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NUMERICAL MODELING OF HEAT AND MOISTURE TRANSPORT IN MICROCLIMATE BETWEEN CLOTHING AND HUMAN BODY: EFFECT OF MICROCLIMATE THICKNESS AND ORIENTATION

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ABSTRACT

The microclimate between the clothing and human skin has a significant effect on the heat and moisture exchange between the human body and the environment, which plays an important role in maintaining thermo-physiological comfort. In the present study, a numerical model of heat and moisture transfer through the microclimate and a single layer fabric in dry and sweating conditions is developed using COMSOL Multiphysics. The model has been validated against the data from previous research and the accuracy of the present results is found satisfactory. The effects of horizontal and vertical orientations on thermal resistance (Rct) and evaporative resistances (Ret) are analyzed. The findings reveal that heat and moisture transfer in the horizontal microclimate orientation is better than in vertical microclimate orientation and the difference in heat and moisture transfer grows as the microclimate thickness increases. The developed numerical model is then used to study the effect of microclimate thickness ranging from 0mm to 30 mm on the thermal resistance (Rct) and evaporative resistance (Ret). It is found that Rct and Ret first increase with increasing microclimate thickness which indicates that the introduction of an air gap between the clothing and skin has a significant effect on heat and moisture transfer. It is also found that natural convection occurs in both horizontal and vertical orientations as the microclimate thickness increases, which promotes the heat and moisture transfer from the human body to the environment. Further, the microclimate temperature distribution, water vapor concentration and moist air flow behavior are also studied for both the horizontal and vertical microclimate orientations in dry and sweating conditions.