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Thermoregulation of Risers As A Means of Qualitative Regulation of Heat Transfer in the Heating System

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ABSTRACT

The standards that have recently appeared that establish the energy efficiency classes of buildings depending on the level of their heat consumption pose a similar task for individual elements of building engineering systems. The essence of this task is to select the most energy efficient equipment or technical solution for each of the system elements.

KEYWORDS: *heating systems, coolant, energy efficiency class, individual heat metering, metering devices, thermal control of risers.*

The improving the energy efficiency of a traditional single-pipe heating system is to provide quantitative regulation of the heat transfer of the system not only at the level of heating devices, by means of thermostats, but also at the risers, by installing temperature controllers at the root of the risers, structurally combining them with balancing valves. The principle of riser temperature control is shown in fig. 1.

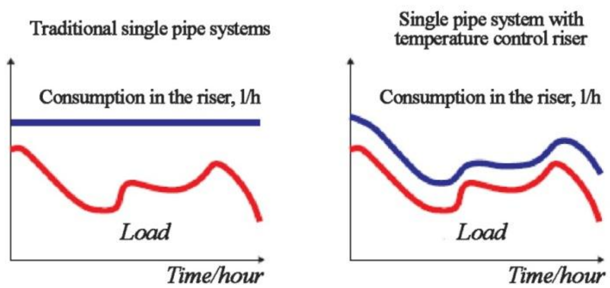

Figure 1. Schematic diagram of the operation of risers

The effect is achieved by reducing the flow of the coolant through a specific riser, the temperature of the coolant in which rises as a result of closing the thermostats with excess heat in individual rooms.

The results of the operation of the thermostat on one of the control risers are shown in fig. 2. The graphs show a reduction in the flow rate of the coolant in the riser as a result of an increase in the temperature of the coolant in it as a result of closing the thermostats on individual heaters. At the same time, the air temperature in the control room does not change.

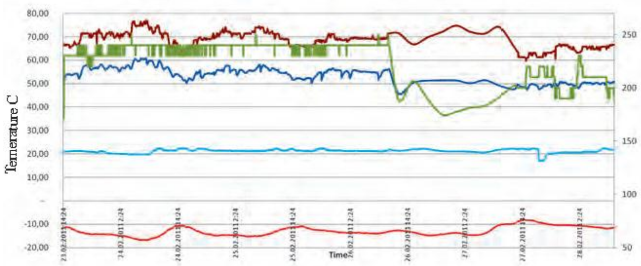

Figure 2 The results of the operation of the thermostat on the control riser

The setting values of these devices are determined during the survey of the building and the identification of the potential for excess heat. The most effective are "trifle" thermostats with an electric drive and an automatic control system for the temperature of the coolant in the risers.

The economic effect of the use of thermal control of risers depends on the amount of excess heat entering the building not taken into account in the project, including the excess heating surface of heating devices. According to the results of the survey of experimental buildings, the effect ranged from 8 to 12%, depending on the condition of the building.

Energy efficiency of heating devices. Heating appliances largely determine the energy efficiency of the heating system. The choice of the type of heating device is not unambiguous and requires the analysis of a large number of its properties and features. To facilitate the choice that is adequate to the task of energy efficiency of the system as a whole, it seems appropriate to introduce a system for assessing the energy efficiency classes of heating appliances, by analogy with the classification of buildings.

Below, in the order of discussion, the ideology of one of the possible options for the system for assessing the energy efficiency class of heating appliances is presented. The system involves a scoring of the quality of heating devices for a number of indicators. Indicators can be presented as a quantitative assessment - kW,%, hour, etc., or as a qualitative assessment - many, few, high, low, etc. Each energy efficiency class corresponds to the amount of points scored as a result of an expert assessment of the heater for each of the indicators. Below is an example of such a rating system for certain instrument types.

***Table 1* An example of determining the energy efficiency class of heating appliances**

№	Indicators	5 point	4 point	3 piont	2 point
1	Inertia	+/+			
2	Adjustability	+	+		
3	Residual heat transfer		+	+	
4	Material consumption		+/+		
5	Hydraulic resistance	+	+		
6	Fraction of radiative heat transfer				+/+
7	………………………………				

For presented in table. 1 indicators, we accept the following classification of energy efficiency of heating devices by the sum of points:

A classe – 25–30 points;

B classe – 18–24 points;

C classe – 12–17 points.

As an example, consider a steel plate convector of the KSK type.

Example 1. Convector equipment:

automatic thermostat at the coolant inlet;

"thermal brake" is absent;

the closing section is missing.

The total score is 25 (see black crosses in the table).

Energy efficiency class - A.

Example 2. Convector equipment:

automatic thermostat on kalach;

"thermotormoz" on the return line;

end section installed.

The total score is 22 (see red crosses in the table).

Energy efficiency class - B.

Individual (per apartment) heat metering with payment according to its actual consumption is the most important factor motivating residents to save energy. Without this measure, the system of energy saving measures remains "open", based only on administrative levers.

The following main types of individual heat metering systems used for traditional vertical single-pipe heating systems are known:

A system with allocators (heat cost allocator - distributor of the cost of consumed heat) on each heating device, registering the temperature difference (Δtall) between the surface of the heating device and the room air. The coolant consumption is recorded on the house meter and is used only in the calculation of the house heat consumption.

A system with coolant temperature sensors installed in the riser on each floor, registering the temperature difference (Δte) of the coolant in the riser within each floor. The coolant flow rate is recorded at each riser and in the house heat meter.

For vertical two-pipe heating systems, only a system with allocators is used.

Both of the above distribution systems, the principles of their operation are described in detail in the literature. In this article, only one aspect is considered - the accuracy of the calculation of heat consumption. This information should allow the designer to make a choice between systems that is adequate to the objectives of energy saving and protecting the rights of the tenant to a fair payment for the consumed heat.

Table 2 Temperature fluctuations Δtall u Δtet and the corresponding calculation errors σt

Flors	**System accounting with allocators**		**Accounting system with sensors on risers**					
			Thermostat open			Thermostat closed		
	Δt_{all}, °C	σt, %*	Δt_{et}, °C	σt, %	σt, %**	Δt_{et}, °C	σt, %	σt, %**
5	16–65	5–3	1,6–0,9	5,5–3,2	6,3–4,4	0,4–0,9	12–7,3	12,3–7,9
9	18–70	5–3	0,9–2,8	7,4–4,3	8–5,2	0,2–0,6	17–9,5	17–10,3
12	18–70	5–3	0,7–2,1	8,6–4,9	9,1–5,7	0,1–0,4	19–11,2	19–11,4
17	18–70	5–3	0,5–1,5	10,2–5,8	10,6–6,5	0,1–0,3	22–13,3	23–13,6

25	19–73	5–3	0,3–1,0	12,3–7,1	12,7–7,7	0,1–0,2	27–15,8	26,8–16 (53–32)

Taking into account the error of the flow meter on the riser, 3% is taken into account.

In table. Figure 2 shows the ranges of temperature differences Δt_{all} and Δt_{est} and the corresponding errors in calculating σt in the individual metering systems under consideration, depending on the number of stores of the building and the temperature of the coolant during the heating season.

In this case, the error in determining Δt_{est} is calculated taking into account the measurement error of the temperature sensor Δt_{dat} = 0.05 °C.

During the operation of the system, due to a number of reasons, it is possible to reduce the measurement accuracy of the sensor. For illustration in table. Figure 2 shows in parentheses the data calculated for Δt_{dat} = 0.1 °C for the variant with the highest error.

As can be seen from the table, $\Delta t_{all} >> \Delta t_{et}$, while the absolute values of Δt_{et} are very small. Both of these circumstances significantly affect the accuracy of the calculation of payments. So, with an average monthly charge for consumed heat, for example, 200,000 UZS, unreasonable overpayment or underpayment by individual residents can be:

- 9000–10000 UZS/month for a system with riser sensors at Δt_{dat} = 0.05 °C;
- 6000 - 8000 UZS/month for a system with sensors on risers at Δt_{dat} = 0.1 °C;
- 600-900 UZS per month for an accounting system with allocators.

As can be seen from the example, the error in calculating payments for a system with sensors on risers is several times higher than the error in a system with allocators.

Obviously, the accrual error is possible in both directions: both in favor of the tenant and in favor of the resource provider. In both cases, it is impossible to bring the balance according to the readings of the apartment and house meters, as well as to exclude complaints from the tenants or the heat supplier, up to litigation.

In any case, in the case of commercial calculation for heat, an individual metering system with the smallest possible error should be recommended for use.

Conclusion. To ensure a given energy efficiency class in the process of designing a new building or upgrading an existing building, it is advisable to develop recommendations for the optimal choice of the main building elements, up to the development of special classification systems for some of them, similar to the general building classification system.

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