Problems of operating the hot water supply system during transferring the hostel to the apartment house status

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Abstract. The energy infrastructure modernization is a complex social and technical problem that requires an integrated approach. After analyzing the hot water system operation in a residential apartment building, previously a hostel, the reason for the temperature regime violation was determined. In connection with the building status change the number of residents has significantly decreased, the service block has been eliminated, which led to the changes in water consumption conditions. In addition, the requirements for minimum water temperature in the centralized hot water systems have changed. The using a dead-end hot water supply system possibility question, provided for by the project or its reconstruction into the circulation network, was considered.

The studies were conducted in accordance with the methodology described in MUK4.3.2900-11 “The centralized hot water supply systems hot water temperature measurement”. There was a discrepancy in the standard indicators of the coolant temperature at the points of dismantling on different floors of the building. The difference in temperature at the input (data of the heat meter and thermometer) and at the end user is associated with additional water cooling in the supply pipes of the HWS system. When transferring public buildings to housing stock, it is necessary to revise not only water consumption volumes, but also the hot water supply scheme in general. The lack of circulation leads to hot water waste and increases the cost to the consumer.

To ensure the required temperature standards for a full day in a dead-end hot water supply system, which is provided by the project, continuous dismantling of the water is required, which is difficult to achieve with a changed building status. The resolution of the problem is possible only when the hot water supply system is switched to the circulation mode with the installation of circulation piping and the circulation pump.

Introduction
In our country, housing and public utilities is one of the largest sectors of the economy, where about 25% of state fixed assets are concentrated, the municipal energy sector consumes more than 45% of heat and 20% of electricity. Therefore, the engineering systems modernization is a very time-consuming, costly, socially important process affecting the comfortable working and living environment of any person. At the same time, the number and scale of problems is a significant indicator of the state of society [1, 4].

The main mistake in making the informed decisions is the lack of a full-scale experiment with bringing the idea of modernization to all interested parties with the results demonstration that clearly show the feasibility of energy-saving measures [7].
Many residents are not satisfied with the level of quality of housing and communal services provided by them and suggest that it does not match the cost. The current situation in the housing sector is characterized by a significant deterioration of the main equipment, outdated technologies, large losses of energy resources and low energy efficiency. More than 70% of the country’s housing stock was built before 1980, equipment wear exceeds 60%, energy consumption is 2-3 times higher than in European countries; while in the early 1990s, the national average per 100 km of utility networks was 30–40 accidents, over the past 10 years the accidents number increased to 180 per 100 km of water supply and 10–20 per 100 km of heat supply networks [5].

The social aspect of this problem is the industrial enterprises’ refusal to maintain the departmental housing stock and transfer it to the balance of the city, the management company or the HOA [6]. For example, in the city of Tolyatti, back in 2006, the integrated dormitories of PJSC “AVTOVAZ” were transferred to the municipality in the multi-family residential buildings status, with many problems, such as privatization issues, an unknown number of people actually living there, as well as a change in the degree of improvement and technical condition engineering communications.

Relevance of the work
The article discusses the reason for the discrepancy between the temperature of hot water at the point of water intake of an apartment building that was previously a hostel of one of the enterprises of the city of Togliatti. The building was constructed according to the standard project 164-80-4 “9-story dormitory for 537 beds with a service unit”. In the service unit were laundry, dining room, households, premises.

According to the Housing Code of Russia, residential accommodation in a dormitory is provided to citizens at the rate of at least 6 m² of living space per 1 person. At the survey time, about 300 people live in the building permanently, the maintenance block has been liquidated.

Considering the numerous complaints of residents, it became necessary to determine the discrepancy cause between the hot water temperature at the point of dismantling [11, 12]. This requires to conduct a survey of the hot water supply system of a dwelling house; to measure the hot water temperature at the dismantling point; to establish the cause of temperature non-compliance with regulatory requirements [2, 3].

The hot water supply system of a 9-storey single-entrance residential building, built in 1980, is made of steel water and gas galvanized pipes GOST 3262-75. The inlet pressure is 0.56-0.6 MPa, the temperature is 58 ± 1 °C. The main pipeline is made of steel pipes, insulated with mineral wool with a fiberglass covering layer. The isolation condition is satisfactory and, at the time of the survey, meets the requirements of [8]. Connection to the risers is made in accordance with the requirements of [14]. The DHW system is dead-end, the T4 pipeline is missing and complies with the project “9-storey dormitory for 537 beds with a maintenance unit. Typical project 164-80-4” sheet VK-15 Axonometric scheme.

The following object elements were examined:
1. Entering the hot water pipeline to a residential building.
2. Input unit (metering unit for heat energy and heat carrier).
3. Trunk pipeline laid in the basement.
4. Risers, internal wiring, water folding devices.

The measurements were carried out in accordance with the method described in [10]. When conducting a study of the hot water supply system on 09/27/2018, from 10.00 to 11.30, the hot water temperature selective measurements on the risers in the kitchen and bathrooms were carried out. The instruments used are: laboratory electronic thermometer LT-300 with a measurement range from minus 50 to plus 300 °C, accuracy class 0.05; graduated glass cylinder: volume of 100 milliliters, class A, division value 1 ml, total height 256 mm, outer diameter 29 mm [13].

The sampling was carried out on different risers (from the closest to the input node to the most remote) on different floors, where the measurement is possible [10 p.7.2]. Sampling was carried out in a heated heat-insulated flask after draining the water for at least 5 minutes, then every 1 to 2 minutes
at a constant flow of hot water. As the measurements were carried out from 10.00 to 11.30 during the lowest water consumption hours (Figure 1); in the circulation riser absence, the water temperature strongly depended on the flow rate (discharge time) [16].

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Considering the numerous complaints of residents, it became necessary to determine the cause of the discrepancy between the hot water temperature at the dismantling point [11, 12]. This requires: to conduct a dwelling house hot water supply system survey; to measure the hot water temperature at the dismantling point; to establish the cause of temperature non-compliance with regulatory requirements [2, 3].

The hot water supply system of a 9-storey single-entrance residential building, built in 1980, is made of steel water and gas galvanized pipes GOST 3262-75. The inlet pressure is 0.56-0.6 MPa, the temperature is 58 ± 1 °C. The main pipeline is made of steel pipes, insulated with mineral wool with a covering layer of fiberglass. The isolation condition is satisfactory and, at the time of the survey, meets the requirements [8]. Connection to the risers is made in accordance with the requirements of [14]. The HWS system is dead-end, the T4 pipeline is missing and complies with the project “9-storey dormitory for 537 beds with a maintenance unit. Typical project 164-80-4” sheet VK-15 Axonometric scheme.

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The pipelines (some sections) of hot water supply have been in operation since 1980, they show signs of corrosion, which leads to an increase in hydraulic resistance and a decrease in the consumption of water-folding devices [18, 19].

Figure 1 shows a graph of temperature measurements (° C) constructed from experimental data.

![Figure 1. Daily schedule of water consumption in apartment buildings.](image1)

The dashed line shows the forecast (up to 16 minutes) of temperature change with further discharge of water. Pearson's R2 criterion shows the measurement results distribution probability degree with the number of measurements more than 10 R2 criterion> 0.95, which confirms the closest to the linear distribution of the results [17].

The report on the heat supply hourly parameters obtained from the VKT-7 heat calculator shows that during the most intensive water consumption hours, the temperature regime meets the requirements of [11 p.2.4]. However, the average values for the period of 09/24/2018 - 09/27/2018 are lower than the normative values by 1 - 2 ° C.

The decree of the Government of the Russian Federation of 06/05/2011 N 354 (as amended on 03/27/2018, as amended of 10.07.2018) “On the provision of public services to owners and users of
premises in apartment buildings and residential houses” (paragraph 5 of Annex 1) prescribes the hot water temperature permissible deviation at the point of dismantling from the temperature of hot water at the point of dismantling that complies with the requirements of the RF legislation on technical regulation: at night (from 0.00 to 5.00 hours) - not more than 5 degrees Celsius; in the daytime (from 5.00 to 0.00 hours) - no more than 3 °С.

**Figure 3.** Temperature distribution of hot water by the day hours.

The difference in temperature at the input (data of the heat meter and thermometer) and at the end user is associated with additional cooling of water in the risers of the DHW system, since the temperature of the water in the dead-end hot water system depends on the intensity of water consumption (similar to the graphs of figures 1 and 3), while ensuring the temperature required for the standards for a full day is possible only by organizing the circulation [20]. Work on the normalization of the temperature regime in the HWS system refers to works of a capital nature, i.e. involves the disassembly and revision of the entire system in order to identify the hidden deficiencies and assess the residual resource [15].

**Summary**

When transferring public buildings to housing stock, it is necessary to revise not only water consumption volumes, but also the hot water supply scheme in general. The lack of circulation leads to hot water waste and increases the cost to the consumer.

The reason for the discrepancy between the hot water temperature at the point of dismantling is a significant cooling of the hot water at a low water level and the absence of the circulation pipe T4 under the project. A significant decrease in hot water consumption was due to the transfer of the dormitory to the status of a residential house, a decrease in the number of tenants, and the elimination of the maintenance unit from the laundry and dining room.

It is possible to normalize the temperature regime in the HWS system by installing a T4 circulating pipeline from TsTP-57 (option - installing a heat exchanger in the residential building itself), as well as with an obligatory installation of the T4 internal circulating pipeline.

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