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ENERGY EFFICIENT SYSTEM OF URBAN AUTONOMOUS HEAT SUPPLY BASED ON HEAT PUMP TECHNOLOGY

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ABSTRACT

In this article, the essence of the proposals is the introduction on a mass scale of small reversible heat pumps (HP), which are installed in each apartment. At the same time, the connection of the house to the centralized city heating system is carried out not to the "direct" pipe, but to the "reverse" one, in which the water temperature is 40 - 50°C. Heat pumps, cooling this water, pump heat to the room air, the temperature of which is ≈20°C. In this temperature range, the thermal efficiency of HP will have a value of 5-6. The consumption of heat from "return" water makes it possible to connect new heat consumers to overloaded heating mains .

The described method of modernizing the heating system, based on the technology of heat pumps, in conjunction with other systemic measures - such as building insulation, laying new heating mains with polyurethane foam insulation - will reduce fuel consumption for heating by 2-3 times. The implementation of this approach throughout the country as a whole will not allow to reduce CO2 emissions by 300-500 million tons per year. This figure can be compared with the total CO_2 emissions from all power plants in Japan, which is 302 million tons. Given the global situation with the greenhouse effect, it is fashionable to count on the investments of international funds in the development of a new heating system in Russia. The scope of heat pumps is widely used in various industries, residential and public sectors:

- in public buildings with air conditioning, reversible heat pumps are usually used to provide cooling during the warm period and heating during the cold period of the year;
- in the housing and communal sector, with the help of HP, autonomous heat supply of cottages and individual buildings for heating and hot water supply can be carried out, as well as air

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conditioning is carried out in the summer season;

- at industrial enterprises of various industries, heat pumps are used to utilize heat from low-potential process emissions, water circulation systems and wastewater, in order to use such heat for heat supply, heating and hot water supply.

If necessary, the cold produced by heat pumps is also used. [L.1;, 2;,3;].

Discussion. Autonomous heat supply of cottages, individual houses (including schools, hospitals, etc.), urban areas, settlements mainly use heat pumps with a heat output of 10 ... 30 kW per unit of equipment (cottages, individual houses) and up to 5.0 MW (for regions and settlements). Groundwater is mainly used as sources of low potential heat.

(T_{int} = 8-15 °C), soil (T_{int} = 5-10 °C), water of rivers and lakes (T_{int} = 5-20 °C),

The heat of ventilation emissions and sewage (T_{int} = 10-30 °C). Decentralized heat supply makes it possible to use modern low-temperature heating systems with a coolant temperature Twt = 35…60°C, which provide sufficiently high $_{HPI}$ conversion factors μ= 3.5…5.0. The use of decentralized heat supply systems based on heat pumps in areas where there are no heat networks, or in new residential areas, avoids many technological, economic and environmental disadvantages of district heating systems. [L.3;, 4;].

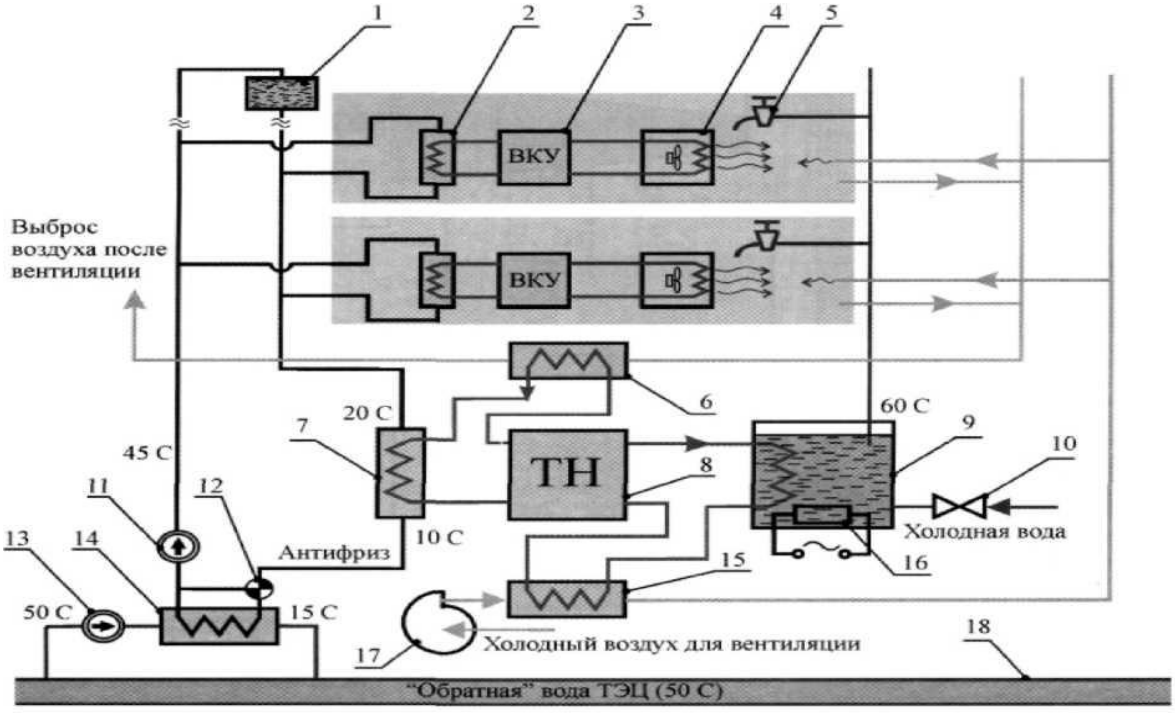

Fig.1 - Heat supply scheme

***1* - reservoir for coolant; *2* - heat exchanger; *3* - *all-* season climatic installation; *4* - air heat exchanger; 5 - hot water tap; *6* - air heat exchanger; 7 - heat exchanger; *8* - heat pump; *9* - hot water tank; *10* - automatic cold water valve; *11* - pump; *12* - *two-* way valve; *13* - pump; *14* - heat exchanger; 15 - heat exchanger; *16* - additional electric heater; *17* - blower; *18* - main pipe with "reverse" water.**

Competitive with them in terms of economic parameters can only be regional mini-boilers running on gas (if we neglect environmental requirements). A significant number of such installations are currently in operation. And in the future, in connection with the adoption of the Kyoto agreements to limit harmful emissions into the atmosphere and the constant rise in energy prices, the quantitative demand for them will constantly increase. [L.4;, 5;].

The heat supply scheme is shown in the figure. The diagram shows the heat source - "reverse" water. The transfer of thermal energy to the house is carried out through a heat exchanger, in which the coolant is heated up to 45 ° C. Antifreeze can be used as a heat carrier, which guarantees the heating system of the house from defrosting. The coolant is supplied to each apartment, where it transfers heat to freon through a heat exchanger- evaporator. Individual heat pumps (re-equipped multi -split systems, in which there are several air heat exchangers-condensers per compressor) provide a controlled heating process for the entire apartment. After the heat is distributed over the floors of the house, the coolant with a temperature of = 20 ° C enters the basement , where a powerful heat pump is installed (one for the entrance or one for the house). This heat pump is designed to utilize the residual heat of the heat carrier and heat the water in the storage tank with this heat to a temperature of 60 °C. Water is supplied from the tank for hot water supply. The house has a forced ventilation system that uses hot freon after the compressor to heat the air entering at a low outside temperature and cool the air with cold freon before it is removed from the building. The latter is a very important advantage of the new heating system, since houses with sealed plastic windows require a forced ventilation system. This system may additionally include filters that purify the air. [L.4;].

Purpose and objectives of scientific research . Let's list the main advantages of the new heating system, which make it attractive for consumers, practical tests and results of all cities of the CIS.

Studying from the experiences of Russia shows it is possible to distribute economic and environmentally efficient heat supply based on heat pumps.

- The domestic HP acquires a new function - a highly efficient all- season heating system, but at the same time retains the function of an air conditioner . During the hot season, the HP will cool the air in the premises, and heat will be transferred to the coolant, which will continue to circulate in the pipes of the building, despite the absence of "return" water. The heat collected by the coolant in the apartments is fed to the inlet of the HP, which prepares hot water. [L.5;].

- Residents of houses with a new heating system will have an uninterrupted supply of drinking quality hot water.

- Installation of household HP in apartments will allow residents to control heat consumption according to the readings of electricity meters. Modern domestic air conditioners are equipped with an automatic control system that allows the user to program heat consumption. For example, reduce the temperature in the

room at night and during the absence of residents. According to the experience of developed countries, where such local regulation is used , it gives a reduction in heat consumption by 30 - 50%.

How it works A geothermal heat pump system works like a boiler for heating and as an air conditioner for cooling. The operation of the heat pump is carried out in a compression-condenser cycle. The heat carrier (usually water) is supplied from the ground or reservoir to the heat pump, where the low-potential heat of the Earth is taken and transferred through the system of air ducts or pipelines to the consumer. As a low-grade source of thermal energy, heat of both natural origin (outside air; ground heat, heat of ground and geothermal waters; waters of rivers, lakes, seas and other non-freezing natural reservoirs) and heat of technogenic origin (ventilation emissions, industrial discharges) can be used. , sewage treatment plants, heat from power transformers and any other waste heat).

Information about some sources of low-grade heat (LHT)

Table 1.

INT	DC link medium	Source temperature, °C
ground water	water	8..10
Priming	brine	2..10
River and lake water	brine	3..15
sewer drains	water	10..20
ambient air	air	5..20
Extract air	air	15..25

The cycle is carried out by an electric motor. Electricity drives an electric motor, from which the mechanical torque is transmitted to the compressor. A thermodynamic cycle is initiated and the heat stored in the ground or water is taken away by the heat pump's heat exchangers. Electric energy is spent only on pumping liquid, but there is nothing surprising in obtaining additional energy, because. the heat already accumulated by the Earth is used. Today, heat pumps are produced with thermal power from 2 kW to 200 MW. [L.5;6;].

Conclusions.

Advantages of geothermal systems:

- **Economy and efficiency.**

Low energy consumption is achieved due to the high conversion factor of the system (from 3 to 7) and allows you to get 3-7 kW of thermal energy at the output per 1 kW of energy consumed. The system is

exceptionally durable and will last up to 30 years without much attention to itself. The payback period for equipment usually does not exceed 7 years.

- **Flexibility.**

One unit can control heating, cooling and hot water.

- **Comfort.**

Throughout the year, the desired indoor climate is created, the system works stably, temperature and humidity fluctuations are minimal. There is no noise. Multi- zone climate control is applied .

- **Design.**

The installation occupies a minimum of space and does not violate the integrity of the interior and the concept of the facade of the building, since there is no indoor and outdoor unit.

- **Ecology.**

Environmentally friendly method of heating and air conditioning, as renewable thermal energy of the earth is used. No harmful substances are released into the environment.

- **Reliability.**

Reliable and durable equipment, has a service life of more than 15 years before overhaul. Works in fully automatic mode. Maintenance of installations consists of seasonal technical inspection and periodic monitoring of the operating mode.

- **Security.**

Installations of even high power have a high degree of safety, as they are not associated with combustible or explosive materials, combustion processes, high temperatures.

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