СЕКЦИЯ «ЭНЕРГОЭФФЕКТИВНЫЕ ТЕХНОЛОГИИ»

УДК: 662.997

THERMAL-TECHNICAL CHARACTERISTICS AND THERMAL REGIME OF ENERGY-EFFICIENT SOLAR HOUSE

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Ensuring a normal temperature environment in residential buildings is one of the primary and topical issues. This requires humidification of indoor air when the outside air temperature is above 25-33 ° C and below 18 ° C [1]. The process of air purification is a process carried out by cooling by removing heat from the indoor atmosphere of a building or by heating it by injecting heat into it from an external source. In addition, the structural balance of buildings and structures requires that the moisture balance be maintained at a normal level [2]. The parameters that represent the thermal conditions of a building are considered to be inextricably linked with its heat, air and humidity regimes and are its thermal technical parameters. It is a parameter that determines the thermal regime of the building. The comfortable living conditions of the occupants of the building, the normalization of production processes, the long service life of building structures and equipment depend on this parameter. The thermal state of a building is affected by a number of factors, including temperature, air movement and humidity, differences in air parameters across the surface and height of the room, and radiant heat fluxes depending on surface temperature, size, location, and radiation characteristics. An indicator that forms the basis of complex physical processes that provide the thermal regime of a building is the heat exchange that takes place on its surfaces. The heat balance on any surface of the building is determined from the following equation [3]:

$$Q_{н} + Q_{к} + Q_{и.ў} = 0 \quad (1.1)$$

The components of the heat exchange Q_l - light, Q_c - convective and $Q_{c.s}$ - conductive on the surface of the building can change over time, have different signs and values, but the expression representing the law of conservation of energy (1.1) does not change even under stable and unstable heat exchange conditions. If additional heat falls on the surface or is absorbed (moisture evaporation, condensation of vapors, heat ingress from an external heat source, etc.), the component of this source is also added to expression (1.1).Radiant heat exchange has the following feature: it occurs at a limited temperature in a closed volume, depending on the exact radiative properties and geometry of the building surface. The thermal radiation of a building can be considered as monochromatic and diffusion, subject to the laws of infrared radiation of Stefan-Boltsman, Lambert and Kirchhoff and gray bodies [3].

One of the radiant surfaces of the building is the window pane, which is a partially conductive radiation conductor. Window panes transmit short-wave radiation well. The indoor air of a building is a transparent environment that transmits light in mutual heat exchange with its internal surfaces.

All surfaces of the building reflect radiant heat and absorb radiant heat from the environment. Convection plays a key role in the overall heat exchange in the interior of a building. Heat exchange takes place between the hot and cold surfaces of the walls, fixtures and other equipment of the building and the air. The streams of heated and cooled air provide a general movement throughout the entire volume of the room. Air entering or exiting through ventilation serves to speed up this process.

In the general case, the index of convective heat exchange K_1 in terms of heat balance for the surface l in the conditional unit can be written as [4,18]:

$$K_{\sigma_1} = \int_{F_1} \alpha_{k,dF_1} \cdot \left(t_{B,dF_1} - \tau_{dF_1}\right) \cdot dF_1 = \alpha_{k,l} \cdot \left(t_{\text{x}} - \tau_l\right) \cdot F_1 \quad (1.2),$$

here $\alpha_{K,l}$ –is the convective heat transfer coefficient of the surface *l* at the average difference between the room air temperature t_a and the surface temperature.

In many buildings, the movement of air results in an equal distribution of temperature t_a per unit area and height of the room, which helps to assume the same temperature value of air t_a to calculate the heat exchange across all surfaces of the room. Except for the air temperature of buildings where excess heat is supplied to the environment or non-isothermal air flow, because in the first case the temperature is unevenly distributed along the height of the room, in the second case per unit area. The convective heat transfer coefficient is important in calculating the heat regime of a building. In the turbulent mode of heat exchange, the average value of the coefficient of free covective heat transfer along the vertical surface can be determined as follows [4]:

$$\alpha_к = \alpha_{к,x} = 1{,}66 \cdot \sqrt[3]{\Delta t}; \quad (1.3)$$

$$\alpha_к = \alpha_{к,x} = 1{,}43 \cdot \sqrt[3]{\Delta t}; \quad (1.3`),$$

where Δt – is the difference between air and surface temperatures, ° C.

These expressions depend on the geometric dimensions and temperature difference of the heated and cooled surfaces in the room and correspond to the turbulent mode of free convective heat exchange.

In free convection mode, the movement of the air stream near the horizontal surfaces is different from that on the vertical surfaces. If the hot surface belongs to the cold part from the top to the bottom, the air will have a normal value only in the middle of them. For downward hot or upward cold horizontal surfaces, convective heat exchange and air movement intensity will not have a significant value. Moreover, in this case, as the surface area increases, the air flow becomes more complicated and the average convective heat transfer coefficient decreases [5,6].

In experiments, expression (1.3) can be used to calculate the average intensity of convective heat exchange on heated or cooled surfaces with a horizontal position, but in this case the value of the numerical coefficients must vary by ± 30% depending on the direction of heat flow. If the heat flow is directed from the bottom to the top, the numerical coefficient in the formula is 1.87, and in the top-down direction it is 1.0 [3]

In the development of structural schemes of residential buildings, special attention is paid to climatic parameters, ie the variability of outdoor air temperature, changes in solar radiation throughout the year, the calculation of cloudy and rainy days. The fact that the climate in the southern regions of Uzbekistan is dry and hot, with relatively few rainy days and 2900-3050 hours of sunny days creates a number of opportunities for the construction of single and multi-storey residential buildings. For example, the definition of window and door locations, the choice of material for wall construction, the choice of material for partition walls do not cause difficulties [24,25].

Experiments are required to substantiate and study the thermal parameters of the building. An experimental house design was designed and built to conduct our experiments and research. The experimental research object (hereinafter referred to as the research object) had a single-storey, one-room structure built on a concrete foundation made of baked brick, and the thermal regime, hot water and heating loads of the object were determined (Figure 1.1).

Fig. 1.1. An overview of the experimental research house.

The internal dimensions of the research object are a = 4 m, b = 3 m, h = 3 m, the internal surface is 12 m^2, the volume is 4x3x3 = 36 m^3. For the heat supply of the facility, an AKTV-12 water heater with cast iron batteries and a hot floor pipe system and a Royal electric water heater with a power consumption of 2.0 kW were selected to implement the hot water supply (Figure 1.2)[7,8,28].

Analysis of modern techniques and technologies used in world practice, as well as the results of scientific research shows that the use of renewable energy sources instead of traditional types, fossil fuels or electric power devices for heating residential buildings allows to achieve high efficiency. To this end, the feasibility of using a solar-based heat supply system operating on the basis of a flat solar water heating collector system for the research object was studied and evaluated.[9,10,11,12,13,14,15,]

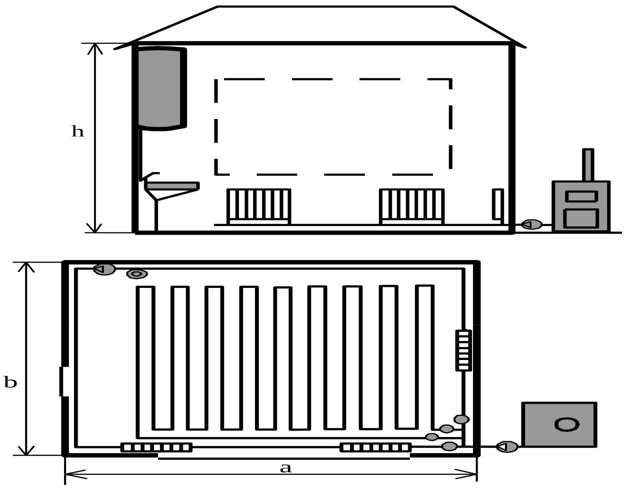

Fig. 1.2. Heat supply scheme for experimental research object.

If a hot water supply system with a flat solar collector is used, the cost of electricity for hot water supply will be reduced by 50-70%, and the cost of fossil fuels for heating will be reduced by 40-45%. This means that the total energy consumption for heat supply during the year will be reduced by an average of 50-55%. [16,17].

This is because the main heat load of the research facility requires that the indoor air temperature of the facility be 20-22 ° C annually and that the hot water supply be maintained at 35-50 ° C throughout the year. However, this requires a heating device used as a heat supply equipment, i.e. a flat solar collector with an efficiency rating (efficiency of at least 65-70%). However, in order to use solar energy in a heat supply system, it is necessary to include traditional fossil fuels and electricity consumption in the system in order not to reduce the daily heat transfer performance of this system. On this basis, the heating scheme shown in Figure 1.3 was developed.[19,20,21,22,23].

The result is a combined heat supply system, i.e. a system based on both conventional and non-conventional heat supply. the creation of a combined system will allow us to fully meet the demand for heat, even in winter. During the operation of the developed heat supply system, it is possible to use a separate flat solar water heating collector for the hot water supply system and solar water heating collectors with the necessary surface for heat supply, or heating purposes. At certain times of the day, i.e. at night and in cloudy weather, a conventional system can be used, while in sunny weather, a non-traditional heating system based on flat solar water heaters can be used.

The heat load of the building consists in heating it and maintaining the microclimate of the indoor air at the same level, providing a hot water supply at the required temperature throughout the year [26,27].

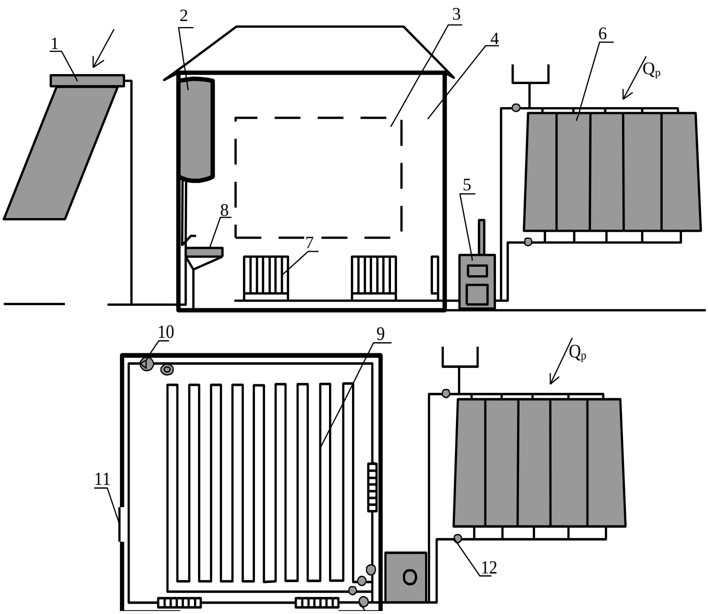

Fig. 1.3. Schematic of a research facility with a combined heat supply system. Here: 1 solar water heater collector; 2 hot water accumulators; 3-window; 4 experimental house; 5 water heating boiler; 6 solar collector for heat supply; 7 heating batteries; 8 water use reservoir; 9th heated floor; 10-pump; Door 11; 12 valves.

Based on the design standards, the construction of the selected scheme was carried out to ensure that the room temperature was maintained at 18-24 ° C in winter and the relative humidity at 40-45%. The lowest temperature in Kashkadarya region in winter was -15 ° C, and the duration of the heating season was 132 days.

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УДК: 662.997

ТЕПЛОВОЙ РАСЧЕТ ГЕЛИОПИРОЛИЗНОГО УСТРОЙСТВА-КОНЦЕНТРАТОРА

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Снижение энергопотребления в технологии пиролиза является серьезной проблемой. Это связано с тем, что сначала необходимо подвести энергию (тепло) для поддержания температурного режима реактора. Разложение отходов биомассы требует много тепловой энергии, а дополнительный нагрев биомассы требует чрезмерных энергозатрат. Обычно процессы, проводимые в установке пиролиза, осуществляются за счет угля, природного газа или электроэнергии.

Проблема снижения энергопотребления при пиролизе биомассы может быть решена за счет использования гелиотермальной системы нагрева. В результате исследований в этой области был предложен способ использования солнечных концентраторов в процессе пиролиза биомассы, т. е. метод гелиопиролиза (рис. 1) [1].