AUTEX 2022
21st World Textile Conference

Analysis on heat transfer properties of the sandwich fabrics based on ANSYS workbench

Dan Wang[1], Shi Hu[1], Yordan Kyosev[2], Dana Kremenakova[1], Jiri Militky[1]
[1] Technical University of Liberec, Studentská 1402/2, 46117 Liberec, Czech Republic
[2] Technical University of Dresden, Hohe Str.6, 01069 Dresden, Germany

Abstract
In recent years, the application of simulation software to analyze the heat transfer properties of fabrics has become a research hotspot. In this paper, the ANSYS workbench simulation software is used to simulate the heat transfer properties of a kind of sandwich fabric. The results obtained by establishing different models show that the application of single-layer fabric with different thermal resistances in the sandwich fabric will lead to greatly different thermal resistances of sandwich fabric; the same material has different thicknesses, and its thermal resistance will increase with the thickness; the same single-layer fabric with different combination positions will cause the thermal resistance of the sandwich fabric to change.

Material of sandwich fabrics
From the below table presents the basic information of the sandwich fabrics. It has different layers, including anti-electromagnetic inference layer (Meftex10 [1]), insulation layer (Nonwoven1 and Nonwoven2), surface layer and lining layer (Woven1 and Woven2).

Table 1. Basic information of single-layer fabrics

Name	Sample description		Area density [g/m^2]	Thickness under 200Pa [mm]
Meftex10	100% polyester with copper and nickel coating	nonwoven	13	0.05
Woven1	100% polyester	woven	52	0.06
Woven2	80%cotton/20%polyamide	woven	88	0.2
Nonwoven1	100% polyester with acrylic binder	nonwoven	100	5
Nonwoven2	100% polyester with acrylic binder	nonwoven	300	15

Method for Alambeta and simulating heat transfer properties by ANSYS workbench
Alambeta is used to measure the heat transfer properties of fabrics, including thermal conductivity, thermal resistivity, and sample thickness under 200Pa pressure [2]. And this paper is based on simulating the heat transfer performance of textile materials, and the "steady-state thermal" module can be selected in the ANSYS workbench software. At the end, the data and images of temperature distribution and heat flux distribution are obtained through the software's own simulation.

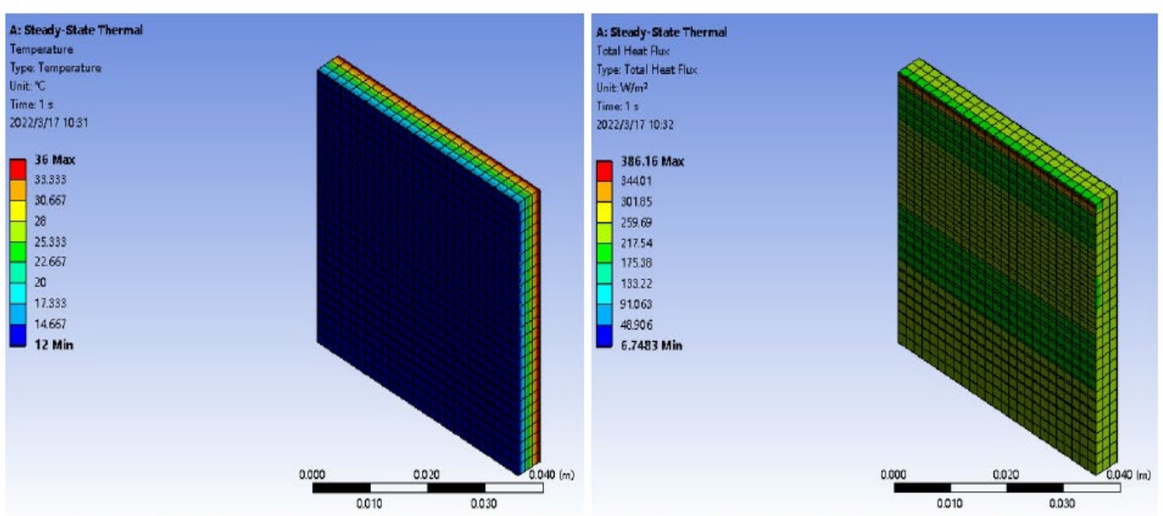

Figure 1. Data and image of temperature (left) and heat flux (right) by ANSYS workbench

Results and discussion
It can be seen in Table 2 that the two sets of data show the same trend. However, it can be clearly seen that the actual test data is lower than the simulated data, because the porosity of the actual samples are much larger than that of the simulated models. In addition, the following points can be drawn from the comparison of different groups of samples: (1) The higher the thermal resistance of the single-layer fabric obtained from the comparison of sample 1 and sample 2 will directly lead to the higher thermal resistance of the sandwich fabric; (2) It can be seen from the comparison of sample 2 and sample 3 that the thicker the thickness of the fabric, the higher the thermal resistance of the fabric; (3) The comparison of sample 3 and sample 4 shows that the same single-layer material placed in different position will also lead to the sandwich fabric's thermal resistance is different.

Table 2. Thermal resistance of different sandwich fabrics by Alambeta and ANSYS workbench

Name	Sample description (Fabrics sequence is from human body to external environment.)	Thermal resistance by Alambeta (K.m^2/W)	Thermal resistance by ANSYS workbench (K.m^2/W)
Sample 1	Woven1+Meftex10+Nonwoven1+ Woven1	0.11639	0.14341
Sample 2	Woven2+Meftex10+Nonwoven1+ Woven2	0.12367	0.15241
Sample 3	Woven2+Meftex10+Nonwoven2+ Woven2	0.26101	0.33508
Sample 4	Woven2+Nonwoven2+Meftex10+ Woven2	0.26444	0.37649

Conclusion
The thermal resistance data from Alambeta and ANSYS workbench show the same trend, but the actual test data are lower than the simulated data because the porosity of the actual samples is much larger than that of the simulated models. The thermal resistances of sandwich fabrics will be influenced by the different thicknesses, different fabric types and different combination positions.

Acknowledgment
This work was supported by the Ministry of Education, Youth and Sports of the Czech Republic and the European Union - European Structural and Investment Funds in the Frames of Operational Porgramme Research, Development and Education - project Hybrid Materials for Hierarchical Structures (HyHi, Reg. No. CZ.02.1.01/0.0/0.0/16_019/0000843). And many thanks to the Bochemie company for providing Meftex 10 samples.

Reference
[1]"Meftex 10." https://www.meftex.cz/cs/meftex-10/p-1/.
[2] L. Hes and I. Dolezal, "Indirect measurement of moisture absorptivity of functional textile fabrics," *J. Phys. Conf. Ser.*, vol. 1065, no. 12, Nov. 2018, doi: 10.1088/1742-6596/1065/12/122026.