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FEATURES OF CLOTHING HEAT BALANCE CALCULATION UNDER HIGH TEMPERATURES

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Annotation:
The basis of the hypothesis about the need to select clothes for workers in terms of heat resistance depending on energy consumption when performing work at different temperatures of the air while maintaining the heat balance is outlined.

Key words: Thermal resistance, heat balance, microclimatic conditions, energy consumption during operation .

The world practice of predicting human heat sensations in conditions created in residential and industrial premises is based on the calculation of the heat balance, that is, the balance between heat production and heat loss of the human body during heat exchange with the environment. The American[11] and European[12] standards for thermal environment ergonomics are based on this principle. In domestic practice, a strict, a priori sanitary and hygienic rationing [1] of microclimatic parameters has been adopted, justified in the standard for air quality in the working area [4].

Of course, the first principle seems to be more preferable, however, the direct replacement of domestic standards with Western analogues seems inappropriate due to the internal insufficiency of calculations [11] and [12], which practically do not take into account the adaptive capabilities of the body when performing work of varying severity (with various total energy costs).) and under different environmental conditions. The adaptive responses of the body have been the subject of numerous studies (for a review, see, for example, in [7]), serious developments in this area belong to domestic authors.

It seems expedient to modify the norms for the microclimate of industrial premises [1] on the way of combining Western methods for calculating the heat balance and domestic results of the study of physiological reactions aimed at maintaining the optimal thermal state of a person. Generalization and systematization of the results of domestic research on the physiological indicators of the optimal and permissible thermal state of a person when performing work of various categories of severity is given in [5].

These data are used below in calculating the heat balance of the human body. Human energy metabolism consists of three components: basal metabolism, food thermogenesis and energy expenditure for physical activity. Energy production. The main metabolism is usually called the intensity of energy release in the body in conditions of mental and physical rest. This is due to the constantly active state in which the brain, heart, respiratory muscles, liver and kidneys are located. The average intensity of basal metabolism in an adult can be taken equal to 1800 Kcal/day, which corresponds to a power $W_o \approx 90$ W.

Nutritional thermogenesis is the energy used to absorb, digest, and assimilate food. The magnitude of food thermogenesis is regulated by the sympathetic nervous system, it depends on the time of day, the composition of the food, and the physiological characteristics of the body. On average, food thermogenesis is W1 ≈ 10% of all daily energy costs [2].

When calculating, it is possible to include the value of W1 in the composition of the main exchange by increasing the power Wo to a value of ≈ 100 W. The rate of release of total metabolic heat Wpol (total energy release from all sources) differs from the basic metabolism by the amount of additional energy Wadd associated with muscle activity: Wpol = Wo + Wadd.

In this case, part of the energy of chemical transformations is used for the synthesis of ATP and a certain proportion of the energy of ATP decay goes directly to muscle contraction. The main part of the additional energy Wadd is dissipated in the form of heat. The mechanical power developed by the muscles Wmech is the fraction η = Wmech / Wadd, which can be conditionally called the "efficiency factor" of the muscles. The value of η varies from person to person, depends on the general state of the body and the type of mechanical work [6]. For walking and running (at low speed) $\eta \approx$ (20-30)%, for lifting and carrying weights $\eta \approx$ (10-15)% . Let's accept for the further η = 20 % .

If we are only interested in the heat Wtherm released at a certain level of muscle activity, its estimate can be obtained from quite obvious relationships thermal power generated by the body, while taking into account the following types of heat loss: pulmonary heat loss, heat loss associated with sweating and evaporation of sweat, conductive heat transfer from the surface of the body and clothing, and thermal radiation from the surface of clothing[16]. The body can regulate (within certain limits) the intensity of heat loss through various channels and "turn on" them in various combinations, depending on the situation: the intensity of work, environmental parameters, the degree of thermal insulation of the body, etc. Lung heat exchange.

The physiology of respiration is described in detail in many works (see, for example, [9]). Heat and moisture exchange during respiration is a complex process in which the inhaled air is moistened and warmed (or cooled) in the upper respiratory tract, and the exhaled air is dried and cooled (or heated). The process is almost cyclical. Heat losses during respiration are due to deviations from cyclicity - the partial pressure of water vapor in the exhaled air is greater than in the inhaled air, and the latent heat of vaporization is spent on this. The quantitative dependence of the rate of moisture loss during respiration on meteorological parameters (air temperature and humidity), as well as on the physiological characteristics of the body (respiratory rate, tidal volume) was studied in the work.

The authors calculated a multiple linear regression dependence of moisture loss. In the book [7], this formula was recalculated to the parameters directly included in the balance equations, that is, for the dependence of heat loss during breathing Wleg on the intensity of muscle activity and air parameters - temperature ta and absolute humidity aa: Wleg = Wp*$\gamma(\omega)$*[1- ta /tp - aa /ap - $\gamma(\omega)/\gamma p$]. (2) Here, the p index marks the quantities characteristic of pulmonary heat transfer that determine heat loss: Wp = 31 W, tp = 164 °C, ap = 56 g/m3, γp = 12. The proportion of additional energy release due to muscle activity is denoted by ω: ω = Wadd/Wo , and the function $\gamma(\omega) = 1 + \omega*(0.5 + \omega)$ interpolates an increase in the rate of pulmonary ventilation with an increase in muscle activity.

The value of Wleg should be subtracted from the thermal power Wtherm when calculating heat losses from the body surface. It is during heat exchange at the skin-inner surface of the clothing that the power Wpol - Wleg should be removed. Recalculating the power per unit surface of the body, we obtain the heat flux density Jko = (Wtherm - Wleg)/S. (3) Here S ≈ 2 m2 is the surface area of the body of an adult. The flow with density Jco should be provided by conductive skin-clothes heat exchange. Conductive heat transfer leather clothing. The flow Jco of heat through the clothes is determined by the temperature difference between the skin tc and the surface of the clothes tc and the thermal resistance of the clothes Iclo : Jco = (tc - tc) / Iclo. (4) In hygienic studies, it is customary to express the value of thermal resistance of clothing in dimensionless units Clo.

The relationship between the values of Iclo and Clo is given by the relation Iclo = ι*Clo, (5) where ι = 0.155 °C*m2 / W is the coefficient for converting conventional units of Clo into the actual thermal resistance of clothing. The standard [12] gives characteristic values of thermal resistance both for individual items of clothing and for various sets. The Clo value varies from tenths of a unit (shorts, T-shirts, summer skirts) to units (coats, down jackets, quilted overalls). If the clothes are multi-layered (for example, underwear + outerwear + coat), then the thermal resistance of each layer is added up so that the total resistance can be several units of Clo. Heat loss from the surface of clothing. Conductive and radiative heat exchange channels operate on the clothing surface.[14]

Calculations by the proposed method can be extended to a wider range of air temperatures and energy consumption. The calculation results are given in Table.

2. As in the example discussed above, it was assumed that the air velocity was 0.1 m/s and the humidity was 40%. The radiation temperature was assumed to be equal to the air temperature. The left column of the table shows the values of the total energy release during the performance of work. The top line shows the air temperatures at which this work is done. The thermal resistance of clothing (in Clo units) is given in cells at the intersection of the corresponding rows and columns. The area in the upper left corner of the table is bounded by a double line, occupied by thermal resistance values that are too large for ordinary clothing. They should be excluded from consideration. Also excluded is a limited area with negative values of thermal resistance in the lower right corner of the table.[17]

Between these areas lie the values of the determining parameters (energy release and air temperature), for which the selection of suitable clothing can provide comfortable working conditions. In the middle part of this area, cells are shaded, in which the optimal (according to [1]) microclimate standards are met at the workplaces of industrial premises. The area of optimal microclimate parameters is located in the zone where it is possible to select clothes to create comfortable conditions. The last zone, however, is much wider than the region of optimal parameters. This means, in particular, that the selection of clothing can compensate for the influence of suboptimal both low and high temperatures and make working conditions comfortable without spending money on heating or cooling air in industrial premises.[15] Similar results can be obtained for acceptable microclimate parameters in industrial premises.

Conclusion

The main result, which follows from the consideration of the heat balance of the human body performing work with a given energy release, is to demonstrate the possibility and effectiveness of combining calculation methods adopted in Western standards and domestic developments in the field of studying changes in physiological parameters (weighted average skin temperature, moisture loss etc.) during muscular activity.

The systematization of the body's heat exchange channels with the external environment, in particular, the inclusion of pulmonary heat loss and heat loss during sweat evaporation into the system of balance equations made it possible to clarify and expand the boundaries of the area of determining parameters (energy release and air temperature), in which the selection of suitable clothing can provide comfortable working conditions. It seems appropriate to continue research in this direction in order to clarify, in particular, the limits of permissible values of the determining parameters of work.

REFERENCES:

1. Hygienic requirements for the microclimate of industrial premises. SanPiN 2.2.4.548-96.
2. Dietology / A.Yu. Baranovsky. S.-Pb.: Peter, 2008.
3. Ivanov K.P. etc. Physiology of thermoregulation. L.: Nauka, 1984.
4. General sanitary and hygienic requirements for the air of the working area. GOST 12.1.005-88 SSBT.
5. Guide to occupational health / N.F. Izmerov. M.: Medicine, 1987.
6. Solodkov A.S., Sologub E.B. Physiology of sports. S.-Pb.: GAFC im. P.F. Lesgaft, 1999.
7. Timofeeva E.I., Fedorovich G.V. Ecological monitoring of microclimate parameters. M.: NTMZaschita, 2007.
8. Fedorovich G.V. // Med. labor. 2010. No. 7. S. 41-44.
9. Physiology of respiration / I.S. Breslav, G.G. Isaev. S.-Pb.: Nauka, 1994.
10. Kasimova, A. B., Shomansurova, S. M., Pulatova, L. B., Pulatov, M. Z., & Temirova, G. (2022). CREATION OF ELASTIC KNITTED FABRICS WITH SHAPE RESISTANCE INDICATORS. Journal of Positive School Psychology, 5884-5888.
11. ASHRAE Standard 55, Thermal Environmental Conditions for Human Occupancy: International Standard.
12. Ergonomics of the thermal environment - «Analitical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria» ISO 7730:2005(E).
13. Ergonomics of the thermal environment - «Instruments for measuring physical quantities» ISO 7726:1998(E).
14. Abdurakhmanova, N. D., Yunuskhojaeva, H. M., & Mirtolipova, N. K. (2022). Development of a package of materials for women's uniforms of law enforcement agencies. Academicia: An International Multidisciplinary Research Journal, 12(5), 80-83.
15. Xasanxodjayevna, M. N. (2022, September). METHOD OF TEACHING STRUCTURAL AND COMPOSITIONAL DESIGN FOR A CLOTHING DESIGNER. In Conference Zone (pp. 75-77).
16. Nigmatova, F., Maksudov, N., Kasimova, A., & Shin, E. (2018). Compression Clothes for Sports-Critical. International Journal of Advanced Research in Science, Engineering and Technology, 5(12).
17. Vakhidova, U. A., Ibragimova, Z. I., & Apakhodjaeva, T. U. (2020, December). Estimation of the temperature and humidity kinetics during the passage of vaporous moisture through textile materials. In IOP Conference Series: Earth and Environmental Science (Vol. 614, No. 1, p. 012024). IOP Publishing.
18. Rakhmatullaeva, U. S., Mirziyodova, K., Kamolova, F., & Berdieva, C. (2022, February). ANALYSIS OF THE SYMBOLOGICAL SIGNIFICANCE OF THE HISTORY OF THE NATIONAL SKULLCAP BY REGION AND ITS REGULARITIES. In Conference Zone (pp. 302-305).