CALCULATION OF LEVEL OF COMFORT OF THE MICRO-CLIMATE IN BUILDINGS DURING THE ESTIMATION OF THE ENERGY-SAVING MEASURES

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Abtract. The article describes the method of valuation of comfort of microclimate of residential, public and administrative buildings. The method is based on calculation of the coefficient of thermal comfort of a person in the room. Further amendments are introduced to the asymmetry of the thermal radiation, radiation cooling and air quality. The method serves as the basis for a computer program.

In modern Russia the realization of energy-saving measures for increasing the effectiveness in the use of fuel-energy resources is urgent task. For the estimation of effectiveness energy-saving measures different methods are used: conducting full-scale experiments and tests, the mathematical simulation of building as unified power system and the determination of energy consumption during the characteristic periods of the time, the analysis of the results of applying the analogous energy-saving measures in the systems of the power supply of buildings, the use of data of producers about the effectiveness of energy-saving measures and also the express- methods. The use as the criteria of effectiveness only of economic indices (Payback Period (PP), Net Present Value (NPV), Internal Rate of Return (IRR) a.o.) is a large drawback in the utilized methods of the estimation of effectiveness energy-saving measures. However, the practice of the introduction of energy-saving measures shows that frequently the imposing of thermal isolation and sealing the buildings, which are the most popular measures for the savings of thermal energy, lead to reduction in the comfort of microclimate in the accommodations. This leads to reduction in the fitness for work and worsening in the health of people, which are located in the building. Therefore arose the need of developing the new method of the estimation of the effectiveness of energy-saving of measures, considering both the economic indices measures and the level of the comfort of the microclimate before and after of the realization of energy-saving measures.

In the article [1] it is shown that the utilized methods of evaluating the comfort of microclimate have deficiencies: majority of them can be used only for the accommodations of production buildings, the range of the parameters is limited. For the habitable, public and office building in Ivanovo State Power University named after V.I. Lenin was developed the more universal method of determining of comfort of microclimate in accommodations of buildings.

The calculation of the coefficient, which characterizes the state of the thermal comfort of man in the accommodation is the basis of the method of evaluating the comfort of microclimate in the ac-

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commodations of buildings. Then amendments on asymmetry of thermal radiation, radiation cooling and quality of the air environment (the content of carbon dioxide), characteristic for residential, public and office buildings, are entered

The determination of the level of comfort includes the series of stages. At the first stage define type and characteristics of the works which are carried out in the surveyed room: heat of a metabolism of the person, (q_m); efficiency of mechanical work (η); relative speed of the movement of the person in motionless air (w_o). The thermal resistance (R_0) of the clothing of people, which are located in the accommodation is determined according to reference data [2]. In the second phase of work is measured: air temperature (t_a); relative humidity (φ); the surface temperature of clothing (t_c); air speed (w); the temperature of surfaces ($t_{s,i}$); the concentration of carbon dioxide (CO_2) in air of accommodation (C_n) and in the surrounding air (C_o). Maximum ($t_{s,max}$) and minimum ($t_{s,min}$) temperatures of the surfaces of accommodation then are selected.

On the third stage of calculation of level of comfort the parts of the equation of the heat balance of man employing the procedure, proposed in [2, 3, 4], find.

The heat flux, which exits from the body surface of man, is calculated from the formula:

$$q_e = q_b - q_d - q_{ss} - q_{lr} - q_{ar}, \qquad (1)$$

q_b – the heat generated by the human body; q_d – the loss of heat through the skin in the diffusion of water vapor; q_{ss} – heat loss from the skin surface by evaporation of moisture; q_{lr} – latent loss of heat during respiration; q_{ar} – apparent loss of heat during respiration.

Heat flux with the assigned parameters of microclimate radiated by the human body is calculated from the formula:

$$q_f = q_{rad} + q_{cnv}, \qquad (2)$$

q_{rad} – radiant heat flux; q_{cnv} – convective heat flux. Values q_{rad} and q_{cnv} are calculated from the known empirical formulas [4, 5].

Calculating equations 1 and 2, calculates the state of the thermal comfort of man in the accommodation:

$$k_1 = (-1)^n \left[1 - \frac{|q_e - q_f|}{q_e} \right], \qquad (3)$$

n = 1 if $q_e < q_f$ ($k_1 < 0$ lack of heat) and n = 2 if $q_e \geq q_f$ ($k_1 > 0$ excess heat).

Coefficients to account for radiative cooling, asymmetry of heat fluxes and quality of air k_2, k_3 и k_4 are introduced into the calculation/

The estimation of the radiative cooling of the human body (coefficient k_2) is carried out in the value of the radiant thermal flux, which exits from the body surface of man to the coldest surface of the accommodation:

$$k_2 = \frac{q_e - q_{rad,m}}{q_e}. \qquad (4)$$

$q_{rad,m}$ – radiant heat flux, radiated to the coldest surface of the accommodation.

The calculation of the asymmetry of the heat flows (coefficient k_3)is based on empirical formulas derived S. Olesen, A.P. Fanger a.o. [2]:

$$k_3 = 1 - 0,01(0,17\Delta t_a^2 + 0,72\Delta t_a - 2,12). \qquad (5)$$

Δt_a – the temperature difference between the warmest and the coldest room surfaces, ^{0}C.

Coefficient k_4, determines the quality of air is calculated by the excessive concentration of carbon dioxide (CO_2) in the room:

$$k_4 = -0,00045C + 1,18, \qquad (6)$$

C – excessive concentration of carbon dioxide in the room, ppm.

Since the calculation of equations (1), (2) and coefficients k_2, k_3, k_4 requires a lot of time, has developed software programs to calculate the level of comfort of microclimate.

Described in the article the method of evaluating the microclimate of comfort in residential, public and administrative buildings, as well as developed on the basis of its computer program, that can be used to assess the effectiveness of energy saving measures.

References

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