The Impact of the Outer Layers in Multi-Layer Clothing Systems on the Distribution of the Air Gap Thickness and Contact Area

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Abstract

The heat and mass transfer in clothing, and hence its thermal comfort, do not only depend on the properties of fabric but also on the variation of the thickness of air layers and the magnitude of the contact area. The garment design and the body geometry have major influence on the above-mentioned parameters. Until now several studies have been conducted to analyse the impact of clothing fit at lower and upper body, moisture content and body shape and posture on the distribution of the air within garment. The present study addressed the effect of adding on a second layer to the clothing system on the air gap thickness and the contact area.

For this reason, the distribution of the air gap thickness and contact area for the upper body dressed with regular- or loose-fitted inner layer and the regular-fitted jacket was experimentally determined. The outer layer of the 2-layer clothing system was made out of transparent foil. The foil was chosen to ensure high stability, good transparency, least reflection and similar stiffness to typical jacket fabrics. The 3D scanner was able to scan through the outer layer in a smooth process and capture the shape of the inner layer underneath. Each inner layer garment and a combination of inner and outer layer garments was subjected to 3D scanning and analysis of air gap thickness and contact area by imposing 3D scans of the nude and dressed manikin and advanced post-processing in dedicated software. Finally, the results for the inner layer with and without outer layer were compared.

The air gap thickness and the contact area varied with different fit levels corresponding to the ease allowance, which was in agreement with other studies in the literature. The contact area increased and air gap thickness decreased, when the foil jacket compressed the inner layer in both fits (Fig. 1). However, as soon as the ease allowances of the inner and outer layers were similar, the compressing effect of the outer layer disappeared. The findings can be used to optimize the fit and comfort of garments.

Figure 1. Photographs and corresponding post-processed exemplary 3D scans indicating the contact area and the air gap thickness of the loose-fitting inner layer alone and in combination with the outer layer jacket.

Keywords: air gap, clothing contact area, 3D body scanning, heat and mass transfer in clothing