

Effect of thermal and mechanical properties of yarn on the heat retention properties of socks

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Abstract: Many people suffer from cold toes, and socks with high heat retention properties are used as a solution. The aim of this study is to quantify the thermal insulation effect of different fibers used to make a sock. Acrylic, cotton, wool and polyester were used as the fibers in the socks and the temperature change over time was measured by placing the socks in a container of warm water. The results showed that the thermal properties of the material had a greater effect on the socks than the mechanical properties of the yarn used to knit them.

Keywords: Socks, heat retention, textile materials, yarn.

EXPERIMENTAL CONDITION AND METHOD

The temperature change of socks with a hot water bottle inside is measured over time. The socks are made of acrylic, wool, polyester, and cotton as the outer yarn, as shown in Table 1.

Table 1 Specification of socks

Upper thread	Material	Number of thread	Denier
A80N15W5	Acrylic 80% Nylon 15% Wool 5%	4	1000
W100	Wool 100%	1	1125
P100	Polyester 100%	4	1200
C100-20	Cotton 100%	6	1063
C100-30	Cotton 100%	4	1063

A hot water bottle is placed inside socks made from these five types of yarn, and temperature changes are observed using a thermocouple and an infrared camera. Figure 1 shows an infrared camera image as an example of the actual observations.

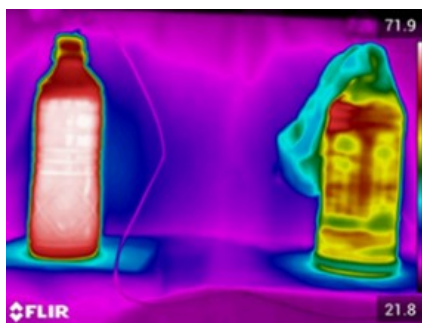
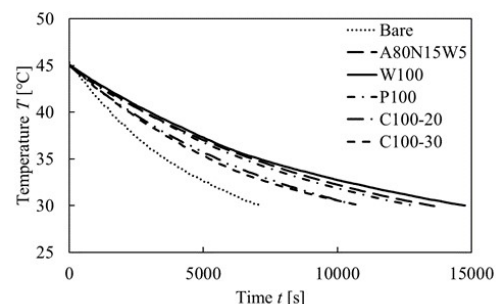
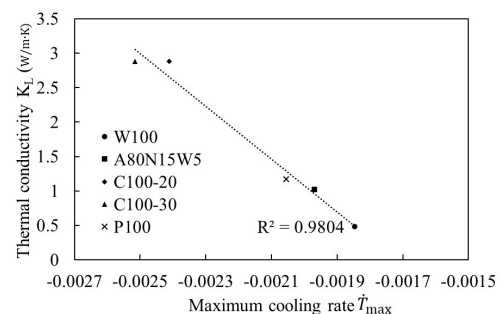


Figure 1 Photo of infrared camera

Figure 2(a) shows the results when the temperature $T(t)$ of five types of socks varied from 45°C to 30°C. These five samples draw curves in which the temperature changes are smaller than that of bare, which is not covered with socks. Among them, wool had the smoothest curve.



(a)



(b)

Figure 2 Temperature curve

RESULTS, DISCUSSION AND CONCLUSION

Figure 2(b) shows the relationship between thermal conductivity [1] and maximum cooling rate T_{\max} for each yarn material of the sample socks. Thermal conductivity was evaluated in two directions, one perpendicular to the fiber direction, and in both cases a relatively high correlation was observed between thermal conductivity and maximum cooling rate T_{\max} . Among the sock materials used in this study, wool showed the mildest temperature change, followed by acrylic. The effect of cotton socks, which are made from different yarn counts, was relatively small. The effect of mechanical properties was also small, but the loosening phenomenon was highly correlated among them.

REFERENCES

- [1] Niwa M.: *Apparel Science*. Asakura Publishing, 1997, pp.60-80