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OPPORTUNITIES OF DIGITAL PRODUCTION TO SUPPLY ARCTIC MILITARY SERVICES FOR THEIR EXECUTION OF THEIR OBLIGATIONS MESSAGE 1

Abstract: *In the article, the authors, using the software they have developed, confirm the possibility of using a package of materials for a reasonable choice of a package of materials in the manufacture of a suit for servicemen in the Arctic. Also, this opportunity guarantees servicemen comfortable conditions and the performance of their duties without prejudice to their health.*

Key words: *software product, package of materials, comfort, suit, accessories, convenience, time spent in an area with high temperatures, climatic chambers, thermal conductivity coefficient.*

Language: *English*

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Introduction

UDC 685.54: 519.14

Analysis of the existing mathematical models of the thermal state of a person under the influence of environmental parameters makes it possible to presumably determine the shape of the elements of the human body, which can be divided into the following sections: head - ball; arms, legs - cylinders; the torso is a set of elliptical cylinders - that's a rough approximation.

Thus, a person can be represented as a collection of geometric shapes.

The concept of mathematical formation of the foot is based on its representation for shoes as a set of multilayer packages of materials of various shapes and compositions. Using the 3D Studio MAX 5 program, a geometric image of a human foot was built.

Main part

The main factors affecting the temperature of the interior of the suit space when constructing a mathematical model are the ambient temperature, the heat generation of the human body, the thermophysical properties of the materials that make up the bags, the shape of these bags and the heat transfer from the outer surface of the suit to the environment.

The main criterion for a person's comfortable state is the value of the temperature of the inner suit space in the range from 21 to 25 ° C. At the same time, when a person is exposed to low temperatures, as a rule, perspiration of a person is not taken into account due to its small effect on the heat exchange process. At elevated ambient temperatures, the main role in maintaining a constant body temperature belongs to the skin, through which heat is transferred through radiation, conduction and evaporation. When the temperature of the surrounding air coincides with the temperature of the human body, heat transfer is carried out mainly due to perspiration (evaporation of 1 liter of water leads to a heat loss equal to 580 calories). Therefore, at high humidity and high air temperature, when evaporation of sweat is difficult, overheating of the human body most often occurs. Such cases occur when working in tight, unventilated clothing and, especially, in protective chemical suits. In this regard, it is very important to take into account sweating when designing a suit that provides the necessary time for a comfortable stay in high temperatures.

The indicators characterizing the thermal state of a person include body temperature, skin surface temperature and its topography, heat perception, the amount of sweat produced, the state of the cardiovascular system and the level of performance.

The human body temperature characterizes the process of thermoregulation of the body. It depends on the rate of heat loss, which, in turn, depends on the temperature and humidity of the air, the speed of its movement, the presence of thermal radiation and the heat-shielding properties of clothing. Performing work of categories Pb and III is accompanied by an increase in body temperature by 0.3 ... 0.5 ° C. When the body temperature rises by 1 ° C, the state of health begins to deteriorate, lethargy, irritability appear, the pulse and breathing become more frequent, attentiveness decreases, and the likelihood of accidents increases. At a temperature of 39 ° C, a person may faint.

The temperature of the skin of a person who is at rest in comfortable conditions is in the range of 32 ... 34 ° C. With an increase in air temperature, it also grows to 35 ° C, after which sweating occurs, limiting a further increase in skin temperature, although in some cases (especially with high air humidity) it can reach 36 ... 37 ° C. It was found that when the temperature difference in the central and peripheral parts of the body surface is less than 1.8 ° C, a person feels heat; 3 ... 5 ° C - comfort; more than 6 ° C - cold. As the air temperature rises, the difference between skin temperature in open and closed areas of the body also decreases.

The software product is written using applied mathematical packages MAPLE and is designed to calculate the distribution of temperature and partial pressure in the process of heat and mass transfer in the system "person - clothes - shoes - environment" for a flat package of materials, in the case when a person is in a climatic environment with high temperature.

Let us introduce the following notation:

T_c - ambient temperature (° C);

U_c - partial pressure of moisture vapor in the environment (mm Hg);

t - time (h);

x_i - coordinate i – th layer of the package (m), $l_{i\ 1} < x_i < l_i$;

$l_{i\ 1}; l_i$ - boundaries i – th layer of the package;

$T_i(x_i;t)$ - temperature i – th layer of the package (° C);

$U_i(x_i;t)$ - partial pressure of moisture vapor for i – th layer of the package (mm Hg);

$T_i(x_i;t) = T_i(x_i;t)\ \ T_c$ - relative temperature i – th layer of the package (° C);

$U_i(x_i;t) = U_i(x_i;t)\ \ U_c$ - relative partial pressure of moisture vapor for i – th layer of the package (mm Hg);

λ_i - coefficient of thermal conductivity i – th layer of the package (W / (m · ° C));

d_i - vapor permeability coefficient i – th layer of the package (kg / (m · h · mm Hg));

$a_{11}(i)$ - thermal diffusivity i – th layer of the package (m2 / h);

$a_{22}(i)$ - vapor diffusion coefficient i – th layer of the package (m2 / h);

$a_{12}(i)$ - diffuse thermal conductivity coefficient i – th layer of the package (m2 / h);

$a_{21}(i)$ - vapor thermal diffusion coefficient i – th layer of the package (m2 / h);

$q(t)$ - heat flux density of the foot (W / m²);

$M(t)$ - the flow density of the mass of moisture released by the human body (kg / (m2 · h));

α - heat transfer coefficient (W / (m2 · ° C));

β - mass transfer coefficient (kg / (m2 · h · mm Hg));

The system of equations for describing the process of heat and mass transfer in the system "man - clothes - shoes - environment" has the following form

$$\frac{\partial T_i}{\partial t} = a_{11}(i)\frac{\partial^2 T_i}{\partial x_i^2} + a_{12}(i)\frac{\partial^2 U_i}{\partial x_i^2};$$

$$\frac{\partial U_i}{\partial t} = a_{21}(i)\frac{\partial^2 T_i}{\partial x_i^2} + a_{22}(i)\frac{\partial^2 U_i}{\partial x_i^2},\ i = 1,2,\ldots n\ldots$$

The following boundary conditions are considered.

The heat flux of the human body entering the inner surface of the suit is $q(t)$

$$\lambda_1 \frac{\partial T_1}{\partial x_1}(0,t) + q(t) = 0;$$

The flux density of the mass of moisture released by the human body is $M(t)$

$$d_1 \frac{\partial U_1}{\partial x_1}(0,t) + M(t) = 0;$$

Heat transfer on the surface of the suit occurs according to Newton's law

$$\lambda_n \frac{\partial T_n}{\partial x_n}(l_n,t) + \alpha T_n(l_n,t) = 0;$$

The sole of the suit is waterproof, which is expressed on its inner surface by the equality:

$$\frac{\partial U_n}{\partial x_n}(l_{n\ 1},t) = 0;$$

ideal contact is assumed between the layers of the bottom of the shoe, which is expressed by the mating conditions at the joints:

$$T_{i\ 1}(l_{i\ 1},t) = T_i(l_{i\ 1},t),$$

$$\lambda_{i\ 1}\frac{\partial T_{i\ 1}}{\partial x_{i\ 1}}(l_{i\ 1},t) = \lambda_i \frac{\partial T_i}{\partial x_i}(l_{i\ 1},t),\ i = 2,\ldots n,$$

$$U_{i\ 1}(l_{i\ 1},t) = U_i(l_{i\ 1},t),$$

$$d_{i\ 1}\frac{\partial U_{i\ 1}}{\partial x_{i\ 1}}(l_{i\ 1},t) = d_i \frac{\partial U_i}{\partial x_i}(l_{i\ 1},t),\ i = 2,\ldots n\ldots$$

Initial conditions:

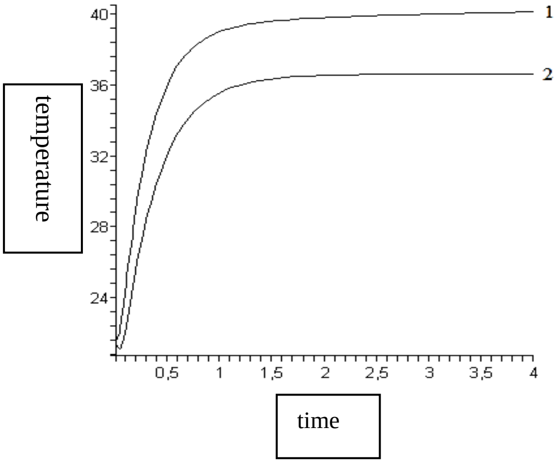
$$T_i(x_i,0) = f_i(x_i)\ U_i(x_i,0) = g_i(x_i)\ \ i = 1,2,\ldots n$$

As an example, consider the theoretical calculation of heat and mass transfer through the sole of a shoe at an elevated ambient temperature of 40 ° C. The characteristics of the package of materials for the bottom of the shoes are shown in table 1.

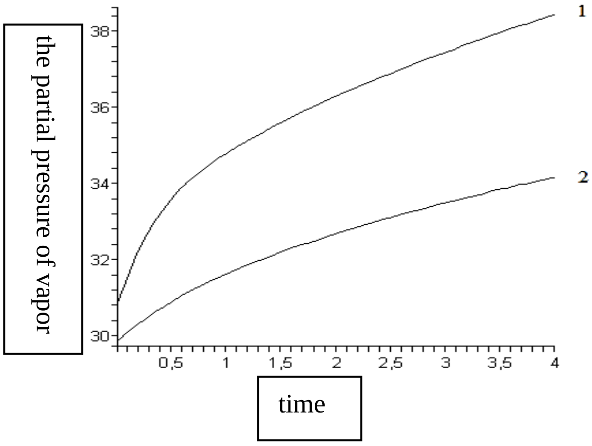
Table 1 - Characteristics of the package of materials for the bottom of the shoe

Layer no.	Layer material	Layer thickness (mm)
1	Cotton sock	2
2	insole	5
3	cardboard	1.8
4	sole	10

The heat flux density of the foot is 10 W / m2, the density of the mass of moisture emitted by the foot is 0.02 ((kg / (m2 · h)). The results of calculations of changes in temperature and partial pressure of vapors of the intra-shoe space are shown in Figures 1 and 2, on of which curve 1 - for bags of materials for the bottom of shoes used as a sole non-porous waterproof rubber; and curve 2 - for a package of materials for the bottom of shoes, when a material made by nanotechnology and having the ability to ventilate, i.e. to air exchange in the shoe space.



a



b

Figure: 2. Characteristics of the shoe space:
***a*- temperature**
***b* - partial vapor pressure Conclusion**

Thus, the development of a software product for the formation of comfortable conditions for a person when he is in a climatic environment with an elevated temperature will for the first time make it possible to make a reasonable choice of a package of materials for a suit in order to realize these very conditions of comfort and significantly improve working conditions for a person in extreme conditions.

If the software for justifying the choice of packages of materials for clothing and footwear in the formation of comfortable conditions for a person who is in climatic zones with a low temperature is due to control over a decrease in the temperature of the inner suit space to 21 ° C for the foot and to 31 ° C for the human body, which were into the developed software with a reasonable choice of a package of materials taking into account thermophysical characteristics, then when developing software for a reasonable choice of packages of materials for a person in climatic zones with elevated temperatures, the problem was solved differently, namely, based on the need to control to prevent an increase in body temperature person.

This is due to the fact that an increase of 0.3-0.5 C already forms a person's discomfort, and with an increase over 1 C, this excludes his being in these conditions. Consequently, packages of materials and a suit made of them must guarantee a person the fulfillment of these requirements during the entire time he is in these conditions.

References:

1. Prokhorov, V.T., et al. (2017). *The concept of import substitution of light industry products: prerequisites, tasks, innovations:* monograph. under the general editorship of Doctor of Technical Sciences. Sciences, professor V. T. Prokhorov; Institute of Services and Entrepreneurship (branch) of the Don State Technical University. (p.334). Mines: ISOiP (branch) DSTU.
2. Surovtseva, O.A., et al. (2018). *Management of the real quality of products and not advertising through staff motivation behavior of the head of a collective enterprise of light industry*: monograph. Under the general editorship of Doctor of Technical Sciences. Sciences, professor V. T. Prokhorov; Institute of Services and Entrepreneurship (branch) of the Don State Technical University. (p.384). Novo-Cherkassk: USU (NPI).
3. (1975). *Hegelian Encyclopedia of Philosophical Sciences*, T. 1. Science of Logic: Translation from English Djeman. (p.452). Moscow: "Thought".
4. Engels, F. (1961). *Anti-Dühring*. K. Marx and Friedrich E.: sobbing. archive: Ed. (p.827). oscow: Gospolitizdat, t. 20.
5. Aleshin, B.S., Aleksandrovskaya, L.N., Kruglov, V.I., & Sholom, A.M. (2004). *Philosophical and social aspects of quality*. (p.438). Moscow: Logos.
6. Ricardo, D. (1955). *The beginning of political economy and taxation*. Coll. Op. in 3 t, gt 1, (p.360). Moscow: Gospolitizdat.
7. Galbait, J. (1969). *New industrial society*. (p.480). Moscow: Progress.
8. Hanika, F. de P. (969). *New ideas in the field of management*. (p.124). Moscow: Progress.
9. Beer, S. (1965). *Cybernetics and Production Management*. (p.287). Moscow: Nauka.
10. Aleshin, B.S., et al. (2004). *Philosophical and social aspects of quality*. (p.438). Moscow: Logos.
11. Adler, Yu.P., et al. (1999). What is the coming century for us? (Management of the 21st century - a brief overview of the main trends). *Reliability and quality control*, No. 1
12. Boytsov, B.V., et al. (2007). *Concept of quality of life*. (p.240). Moscow: Academy of quality problems.