THE PHENOMENON OF SWEATING AND ITS EFFECTS ON WEARING COMFORT

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Abstract: The study of the effects of clothing on the thermoregulation of the human body is very complex because clothing or a clothing system, as a heat exchange layer between the body and the environment, must ensure a balance between heat production and heat dissipation in different environments and during different activities. The process becomes even more complex in case of sweating, when sweat evaporates and condenses, imbibed vaporous water making the clothing wet and thus restricting the dry heat flow. This work deals with the investigation of the influence of wet clothing as baseline clothing made of different functional textile structures - merino wool - on thermal resistance. The results show that the thermal conductivity increases with increasing amount of moisture absorbed into the textile structure, while the thermal resistance decreases with increasing amount of moisture.

Keywords*: Clothing, sweating, heat transfer, wearing comfort.*

The human body is continuously losing moisture, i.e. the human body produces a certain amount of sweat or saturated water vapour that must be gradually removed in order to maintain thermoregulation and a sense of thermal comfort. The water diffuses from the underlying skin layers to the skin surface and evaporates. Since heat is required to convert the liquid water into vaporous water, the loss of the diffused water cools the body.
When the body produces more heat than it can lose through the heat exchange between the human body and the environment, i.e. through the evaporation of the diffused internal water and through conduction, convection and radiation, insensible perspiration ceases and the body begins to sweat or produce sensible perspiration.
When vaporous and liquid water passes through a fabric, the fibres and trapped air in the interstices of the fabric can become loaded with moisture, reducing the insulating ability of the fabric. The water can be held in the fibres (absorbed water), on the surface of the fibres (adsorbed water) and in the interstices of the fabric (imbibed water), as shown in Fig. 1 [1, 2].

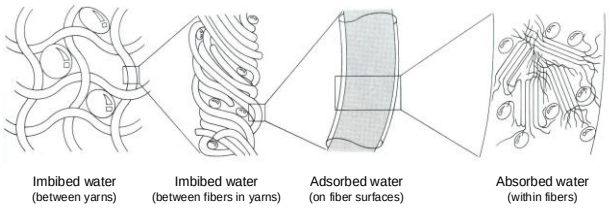

Figure 1 The location of liquid and vaporous water in a fabric [1].

Vapour water, which does not diffuse through the fabric, and liquid water, which is not transported through the fabric, is held in the material until it reaches its saturation point.
The water held in the fibres (absorbed water), on the fibre surface (adsorbed water) and in the interstices of the fabric (imbibed water) can have a considerable influence on the thermal resistance of the textile structure and the associated wearing comfort.
Sweating is an effective cooling mechanism in a warm environment, while it is less desirable in a cold environment (when sweating occurs as a result of physical activity, e.g. running in a cold environment).
This work deals with the investigation of the influence of moisture absorbed by clothing on thermal resistance. The study was carried out on the 15 baseline clothing, i.e. merino wool T-shirts.
The tests on the effect of the material properties of baseline clothing on the thermoregulatory responses of the human body in a cold environment were carried out under artificially generated climate conditions in a computer-controlled climate chamber.
The subjects performed the same physical activities for each test according to a predetermined protocol:

1) Environmental conditions:
   Ambient temperature T = 0° C; relative humidity RH = 60%; air velocity v = 1.0 ms-1
2) Protocol of the test exercises:
   5 min acclimatization under specific test conditions: at T = 0° C; RH = 60%; v = 1.0 ms^{-1}
   20 min running (v = 10.0 km/h)
   5 min resting at room temperature (sweating)
3) Clothing system: warm-up shirt, running shorts, socks, running shoes.

The results show that the thermal conductivity increases with increasing amount of moisture absorbed into the textile structure, while the thermal resistance decreases with increasing amount of moisture.

REFERENCES

[1] Hatch Kathryn L.: *Fibre Science*. Minneapolis: West Publishing Company, 1993.

[2] Grujić D., Geršak J., Ristić M.: Effect of physical and sorption properties of the fabric on the amount of the absorbed sweat in the garment (Utjecaj fizikalnih i sorpcijskih svojstava tkanina na količinu upijenog znoja u odjeći), *Tekstil*, 59 (2010) 3, 68-79.

[3] Geršak J.: Physiological responses of human body as criterion for estimating the thermal characteristics of a clothing system. Textile bioengineering and informatics symposium proceedings, Hong Kong, 2014, 934-945.