SYSTEMS OF TEXTILES LAYERS FOR PROTECTION FROM COLD

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EFFECT OF COLD ON THE THERMOPHYSIOLOGICAL REACTIONS OF THE HUMAN BODY

The human body is arranged as to maintain the same body temperature of about 35.7 to 37.2 degrees [12]. Person exposed to cold may suffer from direct tissue damage, such as frostbite, hypothermia or cold urticaria allergy. At low temperatures, the hypothalamus - a gland located in the brain - sends signals to the constriction of blood vessels. This to some extent prevents the loss of heat, but the limbs and skin remain not so protected. The vasoconstriction, as a protective reaction of the body against low temperatures, hinders the blood flow. The blood pressure increases, which is a risk for people with high blood pressure and predisposed to vascular events [10].

The main cold injuries that may occur are as follows:

Frostbite. Redness of the skin occurs, which then turns white; after a while scars appear, and frozen parts become bluish, the trembling arises, burning feeling that evolves in extreme pain appears, finally blisters with dark fluid cracking come into sight and the white cold and hard skin dies and turns black, tingling.

Light hypothermia effect. In the case of light hypothermia shivering, cold, pale and dry skin, as well as respiratory changes are observed: from hyperventilation to slow and shallow breaths; confusion (often), fatigue and drowsiness, impaired consciousness also appear.

Sever hypothermia effect. The severe hypothermia leads to stop shaking, loss of consciousness, loss of reflexes, slow heartbeat, muscle stiffness, possibly bruising of the lips, ears, fingers and feet [11].

Cold urticaria allergy. In this injury red and itchy pimples with tips on places exposed to the cold are observed. They usually disappear after about half an hour. Other signs for this injury are swelling of the hands when grasping cold objects, swelling lips when eating cold foods, in rare cases, severe swelling of the tongue and throat, which can block breathing. In more severe conditions the cold allergy can cause swelling, fever, rapid heart rate, swelling of the limbs or torso.**[**8, **9].**

Therefore when the human body is exposed to low temperature environment, it is necessary to provide respective protective clothing to prevent heat transfer between the body and the environment. The ensembles have to be good insulators, preventing the entry of cold air and water towards the body and reducing the transfer of heat from skin to the environment [10]

METHODS FOR HEAT TRANSFER AND HEAT LOSSES

As mentioned before, the human body is functioning properly in a narrow temperature range and the heat transfer from and to the environment is an important factor. It could occur in several ways [6]:

Conduction: the heat is transferred through direct contact from the body to the environment with lower temperature [7]. In the particular case this is the contact between the layers of clothing or contact between the human body and clothing [5].

Convection: the heat transfer is assisted by the mechanical movement of the molecules in the fluid [7]. According to the type of flow, the convective heat transfer can be classified as a forced, when the flow is caused by external agents, or "free", when the flow is caused by the temperature differences in the fluid [5].

Radiation: thermal radiation is emitted by all matter with non-zero temperature [5]. Thermal radiation should be transmitted in the form of electromagnetic waves and rely on heat transfer as conduction and convection, i.e. it can happen in vacuum and in fact is the most effective.

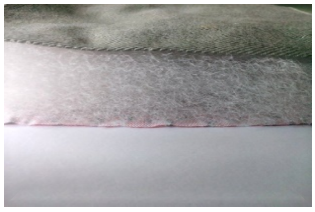
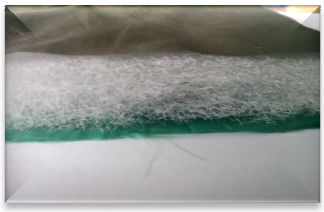
Evaporation / condensation: heat transfer may also occur due to phase changes of water, for example, evaporation and subsequent condensation of sweat.

In the case of clothing ensemble for protection from cold the convection can occur naturally or in a forced way, the transmission is from clothing to the environment[2]. Moisture from the body can be transported to the environment by diffusion, convection, adsorption, desorption, absorption, condensation and as a result of the difference of water vapor concentration [1]. Some fibers absorb water vapor due to internal chemical composition and structure of the constituent polymers [3,4]. In an environment with no wind, the free convection, as opposed to forced convection, is dominant. With respect to the air present in the layers clothing free convection observed at 12.7 mm, convection may occur in a layer - less than 8 mm, and is observed in a layer of 13 mm. Textile areas are considerably smaller than that i.e. convection is limited [5].

EXPERIMENTAL

An analysis of three types of garments for protection against cold is presented. Outerwear is made up of three layers: protection from wind layers, insolation layers and tactile comfort and aesthetic comfort layers. The systems of layers are presented in Table 1.

Table 1. System of layers, used in outerwear for protection from cold

		
System 1	System 2	System 3

The data analysis for Systems 1 - 3 are presented in Table 1. Each system is composed of a protection from wind layer A, insolation layers B and tactile comfort and aesthetic comfort layer C.

Table 2. Data for the studied samples

Layers	A_1	B_1	C_1	A_2	B_2	C_2	A_3	B_3	C_3
Thickness, mm	0.24	12.86	0.14	0.99	9.56	0.64	0.16	3.97	0.14
Weight, g/m^2	0,87	10.04	0.16	0.76	5.86	0.30	0.19	3.58	0.18
Warp density, threads/dm	380	-	288	232	-	280	348	-	432
Weft density, threads/dm	280	-	308	635	-	316	237		300
Weave	plain	-	twill	twill	-	plain	twill		plain
Fiber type	90/10% C/PU	100% PE	100% PE	100% C	100%PE	100% C	100% PE	100%PE	100% PE

The specific water permeability of the upper layers of the systems is visualized in Table 3. The analysis shows that Sample 1 has the best performing thermal insulation, it is suitable for the winter season, resistant to wind and rain. Sample 2 is suitable for warmer winter days, it is not suitable for rain protection.

Table 3. Water retain

sample A_1	sample A_2	sample A_3
		
Very difficult to absorb water	Easily absorbs water	Difficult to absorb water

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