INFLUENCE OF ROTIS STRUCTURE ON SANDWICH MATERIAL'S THERMAL PROPERTY FOR CONSTRUCTION APPLICATION

Dan Wang[1], Shi Hu[1], Mohanapriya Venkataraman[1], Dana Křemenáková[1], and Jiří Militký[1]

[1] *Technical University of Liberec, Studentská 1402/2, Liberec, Czech Republic:* dan.wang@tul.cz

Abstract: Construction materials refer to a diverse range of materials that are used in construction projects. In light of societal progress, numerous scholars have proposed a strategy for developing ecological construction materials. One important aspect of saving energy and improving the living environment is the thermal insulation performance of buildings. The building sector accounts for approximately 30–40% of total energy consumption worldwide, with the majority of this energy being used for heating and air conditioning [1]. Therefore, improving energy efficiency in the construction industry is highly important.

This study examines the thermal insulation characteristics of a sandwich material with the ROTIS structure. The sandwich material consists of polyester nonwoven with an acrylic binder that exhibits a high level of spectral absorbance, as well as polyester nonwoven with copper plating that exhibits a high level of spectral reflectance. The sandwich material featuring the ROTIS structure is derived from the ROTIS technology pioneered at TUL Liberec [2]. The process involves the twisting of fiber ends that stick out from the surface of the web into structures known as quasi-yarns. One advantage of this technology is its capability to attach surface-reinforcing nets to fixed structures. Simultaneously, when subjected to the machine's pressure, the 2D textile material undergoes a transformation into a 3D textile material [3].

Comparing the thermal conductivity of all samples shows that the samples with the ROTIS structure have a slightly higher thermal conductivity than the samples without the ROTIS structure. An explanation for this phenomenon is that the machine's pressure during the creation of the sample with the ROTIS structure decreases the presence of still air in the sample, resulting in a slight elevation of its thermal conductivity. Another explanation is that the major difference between samples with the ROTIS structure compared to samples without the ROTIS structure is that they contain two parts of the fabric parallel and perpendicular to the direction of heat transfer. The sample without the ROTIS structure contains only the fabric perpendicular to the heat transfer direction. Hence, this alteration in the structure of the textile also results in a modification of its thermal conductivity. The variation of the thermal resistance values of the two groups of samples is more complex, showing the same trend as the thickness variation. This ROTIS structure causes the thermal resistances of thinner original samples to increase, while the thermal resistances of thicker original samples either remain constant or decrease. From the above results, it can be concluded that ROTIS structures will greatly improve their thermal insulation performance for samples with lower thickness.

KEYWORDS: *Sandwich materials, ROTIS structure, Thermal insulation property.*

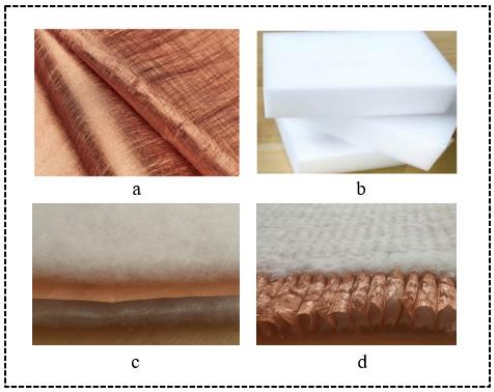

Figure 1 polyester nonwoven with copper plating (a), polyester nonwoven with acrylic binder (IL) (b), sandwich material without ROTIS structure (c), and sandwich material with ROTIS structure (d).

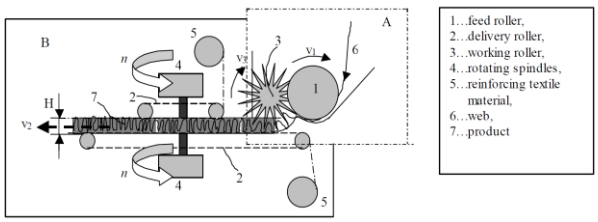

Figure 2 Machine production process of ROTIS technology.

ACKNOWLEDGEMENT*: This work was supported by the by the Czech Science Foundation (GACR)-project Advanced structures for thermal insulation in extreme conditions (Reg. No. 21-32510M)*

REFERENCES

[1] Y. Ke, et al., “Emerging Thermal-Responsive Materials and Integrated Techniques Targeting the Energy-Efficient Smart Window Application,” Advanced Functional Materials, vol. 28, p. 1800113, May 2018.

[2] J. Militký, et al., “Textile Branch and Main Breakthroughs of the Czech Republic in the Field of Textile Machinery: An Illustrated Review,” Textiles, vol. 1, no. 3, Art. no. 3, Dec. 2021.

[3] J. Hanus and J. Militky, “REINFORCEMENT OF COTTON 3-D NONWOVENS BY QUASI-YARNS,” presented at the BELTWIDE COTTON CONFERENCES, SAN ANTONIO, TX, Jan. 2004, pp. 2777–2783.