Taking Thermal Regulation Models from the Lab to the World

With the development of energy efficient localized heating and cooling systems, the demand for an accurate prediction of local skin temperatures and local thermal sensation increased. Recent thermophysiological and coupled thermal sensation models are generally capable of simulating the required local values. Most models were validated for the mean skin temperature prediction of an average person under low clothing as well as low activity conditions. Studies found in literature and a case study performed for this project show that the models lack accuracy in local skin temperatures especially on the extremities under conditions with higher insulating clothing and higher activity levels. In a broad literature review, two reasons were identified: 1. the available local clothing parameters in the literature are not sufficient for simulating typical office situations, and 2. the local heat balances of the thermophysiological models need to be re-evaluated for activity levels above 1 met. The first issue was addressed by measuring local clothing parameters on a thermal sweating manikin in cooperation with EMPA, St. Gallen, Switzerland for 23 typical office outfits including three air speeds and body movement. To identify the problem with the local heat balances, human subject experiments were performed at Maastricht University, where the participants performed light to medium activities while we measured skin and core temperature, skin blood perfusion and their energy expenditure. We could show that the skin blood perfusion in the thermo-physiological models was too low in comparison to measured values for higher activity levels. With the improvement of the mentioned issues as well as considering the individual body composition of the human subjects, the local skin temperature prediction of the thermo-physiological model was improved.

With this knowledge our thermo-physiological model ThermoSEM will be further improved and applied to other fields like sports, exercises and patient thermal management.

Experiments are done in close collaboration with Maastricht University and TNO (Training & Performance Innovations).

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