On the Thermal and Pressure Characteristics of Sport Compression Garments

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Abstract. In this study, various knitted fabric structures were designed to help preventing muscular difficulties in sports. The samples, containing channels in widthwise direction, were produced by jacquard knitting technique. The effects of channel size and quilted inlay design were investigated in terms of pressure behaviour, thermal and water vapour resistance. Increasing of channel size and adding inlay yarns provided higher thermal resistance, as well as an increase in water vapour resistance, they also significantly affected pressure characteristics of samples.

1. Introduction

Sport is one of indispensable activities of daily life and it is becoming a more common living standard with increasing worldwide interest day by day. The sportive activities that constitute the basic building block of the healthy lifestyle dominated in our time have triggered the development of a unique production market. Textile products that are used in sports need to carry many features apart from casual wear. Generally, desired properties are comfort, freedom of movement, breathability, easy care, durability, body fit and lightness [1].

In addition to the “required performance characteristics” in sport textiles, the other important topic is “athlete's health”. As it is known, the human body is influenced by both the environmental factors and the risks in sport activity. Environmental factors occur usually with the effects of nature, such as weather conditions, cold and hot climates and sport field [2]. Risks of sportive activity are the extreme forces applied to the body during sports, such as various muscle and skeletal soreness, collision and falling. Especially in sports such as athletics, football and basketball, which require a high level of energy, the muscles are exposed to various difficulties.

Products with compression effect have both a performance boosting function and a protective function that allows the muscles to work more regularly. Compression products support the muscles with extra forces that are created from outside, tightly wrap the muscles to prevent more energy from vibrating and accelerate blood flow [3]. In addition to these effects, the use of compression products during pre-sports or during sports also increase muscle temperature. The warming of the muscles prolongs the muscular length for making the desired movement easier and the muscular reaction time is shortened in the nerves that control the muscles. Thus, the risk of muscle injury reduces.

During sport, the body produces excessive heat that will affect athlete’s health and durability. Therefore, the body should be in thermal balance to eliminate heat-load. In terms of thermal comfort, a successful product should transport heat, vapour and liquid sweat to the outside as fast as possible and
help to control the body's thermal balance. In addition, the sport product must perform different tasks depending on the ambient temperature [4].

This study aimed to investigate thermal comfort and pressure behaviour of special quilted knitted fabrics, which were designed to use in compression garments. The goals were compression effect that could support muscular systems and thermal insulation to warm muscles before or during sports.

2. Experimental

Fabric design (channel size) and inlay design are selected parameters for this investigation. Experimental design is given on Table 1.

| Fabric Type | Fabric design (channel size) | Inlay design |
|-------------|-----------------------------|--------------|
| A1          | 5 mm                        | Empty        |
| A2          | 7.5 mm                      | Empty        |
| A3          | 12.5 mm                     | Empty        |
| B1          | 7.5 mm                      | 1x1          |
| B2          | 7.5 mm                      | 3x1          |

In the scope of study, the transverse channelled fabric samples are knitted as raw material 150 denier PET, 70/40 Spandex yarns and as quilted inlay yarn 600 denier PET at Monarch VLEC 6SC E20 38” electronic circular knitting machine. Water vapour and thermal resistance of samples were tested in accordance with related standards by using Permetest. The pressure behaviour properties were determined by using Kikuhime pressure sensor with 25% reduction factor of pressure samples on a nonflexible cylinder (12 cm diameter).

3. Results and Discussion

Test results reporting the fabric characteristics, water vapour resistance, thermal resistance and pressure values are given in Table 2. Effects of channel size and inlay design on results were statistically evaluated and significant differences were determined (p<0.05). Analysis of variance tests (ANOVA) were applied by using SPSS software.

| Fabric Type | Thickness (mm) | Mass per area (g/m²) | Pressure value (mmHg) | Water vapour resistance (m²Pa/W) | Thermal resistance (m²k/W) |
|-------------|----------------|----------------------|-----------------------|---------------------------------|--------------------------|
| A1          | 1.52           | 312.17               | 12.36                 | 3.55                            | 0.0156                   |
| A2          | 2.03           | 321.62               | 12.90                 | 6.13                            | 0.0298                   |
| A3          | 2.58           | 340.36               | 10.75                 | 12.95                           | 0.0597                   |
| B1          | 2.46           | 456.68               | 19.40                 | 9.68                            | 0.0409                   |
| B2          | 2.62           | 520.45               | 21.70                 | 11.12                           | 0.0332                   |

Pressure is defined as force per unit area. According to the analytical results, while the large channelled samples showed the lowest pressure value, similar pressure properties were observed for other channel sizes. The inlay yarn design caused a systematic difference on pressure characteristic. As the number of inlay yarn increased, higher pressure values were measured.

Water vapour resistance is a measure of the water vapour transfer through fabric. The results stated that the samples with smaller channel size and without inlay yarn provided better water vapour permeability among all samples, since thicker and compact fabrics constituted a handicap for permeability.
Thermal resistance is a barrier effect for heat flow from one to another surface of fabric. Similar to water vapour resistance, thermal resistance of the fabrics with larger channel sizes increased as well. Also inlay yarns improved thermal resistance effect compared to empty fabric design.

4. Conclusion
This study aims to investigate the effects of knitting structure (channelled effect) and inlay design on pressure characteristics, water vapour permeability and thermal resistance in order to help preventing muscular difficulties in sports. The results revealed that bigger channel size constituted both higher water vapour and thermal resistance, but they had lower pressure values. Increasing of inlay yarn amount provided higher pressure values. While the thermal resistance of the fabrics with inlay yarns was increased, the water vapor resistance values were also increased.

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