Received on : 07/03/2020 Accepted on : 18/03/2020 Publication Date: 31/03/2020

Heat loss in heat supply systems

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Abstract: *This article briefly describes the problems of energy conservation prevailing today in the vast majority of domestic facilities for the production, transportation and consumption of thermal energy, offering options for their effective solution.*

Key Words *coefficient of performance (COP), boiler units, regulation, boiler, heat meter, washer*

1. INTRODUCTION:

A heat network is a system of members of heat pipes firmly and tightly interconnected, through which heat is transported by heat carriers (steam or hot water) from sources to heat consumers. The heat supply to consumers (heating, ventilation, hot water supply and technological processes) consists of three interconnected processes: communication of heat to the coolant, transport of the coolant and use of the thermal potential of the coolant.

1. 2. THEORY:

Existing heating systems, for the most part, were designed and created without taking into account the opportunities that have appeared on the heat and power market over the past 10 years. The massive development of computer technology led to the appearance at this time of a huge number of technological innovations that fundamentally changed the situation in energy conservation. For example, the ability to accurately simulate thermal processes on a computer has led to the emergence of new effective designs of boiler units and heating circuits, and the achievements of the electronic industry have made it possible to widely use heat metering devices and highly economical control devices.

1.3. Review:

In the Soviet period, district heating was widespread. Due to a number of both remote in time and current conditions, the situation in district heating is characterized by unsatisfactory technical level and low economic efficiency of the systems, depreciation of equipment, insufficient reliability of heat supply and the level of comfort in buildings, large loss of thermal energy. The most unreliable part of heat supply systems are heat networks, especially when they are underground installed. This is primarily due to the low quality of previously used designs of heat pipes, thermal insulation, valves, insufficient level of automatic regulation of the processes of transmission, distribution and consumption of thermal energy.

2. MATERIALS:

Loss of thermal energy during transmission.

To assess the performance of any system, including a heat power system, a generalized physical indicator, coefficient of performance (COP) is usually used. The physical meaning of efficiency is the ratio of the amount of useful work (energy) received to the spent. The latter, in turn, is the sum of the obtained useful work (energy) and losses arising in system processes. Thus, an increase in the efficiency of the system (and, therefore, an increase in its efficiency) can be achieved only by reducing the amount of unproductive losses that occur during operation. This is the main task of energy conservation. The main problem that arises in solving this problem is the identification of the largest components of these losses and the selection of the optimal technological solution that can significantly reduce their effect on the value of efficiency. Moreover, each specific object, the goal of energy conservation, has a number of characteristic design features and the components of its heat loss are different in magnitude. And whenever it comes to improving the efficiency of heat power equipment (for example, a heating system), before deciding in favor of using any technological innovation, it is necessary to conduct a detailed examination of the system itself and identify the most significant channels of energy loss.

Heat loss in the area of its transportation to the consumer.

Usually, the thermal energy transferred in the boiler to the heat carrier enters the heating main and goes to consumers' facilities. The value of the efficiency (efficiency) of this site is usually determined by the following:

- efficiency of network pumps, providing the movement of the coolant along the heating main;

- losses of thermal energy along the length of heating pipelines associated with the method of laying and insulation of pipelines;
- losses of thermal energy associated with the correct distribution of heat between consumer objects, the so-called hydraulic mood of the heating main;
- periodically occurring during emergency and emergency situations, coolant leaks.

Typically, heat energy losses in heating mains should not exceed 5-7%. But in fact, they can reach a value of 25% or higher losses at the facilities of heat consumers. The most significant components of heat loss in heat power systems are losses at consumer sites. The presence of such is not transparent and can be determined only after the appearance of a thermal energy meter in the heating point of the building, the so-called heat meter (1). Our experience with a huge number of domestic thermal systems allows us to indicate the main sources of unproductive losses of thermal energy. In the most common case, these are losses:

- in heating systems associated with the uneven distribution of heat in the consumption object and the irrationality of the internal thermal circuit of the object (5-15%);
- in heating systems associated with the mismatch of the nature of heating to current weather conditions (15-20%);
- in hot water systems, due to the lack of recirculation of hot water, up to 25% of thermal energy is lost;
- in hot water systems due to the absence or inoperability of hot water regulators on boilers, hot water supply (up to 15% of the load);
- in tubular (high-speed) boilers due to the presence of internal leaks, contamination of the heat exchange surfaces and difficulty of regulation (up to 10-15% of the load is hotter than water supply).

Total implicit unproductive losses at the consumer can be up to 35% of the heat load.

3. METHOD:

The algorithm for increasing the efficiency of the heating main in the general case can also be represented as a sequence of certain actions:

- Conduct a comprehensive survey of heating mains from the boiler room to heat supply facilities and identify the main channels for the appearance of heat losses in them.
- Conduct hydraulic adjustment of heating mains with watering of consumers according to the actual heat load consumed by them.
- To restore or strengthen thermal insulation of the heating main or, if it is economically feasible, shift existing pipelines using previously insulated pipelines to replace them.
- For domestic hot water systems, provide a switching circuit. If possible, equip the heat points of heat consumers with plate heat exchangers for the needs of hot water.
- Replace low-efficiency domestic network pumps with modern imported pumps with higher efficiency with economic feasibility (high power electric motors of pumps) to use a frequency control device for the speed of rotation of asynchronous motors.
- Replace the stop valves on the track using modern reliable rotary dampers, which will significantly reduce heat losses in emergency and emergency situations, as well as eliminate the possibility of coolant leaks through the valve seals.

The main indirect reason for the presence and increase of the above losses is the lack of heat metering facilities at the heat consumption facilities. The absence of a transparent picture of heat consumption by the object causes the resulting misunderstanding of the importance of adopting energy-saving measures on it. In general, the algorithm for improving the energy situation in buildings looks like this:

- Install heat energy meters at heat consumption facilities. The appearance of a picture of heat consumption by a building over time will make it possible to analyze the current situation and choose the most effective way to use thermal energy;
- Set up the hydraulics of the internal heating system using washers or balancing valves, circulation pumps of the internal circuit. If necessary - make a change to the connection diagram of heating devices, and possibly - use more economical radiators;
- Install an automatic system for regulating the heat load of the building according to weather conditions. The use of "weather" regulation can reduce heat consumption by a building up to 30% while increasing comfort in its premises.
- If possible, equip heating devices with radiator temperature controllers in the rooms, which makes it possible to reduce the heat load of the building by 20%;
- Conduct an audit of existing hot water boilers and, if necessary, replace them with highly efficient plate heat exchangers.

- To ensure reliable operation of the recirculation hot water supply inside the facility, this will save up to 25% of the thermal energy, spent on heating the water.
- Ensure the effective operation of temperature controllers on hot water boilers. A workable temperature controller on a boiler saves about 15% of the heat used for hot water supply.
- Equip the heat points with reliable and modern shut-off and control valves.
- If necessary, carry out a set of works to warm the building

4. DISCUSSION:

Any change in them necessitates the adjustment of heat consumption both at the source of heat supply and directly at the consumer, by reducing or increasing the heat supply, turning on or off certain types of equipment and devices, and establishing a rational mode of their operation taking into account heat losses during transportation. Thus, it becomes necessary to control the processes of supply and consumption of thermal energy, i.e. thermal regulation by them.

4.1. Analysis:

Reducing accidents and heat losses in heating networks. Another important component of forecasting the demand for thermal energy is the assessment of heat losses in district heating systems during its transport and distribution. Losses in heating networks according to (2) reached 24.2% of the heat received in district heating systems.

4.2. Findings:

The problem of heating networks is the bottleneck of district heating systems. The service life of 50% of heating networks exceeds 20 years. The average losses in such networks, determined by calculation, are 19%. The amount of pipe damage in most settlements reaches critical values

However, the problem of modernizing heating networks lies not only in their physical deterioration. The capital costs of their modernization are very high, and the payback period is at least 15 years. It turns out that replacing pipelines is an unattractive project for investors. . The way out is a comprehensive approach to the modernization of heat sources (self-sustaining projects) and heating networks (infrastructure projects). Only within the framework of the implementation of complex projects can raise money for the modernization of heating networks. It is believed that the main advantage of individual heat supply compared to centralize is the ability to account for and control the amount of heat consumed in each apartment. But such an opportunity can be provided in centralized heat supply systems. In new houses, individual heating units are installed that provide weather regulation, and in each apartment there are control valves and heat meters that allow you to control and pay for the actually consumed amount of thermal energy.

5. RESULT:

In the process of modeling, the user independently develops a strategy for reconstruction of the heating network, which can ensure the achievement of the adopted target installations in one or several parameters. The length of the heating networks and their structure by pipe diameters were estimated from the data on the length of the heating networks used to provide heat to the population and communal household consumers, cited in statistical reporting. These networks account for approximately 85-90% of the total length of all heating networks. The length of heating networks is determined based on forecast estimates of the final consumption of heat energy for heating and hot water supply, taking into account losses in the networks, which depend on the efficiency of the reconstruction of the networks, primarily accident rate reduction. Due to the lack in the literature on heat supply of a number of data characterizing the state of heating networks, at the initial stage, approximate expert estimates and assumptions were used, the development of which is an independent task.

5.1. Recommendations:

The magnitude of losses depends on the technical and technological state of the district heating system and the organization of relations between suppliers and heat recipients. The study of heat transport problems has shown that three main factors are crucial: the age structure of heating networks, which largely determines the breakdown of the heating system and the associated this coolant leak; heat losses through the insulation of pipelines; organization of construction and installation works during the laying of heat networks. In this regard, a multifactorial task arises of modeling the dynamics of reliable service of heat networks and the accompanying reduction of heat losses during the development of a district heating system A reasonable solution would be to use only those technologies that will significantly reduce the largest unproductive components of energy loss in the system and at minimal cost will significantly increase its efficiency.

6. CONCLUSION:

The introduction of the developed methodology and computer program for calculating the heat supply system in design and operational practice will increase the reliability and controllability of existing heat supply points and district heating systems. In general, this, in turn, will provide a higher level of comfort for consumers, and will contribute to the active implementation of energy-saving policies in heat supply. It can be concluded that the introduction of a system for monitoring and accounting for released heat at the central heating unit will significantly improve the accuracy of calculating the heat balances of connected loads. At the same time, the amount of thermal energy released into the hot water supply system, measured at subscriber inputs, should be additionally monitored at heating points by installing additional devices Thus, at the end of the twentieth century, energy saving received a large number of effective technologies and new equipment, which can significantly (up to 50%) increase the reliability and efficiency of existing heating systems and design new systems that are qualitatively different from existing ones.

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