ABSTRACT SUBMISSION
-FOR INVITED SPEAKER ONLY

TBIS

Thermal properties of 3D textile structures

Mohanapriya Venkataraman[*1], Dana Křemenáková[1], Jiří Militký[1]
[1]*Department of Material Engineering, Faculty of Textile Engineering, Technical University of Liberec, Studentská 2, 46117 Liberec, Czech Republic*

[*]Presenter's email: mohanapriya.venkataraman@tul.cz

ABSTRACT
The textile and other sector accounts for a significant portion of global energy consumption, with much of this energy used for heating and cooling. Conventional insulation materials often present challenges related to environmental impact or handling. Three-dimensional (3D) textile structures, particularly those with corrugated structures, offer a promising, lightweight, and versatile alternative for energy-efficient construction and apparel due to their inherent ability to trap air and their superior compressional and thermal properties. Engineered 3D textile structures offer an effective, lightweight, and sustainable solution for advanced thermal insulation applications in protective clothing and potentially other sectors, such as aviation or building. Optimizing the internal geometry and modifying these structures offers a high strength-to-weight ratio and superior thermal performance, addressing critical needs for energy efficiency and environmental protection. This lecture will focus on the modeling and experimental evaluation of the thermal insulation properties of 3D textile structures based on nonwoven fabrics and a spatial insert. The experiment was conducted on an apparatus with a heated plate maintained at a surface temperature of approximately 37°C, on which the specimen being tested was placed in direct contact. The surface temperature of the heated plate (Tp), the ambient temperature (Ta), and the surface temperature of the textile (Tf) were continuously monitored using iButton temperature loggers for 30 minutes with a time step of 10 seconds. The proposed approach combines a relatively simple experimental arrangement with a flexible nonlinear model in which the effective order of the process is part of the parameter vector. This methodology provides a consistent tool for quantitatively comparing different 3D textile structures in terms of thermal insulation, serving as a basis for their further design and optimization. In future work, the described model may be extended to include the effects of moisture, variable boundary conditions, and a broader spectrum of spacer textile geometries, in order to capture the behaviour of materials in real applications more comprehensively.

Acknowledgement:

This work was supported by HUBORA project FW12010015 - "Multifunctional textiles using the heat emitted by the human body", which is financed with the state support of TAČR and MPO ČR as part of the TREND program.