



The Fiber Society 2016 Spring Conference

Textile Innovations—Opportunities and Challenges

May 25–27, 2016

Conference Chairs

Pr. Dominique Adolphe, Pr. Laurence Schacher, Dr. Nabyl Khenoussi

Ecole Nationale Supérieure d'Ingénieurs Sud-Alsace

Venue

University of Haute-Alsace

*Ecole Nationale Supérieure d'Ingénieurs Sud-Alsace
Mulhouse, France*

ENSISA – Werner 11 – rue Alfred Werner – Mulhouse

Program

Tuesday, May 24

1:00 PM–5:00 PM

5:00 PM–7:00 PM

Governing Council Meeting: Mechanic Meeting Room, Room 355

Early Bird Registration and Reception: ENSISA Werner Bldg. (**B** on map) – Workshop Lane

ISBN: 978-2-9556560-0-6

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Comfort Effects of Weft-knitted Structures on Rowing Shirts Using IR Thermography

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ABSTRACT

A fundamental factor in high performance sportswear is the thermo-physiological wear comfort. The sportswear is responsible to support the thermal comfort of the wearer and consequently the thermoregulation, which means helping in body's heat regulation by maintaining the skin temperature of 33°C and body's core temperature of 37°C. Each sport has its own requisites and rowing is no exception.

In the following investigation there were examined three different groups of water-repellent finished functional rowing shirts, featuring different knitting structures. The shirts were tested in a climatic chamber with a thermal manikin under constant conditions and afterwards analyzed using infrared thermography. The objective was to find out which sample shirts and knitting structures provide the best performance under different environmental conditions.

INTRODUCTION

Rowing is a periodic movement always repeating several phases. These phases are catch, drive, finish and recovery. One cycle of this periodic movement is called stroke. The stroke count gives the amount of strokes per minute. In order to provide a comfortable microclimate, sportswear design for rowing must always follow the principle that clothing should prevent the wearer to feel too hot or/and cold. A rowing shirt should then provide the following factors: Elasticity; Breathability; Fitting; Water-repellent; Moisture Transport; Windproof; Easy Care; Seamless; Pilling Resistance. Due to the high movement during the activity of rowing, the sport shirt need to have high elasticity. Even simple movements of the body like bending an elbow leads to a skin stretching of 50% (Shishoo, 2005). Breathability is also an important factor. Due to the maintenance of the core temperature of 37°C and the human perspiration, the textile material needs to be able to transport moisture to the outside. Less energy is wasted by cooling the body and the heart rate is lower if fabrics with good moisture transport are used. Consequently more energy is reserved for the rowing activity. Due to the fact that rowing is practiced in an outdoor area of water, like rivers or lakes, the rowing shirt needs to be water-repellent and wind shield. Wind can cool down the athlete causing a higher heat loss in thermoregulation using a high amount of energy. The high rate of movement, especially of the arm area, requires that the shirt should have a high pilling resistance due to the high abrasion rate during rowing. (Shishoo, 2005).

MATERIALS AND METHODS

With the purpose of developing a t-shirt for rowing, several t-shirts were produced with different structures and fiber compositions, as table 1 shows. The same machine and production conditions were used.

Table I. Composition and structure of each one of the t-shirts used in this study.

Code	Code in graphs	Composition	Structure
A	(1)	100% Cotton (CO)	Single jersey
B	(2)	60% Polyamide (black); 35% Polyester (grey); 5% Elastane (transparent);	Composition of structures in different areas used in t-shirt B1, B2 and B3
B1	(3)		False Rib 1
B2	(4)		False Rib 2
B3	(5)		Single jersey jacquard 1
D	(6)		Composition of structures in different areas used in t-shirt D1, D2 and D3
D1	(7)		Single jersey jacquard 2
D2	(8)	Single jersey jacquard 3	
D3	(9)	False Rib 3	

As reference, type A is a white shirt made with 100% cotton, with sewed side seams, round neck and long sleeves. Type B, C and D were produced with no side seams, tight fit due to the presence of elastane, raglan design and long sleeves. Due to the capabilities of full jacquard, Type B shirt contains the three different structures, B-1, B-2 and B-3. Other three shirts were made using exclusively one of the three B structures. The same was done for type D shirt. The first one contains the three structures D-1, D-2, D-3, in different regions, and three additional shirts were made using each one single structure. All t-shirts were treated with the same water-repellent finishing. The study was conducted using a climatic chamber at the Center of Textile Science and Technology of University of Minho. In order to reproduce the conditions in the climatic chamber similar to a rowing environment the selected country was Portugal, in particular the North of the country, specifically Oporto region, where the majority of rowing clubs exist, about 65% (<http://fluvialremo.no.sapo.pt>, 2014).



Figure 1. Images of t-shirts type B (left) and type D (right) under study and detail of the structures used.

It was considered two extreme climatic conditions, as shown in table 2. However, it was not possible to simulate the lower temperature with the climatic chamber, so an annual average temperature and humidity was used instead (<http://weather.com>, 2014).

Table 2. Climatic conditions selected for testing the t-shirts on the manikin inside the climate chamber. (A) and (B) refer to the conditions actually tested, since January's conditions were not possible to reproduce.

Month	Average Max. Temperature	Average Rel. Humidity
January	13.5°C	79%
July (A)	24.5°C	75%
Annual (B)	19.0°C	77%

A thermal manikin TM 3.2 / R 110 of PT-Teknik made in Denmark was also used in order to develop heat in a homogeneous distribution. This is a female model, selected because it is known that exist more variability regarding thermal behavior in the clothing of women compared to men. The Manikin was inside the climate chamber, placed around 0.1m above the floor with hanging arms and legs. The Manikin's temperature during the complete study was maintained at around 33 ± 0.2 °C. Each 5 minutes of the running tests a picture was taken with the infrared camera. As a common scale for both test series ranging from 23°C-35°C in order to compare the series properly.

RESULTS

Figure 2 illustrates two pictures taken during test series A and test series B. Pre-determined points were measured for comparison purposes.

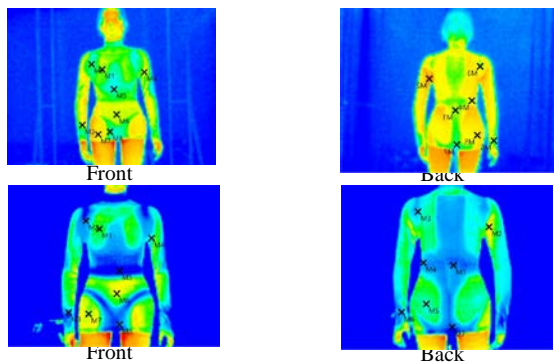


Figure 2. IR pictures for t-shirt code B, for test series A (top) and test series B (bottom).

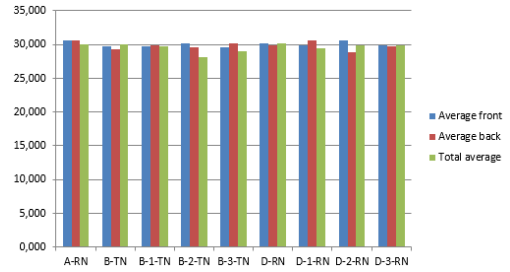


Figure 3. Average temperature of the t-shirts in test series A.

The difference between front and back is relatively equalized. In the front the highest number has sample D-RN and in the back B-TN. In general D-RN followed by B-TN and A-RN represent the hottest surface. Consequently it can be said that the mother shirts have the highest average of the temperature points. The coldest average stands for sample B2-TN.

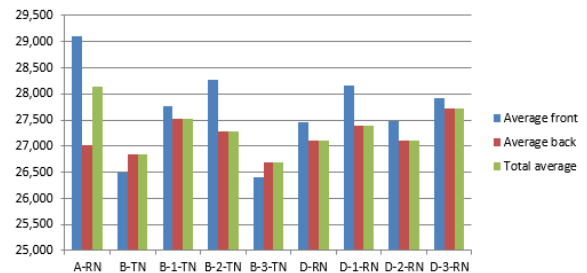


Figure 4. Average temperature of the t-shirts in test series B.

In series B one can observe high variations between front and back. By far the highest temperature reveals in the front part sample A-RN. T-shirt D3-RN has the highest temperature in the back part. The highest total average temperatures is A-RN. The coldest shirt is B3-TN in total as for the front and back part as well.

CONCLUSION

From the results obtained one can state that for weather conditions similar to summer, all t-shirts behave more or less the same, however, for a colder environment there are differences and the material as well as the structure used can be a factor of importance, retaining heat. The combination of different structures in the same t-shirt does not seem to be as important as initially hypothesized. However, one should consider the results for cold weather with care in further studies since it was not possible to simulate winter conditions.

ACKNOWLEDGMENT

This work is supported by Portuguese National Funding, through FCT-*Fundação para a Ciência e a Tecnologia*, on the framework of project UID/CTM/00264/2013.

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