NUMERICAL ANALYSIS ON THE THERMAL PERFORMANCE OF AN ELECTRICALLY HEATED BEDDING PRODUCT

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A bedding system should help maintain thermal conditions near the skin in comfortable ranges [1], regardless of the conditions prevailing in the surrounding environment. However, when the temperature of the environment surrounding the user decreases, it becomes increasingly unpractical to rely only on the passive insulation of fabrics to offer the body the thermal protection it needs to reach thermal neutrality. In these scenarios, electrically heated bedding systems may be interesting alternatives as they help maintaining temperature levels in comfortable ranges, while allowing to avoid some of the drawbacks of typical insulation products (e.g. increased thickness or weight, decreased breathability and passive operation, i.e. absence of adaption to user's thermal needs).

However, in the interest of ensuring a high level of energy-efficiency in such a heating product, it is crucial to address its technical specification with approaches enabling a proper performance optimization, considering all relevant aspects of the problem (properties of the fabric layers and structures, characteristics of the heating system, geometrical features, energy requirements and operation conditions).

With the goal of conducting pre-prototype optimization of a heating system to be embedded in a bedding product, the heat transport across its structures was studied numerically using a FEM-based approach [2] in order to analyse potential performance bottle necks, the effect of the main fabric characteristics and the possible characteristics of the heating system. The analyses were conducted for different exposure conditions, allowing the prediction of the temperature profiles across its structures, as a function of fabrics insulation, position and distribution of the heating elements and imposed heating powers. This enabled the acceleration of product specification activities (e.g. definition of fabric properties, features of the embedded heating system and overall design of the system) and the substantial reduction in the number of prototypes needed for the final performance optimization and fine-tuning. The approached described here can be used to potentiate and accelerate the optimization of different product families with smart/active functionalities (e.g. protective clothing, home textiles products, automotive seats, etc.).

References:

[1] N. Pan , P. Gibson, *Thermal and moisture transport in fibrous materials* , First. Wookhead Publishing in Textiles , 2006 , p. 586.

[2] O. C. Zienkiewicz , R. L. Taylor , P. Nithiarasu, *The Finite Element Method for Fluid Dynamics* , Sixth. Elsevier Butterworth-Heinemann , 2005.