COMPLEX OF MEASURES FOR BUILDING ENERGY SAVING

Aitbayev Sanzhar Sakenuly
student
Baiguscarov Dinar Gazimovich
student
Peter the Great St. Petersburg Polytechnic University, St. Petersburg

Abstract. Several ways to improve the energy efficiency of buildings are described. Thanks to the development of science and technology, new thermal insulation materials, thermoregulators in heating and hot water supply systems have been developed. The main advantage with the use of modern energy-saving technologies is to reduce the thermal losses of buildings and structures, and reduce energy costs.

Keywords: energy efficiency, heating and heat supply system, regulated system, decentralization of heat supply.

КОМПЛЕКС МЕРОПРИЯТИЙ ПО ЭНЕРГОСБЕРЕЖЕНИЮ ЗДАНИЯ

Айтбаев Санжар Сакенулы
студент
Байгускаров Динар Газимович
студент
Санкт-Петербургский государственный политехнический университет им. Петра Великого, Санкт-Петербург

Аннотация. Описано несколько способов повышения энергоэффективности зданий. Благодаря развитию науки и техники разработаны новые теплоизоляционные материалы, терморегуляторы в системах отопления и горячего водоснабжения. Главный плюс при использовании современных энергосберегающих технологий является снижение тепловых потерь зданий и сооружений, и сокращение затрат на энергоресурсы.

Ключевые слова: энергетическая эффективность, система отоплений и теплоснабжения, регулируемая система, децентрализация теплоснабжения.

The condition of old houses does not meet modern standards and norms for energy efficiency.

It is necessary to formulate a set of measures to achieve the energy efficiency of buildings. Such as:

1) increase of the thermal power of the effectiveness of the building envelope, including walls, covers and windows.
2) increasing the controllability of heating and heat supply systems of buildings.
3) increasing the controllability of heating and heat supply systems, including through the transition to the use of alternative systems of decentralized heat supply.

Energy-saving design solutions

In Kazakhstan, the policy of "cheap" energy carriers has been carried out for many years, this has led to the fact that a significant proportion of the buildings constructed at the moment are characterized by extremely low level of heat protection, and therefore unacceptably high heat costs for maintaining the necessary microclimate parameters.

On average, for Kazakhstan, the cost of heating is 55 kg of fuel equivalent/(m^2.year) (kilogram per square meter of fuel equivalent per year) and for hot water supply of 19 kg of fuel equivalent/(m^2.year), i.e. the total heat consumption of the thermal energy is 74 kg of fuel equivalent/(m^2/year), whereas, for example, in Scandinavia, the total heat consumption of thermal energy is 18 kg of fuel equivalent/(m^2.year).

Among the main reasons for the depressingly low energy efficiency of buildings, experts call the insufficient thermal resistance of the main building structure. On average, in the previously constructed buildings in Kazakhstan, the resistance to the heat transfer of the walls is 09.-1.1 m2°C/W, windows 0.39-0.42 m2°C/W, coatings 1.5 m2°C/W, which is 2-3.5 times less than in the countries of Western Europe.

Studies show that when operating a traditional multi-storey apartment house, up to 40 % of heat is lost through the walls, 18 % through the windows, 10 % from the basement, 18 % from the roof and 14 % from ventilation. From the data given, it follows that insufficient thermal resistance of enclosing structures most significantly reduces the energy efficiency of buildings. However, by insulating only the enclosing structures, it isn't possible to achieve a significant reduction in heat losses, since a significant proportion of them are accounted for by the so-called "cold bridges", that is, areas of intensive heat exchange with the environment. Such areas are most often formed in the place of contact of slabs with bearing walls, in places adjacent to the outer walls of internal walls and partitions, as well as when subsidence of poor-quality heat-insulating material in three-layered inclosing structures with a heater as a middle layer.

Therefore, modern thermal insulation systems provide for the creation of an integrated protective thermal envelope around the building structure. Such a shell includes the warming of soil-contacting foundation constructions in combination with the warming of pitched or flat roofs, as well as the arrangement of ventilated facades that move the zone of positive temperatures into bearing structures. This set of measures excludes the appearance of "cold bridges", raises the thermal resistance of the fence and prevents the condensate from falling out, which adversely affects the heat-insulating and other operational characteristics of the structures.

Along with the obvious need to increase the thermal resistance of building structures, it is also necessary to upgrade the engineering systems - ventilations and heat supply. Modern technical solutions in this area allow optimizing the area allow optimizing the arrival and distribution of heat in the building. However, this approach requires considerable and sometimes radical changes in the scheme of centralized heating, which is common in Kazakhstan.

The most preferred method of increasing the thermal protection of reconstructed buildings is the external thermal insulation of walls with the use of effective thermal insulation materials. At the same time, a substantial increase in the thermal engineering uniformity of the outer fences is provided, simplicity of the constructive solutions of the additional heat protection, the possibility of warming the building without eviction of the tenants, preservation of the existing useful area, a significant improvement in the temperature and humidity regime of the existing external fences.

Dissemination in construction practice has received the design of external thermal insulation, which can be conditionally divided into "wet" systems with plastering of a plate (preferably – mineral wool) insulant, and "dry" ventilated system with a lining in relation to the layer of thermal insulation.

For the insulation of coatings, attics and socle floors, light effective thermal insulation materials are used. They are laid on the surface of existing coverings and attic floors, and in the case of socle floors - placed in the space between the floor and the supporting structures or fixed on the ceiling of the basement and underground spaces.

Energy-saving engineering solutions

According to experts, energy sources, various specialized equipment, control and measuring instruments, allow reducing heat consumption for heating and air heating by 25-35 %. Such measures include:

1) Increase of reliability and efficiency of work of heat sources.
2) Autonomous hot water systems using gas or electric heaters and solar panels.
3) Increase of reliability and efficiency of work of heat sources.

Water treatment

To ensure the required quality of make-up water and network water, it is necessary to ensure the correct conduct of water treatment at heat sources.

To soften water with an initial hardness of no more than 6 mg-eq / l, it is advisable to use complex water treatment.

Integrated water treatment replaces traditional (sodium and H-cationing).

Complex dosage is provided by an installation operating in an automatic mode and not requiring constant maintenance and monitoring. The installation is compact and does not require water consumption for own needs. The consumption of complexone depends on the hardness of water and usually does not exceed 1 g per 1 m^3 of make-up water.

The cost of complex processing is much lower than the traditional one. The payback period of the dosing unit is 6-9 months.

An important part of water treatment is the deaeration of water, without which it is impossible to insure the absence of deposits and fistulas in boilers, heating networks and engineering systems of buildings. However, in many boiler houses it is either not carried out, or it is performed poorly.

For a good deaeration, it is recommended to use a new type of deaerator – slotted deaerators, which do not require steam. They are compact, do not need maintenance, exclude water hammers.

The payback period of slotted deaerators depends on their capacity and is no more than 1.5 years.

Protection of accumulator tanks against aeration and corrosion

To exclude the aeration of water in the storage tanks used in open heat supply systems, it is recommended to use a "steam cushion" (if there is steam in the boiler room) or sealing liquids.

Due to the low protective properties of paint coatings existing at the present time at a temperature of up to 95 °C, it is not recommended to apply them for protection against internal corrosion of accumulator tanks.

For this purpose, electrochemical cathodic protection of the inner surface of the tanks should be used, using as poorly soluble electrically conductive elastomeric materials.

Hydrochemical washing and electrohydropulse cleaning of boilers

The presence of deposits on the surface of heat exchange in boilers significantly worsens the characteristics of the boiler equipment. The presence of 1 mm of deposits increases fuel consumption by approximately 12 %. In the case of poor-quality water treatment or its absence, the thickness of the deposits can be much higher.

The choice of the composition for dissolving the deposits is carried out depending on their composition, as in the case of water heaters.

As practice shows, for hydrochemical washing of boilers in many cases, 5 % hydrochloric acid (effective payback period 0.7 years) is quite effective. But it should be used only in the presence of effective corrosion inhibitors. The use of traditional inhibitors (for example, urotropin, thiomycin) is not very effective in hydrochemical washing, since iron corrosion in the detergent composition is higher by 1 g / l, the corrosion rate of the metal in their presence increases by 2 orders of magnitude.

For these purposes, a new corrosion inhibitor, developed by AKH and the Institute of Physical Chemistry of the Russian Academy of Sciences, is suitable. It reduces the rate of corrosion 20 times compared to hydrochloric acid inhibitors.

For hydrochemical washing of boilers can also be used waste complexones, as well as mixtures of organic and mineral acids.

If there is more than 5 % silicon in the sediments, the hydrochemical washing method of the boilers is not suitable.

Pump capacity control

Significant energy savings are achieved by using a frequency-controlled electric drive of network pumps of a heating boiler house, pumping stations of water supply and sewerage, house pumping pumps, pumps of central heating points, etc.

Electricity is saved by reducing the excess head at the output of pumping units, as well as increasing their efficiency.

When using the equipment of frequency converters, the resource of technological equipment is increased, the wear of switching equipment is reduced, the reliability of protection against emergency regimes is increased. Frequency converters allow:

1) reduce the starting current of the motor and insure a smooth start and stop of the pumps;
2) to reduce the consumption of electricity while reducing the required head;
3) carry out automatic restart of the pump;
4) ensure the protection of the pump unit from all types of malfunctions.

Control of the frequency regulation equipment is carried out by the built-in controller, which provides:

1) maintaining the set pressure at flow rate changes;
2) execution of the required sequence of pump starting and stopping operations;
3) technological interlocks;
4) identification of accidents;
5) performing the operations of reclosing or automatic activation of the reserve unit;
6) collection and transfer to the control center of information about the operation of the pump.

The equipment of the adjustable drive optimizes the operation of a group of pumping units (2-3 pumps).

The cost of frequency control equipment is quite high (on average 120-150 dollars per 1 kW of electric drive power). However, the energy savings during the regulation reaches 20-30 %, as a result of which the cost of this equipment pays off, as a rule, for a period of not more than 2 years.

Given the complexity and high cost of equipment, the introduction of frequency control systems should be carried out on the basis of a relevant project with a feasibility study.

Automation of the control of work of heat sources

An important and mandatory part of the work on energy and resource saving on heat sources is the automation of control over the operation of equipment, the production and release of thermal energy and water.

At the output of the boiler rooms, heat meters must be installed in order to control the supply of heat to consumers, flow meters for controlling the flow of make-up water, pressure sensors and other instrumentation.

In order to provide centralized control over the production and supply of heat, it is advisable to connect the boiler houses to an automated control and management system.

Autonomous hot water systems using gas or electric heaters and solar panels.

In the absence of a centralized hot water supply, special equipment should be used. For this purpose, water heaters (flow and storage) are intended, which, by the method of installation, can be:

- autonomous.
- integrated in the design of the heating boiler of an individual heating system.

Depending on the type of energy source used, stand-alone devices for obtaining hot water can be electric or operate on gas. It is obvious that the installation of a gas water heater is most suitable in case of connection to a centralized main (there are models operating on balloon gas, but the cost of their operation is quite high). If there is no "blue fuel", the choice is made in favor of electrical equipment.

In addition to these most important conditions, there are a number of other factors that will, to some extent, determine the rational choice of water heating equipment and its consumption regime. Namely: the need for the amount of hot water and the mode of its consumption, depending on the number of water intake points and the number of residents listed in Table 1, the performance of the device, the state of the electrical networks, the design architecture, environmental aspects, the established service, the price, and, of course, the availability in the house of running water.

Table 1

The need for the amount of hot water and the mode of its consumption

Average statistical need 1 person in hot water (l)				Hot water consumption in water intake point (tentatively) (L/min)			Power flowing water heating equipment in points water intake (kW)			
sink/ wash-basin	washing in the kitchen	shower	bath	wash-basin/ washing	shower	combined points	wash-basin/ washing	shower	bath	jacuzzi
15	25	70-100	180	1,8-2	about 4	over 4	03 june	7	20 okt	26-32

Autonomous and electric water heaters

Electric water heaters are divided into flow and storage.

The flow-through heats the water almost instantly as it passes through the housing with a thermoelectric heater. It is activated automatically, immediately after the hot water tap is turned on. Advantages of a flowing water heater are quite numerous: compact dimensions, instantaneous heating, and as a consequence, hot water is always available.

Devices of this type with a capacity of 3-6 kW are rated for a standard voltage of 220 V. Their capacity is 2-3 l / min of hot water at a temperature of 25-30 ° C (the function of the device is based on the principle: the less water passes through the heat exchanger, the stronger Heats up). At the points of water extraction with a large demand for hot water, a more powerful (from 7 to 32 kW and above) water heater is needed. Typically, domestic wiring is not designed to connect such a powerful device, so for its power supply you will need a separate line with its own circuit breaker, wires of the appropriate section and ground. Water heaters with a capacity of more than 10 kW (for example, German SIEMENS) are designed for three-phase power supply. In addition, such models can only be used at a single point of draw-off. These limitations are the main limiting factors in the use of devices of this type.

The second type of electric water heaters is accumulating (boilers), which are equipped with a capacity for recruiting water from 10 to 500 liters and higher. In contrast to flow-through, where the heating of water begins at the moment of its flow, in the storage water heaters, the heating of the water to a predetermined temperature occurs in advance, and as a rule, using relatively low power.

Storage water heaters are very popular, first, because of the low power of the heating elements, which allows them to be installed in almost any room.

The second advantage is that heated water can be consumed by several water points at the same time. Choosing a water heater, you need to proceed from the fact that appliances with a volume of 5-15 liters can "cope" only with a sink and washbasin. Water heaters with a capacity of 30-50 liters can be used for showering. If you plan to use the bathroom, you need a tank with a volume of 80-150 liters. If the demand for hot water is even greater than it is advisable to use a storage water heater for 200-500 liters.

Autonomous gas water heaters

Like electric, gas water heaters are also divided into flow and storage. A flow-through water heater running on gas is a gas column. Structurally, it consists of a metal casing, inside which there is a burner, which heats the water passing through the heat exchanger, and an automatic system that ensures its safe operation, including protection against boiling. When the tap is opened with water, the valve opens and the gas enters the burner. Gas combustion products are removed through the chimney located at the top of the box, and the hot water pipe goes to the consumer. There are two options: piezo or electric ignition of the burner. Gas columns with piezo ignition are switched on by pressing a special button, and when the column is disconnected, the ignition wick remains, which ensures further ignition of the burner.

In the columns with electric ignition from the batteries, the inclusion occurs automatically, due to an electric spark. Water heaters with electric ignition are more economical, since there is no igniter with a constantly burning flame. Modern columns have protection against emergency situations and turn off when overheating, insufficient chimney draft, in case of flame fading, gas leakage, lack of water in the heat exchanger, etc. Gas columns are widely used due to their compactness. The performance of these devices for hot water is from 10 to 17 l / min at a power of 17 to 30 kW and a minimum pressure of 0.1 to 1.0 atm.

The scope of another type of gas-powered appliances (gas storage water heaters) is somewhat limited. The reason is a rather large size. However, if the area allows, then it is better to use them. Structurally, the gas water heaters are made in the form of a cylindrical heat-insulated tank, at the top of which a chimney is inserted, and a burner is located at the bottom. Like gas columns, the device has control and protection elements: heating indicator, main and backup thermostats, a thermometer for monitoring the temperature of water heating. With the help of a working thermostat, you can set the desired water temperature in the range of 40-72 °C. In devices of this type, the possibility of storing hot water for future use with its heating is combined with a rather powerful gas burner of 7-26 kW. A 150-liter storage heater is sufficient to provide three to four pumping points.

The main advantage of gas water heaters is their resistance to water and gas pressure drops.

The safety of the machine is provided by four degrees of protection: it automatically turns off when the chimney draft is reduced, when the ignition burner is exhausted or if any technical malfunction occurs, and the main burner is switched on only when water enters the heat exchanger and if there is a flame.

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