DISTRIBUTION OF HEATING ENERGY CONSUMPTION FOR APARTMENT BUILDING OF MASS CONSTRUCTION HEATING

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Introduction

The countries of Eastern and Central Europe are characterized by mass typical buildings of the 80s of the twentieth century, which are characterized by central regulation and accounting of energy consumption for heating, vertical single-pipe heating systems, high heating costs caused primarily by low thermal resistance, which does not meet modern requirements more than 3 times. Therefore, the current state of apartment buildings built during mass construction, require full or partial modernization and a significant increase in energy efficiency. In addition to energy saving measures, which are currently being actively implemented for the house as a whole and by individual apartment owners, there are a large number of operational problems [1, 2]. They are associated with changes in temperature schedules of heating systems, local regulation of heating conditions and so on. This, in turn, leads to different air temperatures in the areas of the house / apartments and heat flows in the middle of the building. In terms of increasing attention to energy efficiency and providing the necessary living conditions, it is important to study the impact of heat flows between adjacent areas (apartments), and how the regulation of heating by individual residents affects the comfort in neighboring apartments.

Purpose and research objectives

The aim of the work is to analyze the consumption of thermal energy for heating the block of premises on the riser of a five-storey residential building of mass construction, taking into account local regulations.

According to the set goals, the following tasks should be solved:

1. creation of a mathematical model to determine the thermal state of the premises on the riser;
2. design calculation for this building;
3. determining the impact and analysis of heat flows between apartments in the local regulation of the heating system by residents.

Material and research results

Initial data. Since most apartment buildings were built in the 60s and 80s, they mostly use a single-pipe vertical heating system with a flow-through connection of heating appliances (radiators type MS-140) with a locking area and the possibility of local regulation by bypass. The object of the study is a typical five-storey building without complex architectural and structural or structural solutions, which is located in Kiev, with the upper wiring of the heating system. The temperature schedule of the building heating system is "95/70" (for design conditions). According to the project, the leakage factor for heaters is 0.5. The load-bearing external walls are made of red hollow brick with a thermal resistance of the fence of 0.8 m^2K / W. The house has a flat roof and a floor located on the ground without recesses. The power of heating appliances, cast iron radiators, selected to provide an indoor temperature of 18°C under the calculated conditions of outdoor temperature and temperature schedule of heating.

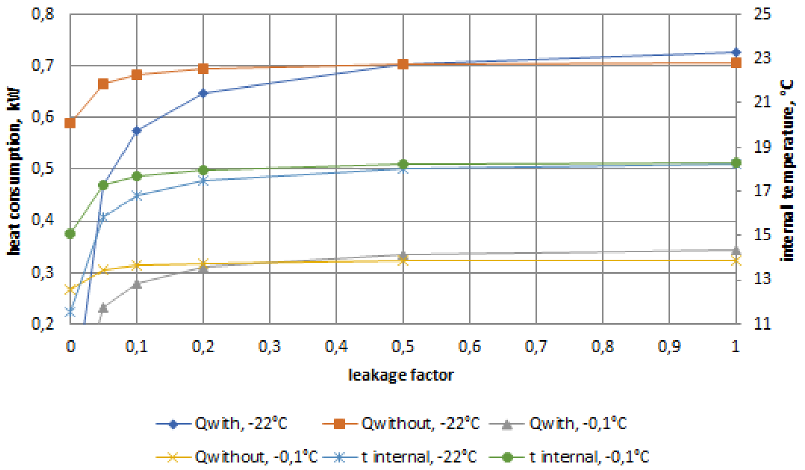
Model description. For simulation, a model of a block of five identical rooms of different floors, which are heated, has been created. Calculation of thermophysical properties of barriers for model adjustment was performed according to the standard DSTU B A.2.2-12: 2015 [3]. In the software environment of the Mathcad model, a design calculation was performed for the design conditions of Kyiv [4], in the absence of solar heat and at an outdoor temperature of -22°C.

In addition, a series of simulations for the average conditions for the heating season - outdoor temperature -0.1°C. The influence of heating system control for example on the 4th floor with the

help of regulators on heating devices for different external conditions, supply temperatures and change of heat carrier flow through the heating device was investigated.

Analysis of the study results. The mathematical model considers a riser of a single-pipe heating system with a closing section, which passes through the same living quarters of a five-storey building. Based on the equations of heat flow balances for rooms and heaters, a system of 48 equations is solved. The equation of heat balance of premises takes into account the heat flow from heating appliances, heat losses through external, internal fences, floors, floor and leakage coefficient α. Solar heat was not taken into account to distinguish the impact of each of the components and the possibility of comparing them under the calculated and average external conditions. The temperature of the coolant at the inlet and outlet of the heater, heat flow from the heater, indoor air temperature, as well as the amount of flow through internal enclosures and ceilings depending on local regulation on the heater 4th floor flow coefficients by bypass were studied.

In fig. 1 shows the dependence of the change in heat flux from the heater on the 4th floor depending on the leakage coefficient α for the calculated temperature of -22°C and the average temperature of the heating season -0.1°C, taking into account internal flows into adjacent rooms and without.



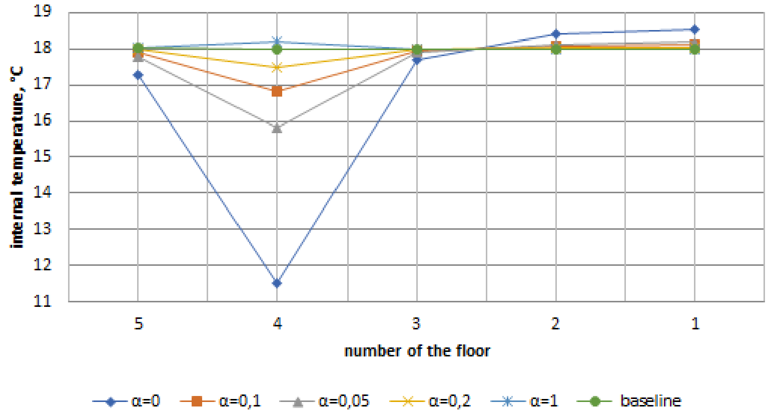
Qwith, -22°C; Qwith, -0,1°C – with flow (outside air temperature -22°C and -0,1°C respectively), kW; Qwithout, -22°C; Qwithout, -0,1°C – without overflows (outside air temperature -22°C and -0,1°C respectively), kW.

Figure 1. The magnitude of the heat flux from the heater of the 4th floor and the room temperature at different leakage factor α

From fig. 1 it follows that the dependence of heat flux on the leakage coefficient α has a typical nonlinear dependence, which is explained by the exponent of 1.3 for cast iron radiators in the equation of heat flux from heaters. The heat flux is more sensitive to small leakage factor (α = 0…0.2), with further increase α the heat flux does not change significantly. For average outdoor conditions, the water temperature in the supply pipe at the entrance to the heating device of the 5th floor is 58°C, respectively, for the temperature graph "95/70".

In fig. 2 shows the dependence of the change in air temperature for different floors under different leakage factor on the 4th floor of a 5-storey building with the upper dilution of heating devices of the heating system. Complete shutdown of the heater on the 4th floor leads to a decrease in temperature on this floor to 11.5°C, this level is maintained by the flow of heat from adjacent rooms through the interior walls, floor and ceiling. This in turn leads to a decrease in temperature in the absence of heating control in rooms 5 and 3 floors due to transmission flows to the 4th floor and increase the temperature on the lower floors to 0.5°C by increasing the temperature of the coolant at the entrance to heating appliances.

At the leakage factor of 0.05… 0.2, the internal air temperature on the 4th floor fluctuates within 16… 17.5°C, and on other floors no noticeable change in air temperature is observed. Further increase in the flow coefficient of 0.5...1 does not give a significant effect, because it leads to a change in air temperature on this floor to 0.1...0.2°C. The estimation of heat flows between the next premises in the conditions of similar regulation is carried out.



** the given coefficients α are characteristic for 4 floors, on other floors correspond to design α= 0,5*

Figure 2. Floor-by-floor distribution of internal temperature in the premises on the riser

Conclusion. The paper analyzes the local regulation of a single-pipe heating system with closing links of a 5-storey typical mass building of the 80s on the basis of a simulation model created in the Mathcad software environment for design/calculation and average conditions. The internal heat flows to the adjacent rooms, the change of the internal air temperature under the influence of the change of the flow coefficients in the heating device of the 4th floor are investigated.

In further research it is planned to conduct a similar calculation for buildings that meet the modern thermal properties of fences, as well as to investigate the impact of operational and behavioral characteristics of residents on energy consumption, taking into account indoor and solar heat in the room.

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