Determination of the amount of internal heat input in the office space

Anastasia Frolova
Moscow State University of Civil Engineering, Yaroslavskoe shosse, 26, Moscow, 129337, Russia

E-mail: FrolovaAA@mgsu.ru

Abstract. A feature of office buildings is the presence in them of constant internal heat inputs during working hours, which, in accordance with the current standards for thermal protection of buildings [1], are not taken into account when determining the required value of the heat transfer resistance of the building envelope. However, they perform an important role in the choice of thermal protection of a building and directly affect the energy consumption of systems for maintaining the internal microclimate of premises [2-20]. The purpose of this study is to confirm the presence of internal heat gains (technological and household) during the day and year at a level close to the studied level [2-4] and the correctness of maintaining a given temperature regime in office premises, in which internal heat gains are known during the working day.

1. Object of research

The object of the research was an office space located in a three-storey mezzanine building in a one-storey warehouse building located in the Moscow region. The considered premises are located at elevation +5.120 on the intermediate 2nd floor in the axes G– II/23–26. The area of the room is 104.67 m². There are offices above and below. Figures 1 and 2 show the general plan of the building and a fragment of the plan with rooms for the experiment. Considered room has one longitudinal external wall with one window. Partitions along the G and II axes separate the investigated room from similar ones, and along the 23 axis from the warehouse.

The external walls of the building are made of Fachmann wall sandwich panels with insulation in the form of slabs of Thermo mineral wool with a thickness of 0.12 m and a coefficient of thermal conductivity of 0.049 W/(m²·°C) under conditions of thermal and humidity operation. Panels with factory-built double-glazed windows in PVC sashes with a total heat transfer coefficient of 1.85 W/(m²·°C) (according to the project). The external wall with a window is oriented towards the north side of the world. Windows have internal light-colored fabric sun shades curtains. Размер окна: ширина 11,0 м. Высота 1,0 м.

The division walls are made of two sheets of plasterboard with painting, between which are laid slabs of mineral wool 0.12 m thick with a thermal conductivity of 0.042 W/(m²·°C). Intermediate ceilings (floor and ceiling structures) - monolithic reinforced concrete slab 0.125 m, sound insulation 0.03 m made of mineral wool, cement-sand screed 0.03 m and floor tiles 0.01 m thick. The total resistance to heat transfer of floors is 0.95 m²·°C/W.
Figure 1. Building plan at elev. +5.120 research object

Figure 2. Fragment of the building plan at elev. +5.120 research object
Since offices with approximately the same microclimate as in the investigated room are located below and above, as well as on the right and left, the heat flows through the floor, ceiling and two transverse partitions of the investigated room are considered to be in the range of the measuring error.

In the warehouse adjacent to the investigated premises, an air temperature of 18 ± 0.5 °C is maintained throughout the year.

The lighting in the room is arranged using built-in lamps in the false ceiling with fluorescent lamps.

To take into account the heat generation in the room, the number of people present and computers turned on was constantly recorded during the working day. In addition, the time of turning on and off the lights and the time of using the printers were noted.

The working hours of the premises are as follows: from 8:00 to 19:00 daily, except Saturday, Sunday and national holidays.

To calculate the year-round thermal regime of the room under study, the following values of heat input were taken:

- from people with their number n at the considered time. There are 9 workplaces in the room. In addition, on a working day, as a rule, from 1 to 3 people came. From one person it is accepted at a temperature close to 20 °C 90 W of the release of sensible heat, at a temperature close to 25 °C - 60 W;
- from artificial lighting with an actual average power of electric fluorescent lamps in the room equal to 24 W / m^2. The investigated room is divided into two zones by area with the possibility of separate switching on of lighting. As a rule, in the window-sill area, the lamps were switched on at low natural illumination, and in the area adjacent to the warehouse, the light was constantly on;
- from solar radiation by the formula:

\[ Q_{str} = Q_{str} + Q_{tr} , \]

where

\[ Q_{str} = (q_n + q_p \cdot K_{cl}) \cdot A_w \cdot \beta_1 \cdot \beta_2 \cdot \beta_3, \]

\[ Q_{tr} = (t_{out} + (q_n + q_p \cdot K_{cl})/\alpha_{out}) - t_{in} \cdot A_w \cdot K, \]

where

\[ t_{out} \] - current outdoor temperature, °C,
\[ t_{in} \] - current room temperature, °C,
\[ P \] - absorption coefficient of solar radiation by filling the light opening: for heat-reflecting glass 0.04,
\[ \alpha_{out} \] - the heat transfer coefficient of the outer surface of the glazing, W/m^2 °C, is determined by the formula, W/m^2:

\[ \alpha_{out} = 1,16 \cdot (5+10 \cdot \sqrt{v}), \] where \( v \) - current wind speed, m/c, according to the meteorological station;
we accept heat dissipation from computers in the amount of 135 W from each and 550 W multifunction devices. According to an approximate estimate of the listed heat emissions, their average level is 44 W/m².

To maintain the normalized temperature in the administrative part of the building, a central water heating system with local heating devices without thermostats and 2 internal blocks of split systems is provided.

Connection diagram of the building heating system to heating networks - dependent, with regulation by a mixing valve according to a quality schedule 80-60 °C.

Steel compact radiators from "Kermi" were used as heating devices.

2. Technique of the experiment

To determine the temperature of the air and surfaces facing the room, temperature measurement sensors were installed around the entire perimeter of the room under study, as well as behind the false ceiling, in the supply duct of the air conditioning system and in adjacent rooms. Figure 3 shows the placement of the sensors.

In the experiment, the following values were measured: the temperature of the internal air in the investigated and adjacent rooms; the temperature of the inner surfaces of the walls in the test room; outside air temperature; supply air temperature of the air conditioning system; temperature and flow rate of the heating agent in the heating system.
To measure the temperature of the internal air, autonomous thermochronous storage sensors of the DS1921G series were used. Sensor manufacturer - Dallas Semiconductor.

The internal air temperature was taken as an average value over 12 sensors installed along the perimeter of the investigated room.

The obtained experimental results are presented in Figures 4-7, illustrating the correlation between the temperature of the outside and inside air, the change in the temperature of the inner surfaces of the fences of the investigated room.

**Figure 4.** Indoor and outdoor air temperature according to measurements from 11 to 15 February

**Figure 5.** Indoor and outdoor air temperature according to measurements from 12 to 16 August
Figure 6. The temperature of the inner surfaces of the fences of the investigated room according to measurements from 11 to 15 February

Figure 7. The temperature of the internal surfaces of the fences of the investigated room according to measurements from August 12 to 16

Note the correlation between the change in outdoor temperature and room temperature.
3. Conclusions
The experiment confirmed the presence of internal heat gains in the office space of about 44 W/m² within the investigated range of heat gains of 30 - 70 W/m².

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