with the climate room. ■

1 In [3] a complete an detaild describtion of the climat room and the investigations are documented.

Acknowledgment

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Literature

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