Evaluating the Effect of Air Temperature Change on Thermal Insulation of Outdoor Sports' Shirt via Thermal Manikin in Constant Heat Flux simulating exercise

Maria José Abreu [1], Derya Tama [2] André Catarino [1],
[1] 2C2T-Center for Textile Science and Technology, University of Minho, Campus de Azurém, Guimaraes, Portugal, [2]EgeUniversity, Department of Textile Engineering, 35100 Bornova/Izmir, Turkey.

josi@det.uminho.pt

In the present experimental research, the thermal insulation of an outdoor sports' shirt was evaluated considering constant heat flux simulating exercise. The shirt was produced using a seamless weft knitting machine by combining different yarns and knitting structures in different parts of the shirt (Figure 1).

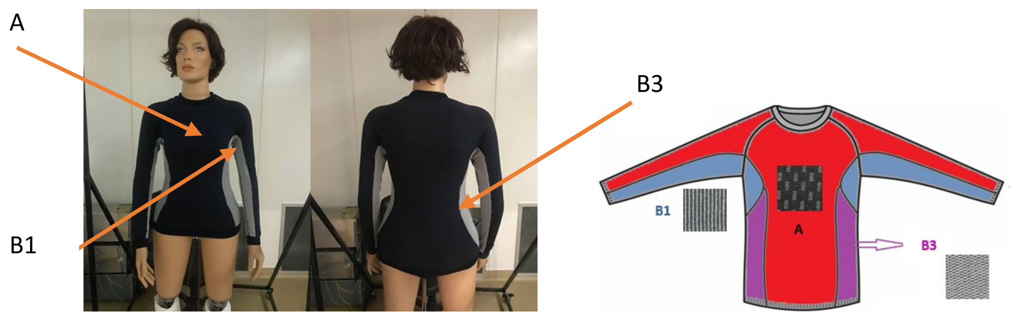

Figure 1. The evaluated outdoor sports' shirt.

The yarn compositions and knitting structures of the shirt according to body parts were presented in Table 1.

Table I. The composition, knitting structures and the codes of shirts

Code	Fiber Composition	Knitting Structures	The Design of the Shirt
A	Polyamide Nexten ® Polypropylene Elastane	Single Jersey jacquard 1	Structure A was mainly placed on chest, back and upper arms
B1	Polyamide Becool ® Polyester Elastane	False Rib 1	Structure B1 was placed on armpits and lower arms
B3	Polyamide Becool ® Polyester Elastane	Single Jersey jacquard 2	Structure B3 was placed on the laterals

The tests were conducted by a thermal manikin and the manikin regulation mode was chosen as constant heat flux (CHF) mode. The thermal manikin is divided in 20 thermally independent body sections. The tests were set according to "ISO 15831: Clothing - Physiological effects - Measurement of thermal insulation by means of a thermal manikin". The manikin was slightly above the floor (0,10 m) in a standing position during the measurements. The dry heat flow from the manikin´s skin surface area through the clothing into the ambient air was measured.

The tests were conducted by a thermal manikin and the manikin regulation mode was chosen as constant heat flux (CHF) mode. The power was fixed at 310W regarding Hagerman (1984). In this study of the US rowing team that competed in the 1992 Olympics, the average female rower produced 310W. This represents a constant heat flux around 200 W/m^2.

In order to calculate the effective clothing insulation (Icle), the global method was used as thermal insulation calculation method. The climatic condition was determined regarding to the past weather data of Porto region. T1 was defined as hottest condition and was set down at constant ambient temperature of 25±1°C and relative humidity of 65±5%.

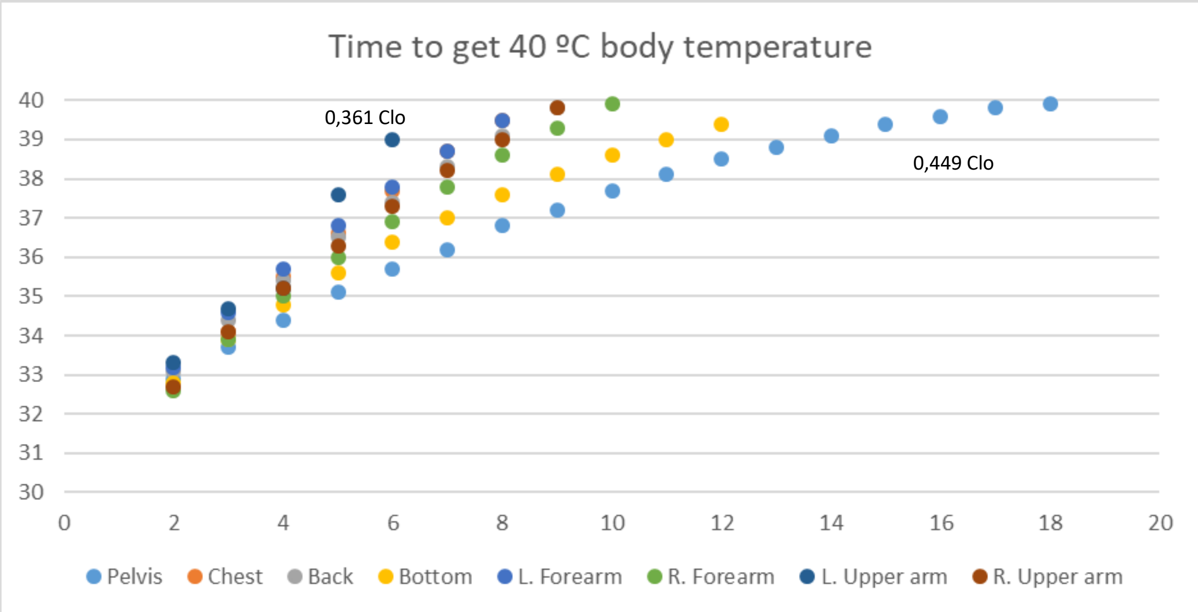

Figure 1. Skin temperature increase during time using constant heat flux simulating rowing exercise

The region of the left upper arm had the lowest thermal insulation with 0,361 Clo after 6 minutes, whereas the pelvis region reached until 0,449 Clo, but just after 19 minutes.

So structure B1 is more thermal conductive than the other structures and A has the highest thermal insulation during exercise time. According to the gathered data, the effective clothing insulation value of the shirt has a good thermal behaviour for this thermal environment. Furthermore, the results were evaluated regarding to the eight body segments, which were related with upper garment, namely pelvis, chest, back, bottom, left forearm, right forearm, left upper arm, right upper arm.

REFERENCES

Hagerman, F. C.; Applied physiology of rowing; Sports Med.1984 Jul-Aug;1(4):303-26.

ACKNOWLEDGMENT

This work was supported by FEDER funds through the Competitivity Factors Operational Program - COMPETE and by national funds through FCT – Foundation for Science and Technology within the scope of the project POCI-01-0145-FEDER-007136. We would like to thank Nadine Häußermann and Silke Küblbeck for their kind support.