USING LOW-GRADE HEAT OF SURFACE WATERCOURSES IN THE HEAT PUMP SYSTEM HEAT VILLAGE HOUSE

V. Kharchenko, Ph.D.

A. Sychev, a graduate student *

All-Russian Research Institute Electrification of Agriculture, Moscow

Currently, most of the individual heat pump units (HPU), providing heating and hot water supply of residential houses, include heat pump (HP) air-to-air, air-to-water or water-water (brine, brine) and used as a source of low-grade heat (NTP), ambient air, soil or ground water. The share of individual heat pumps using low-grade heat of surface waters in the total number of heat pump installations to date is small. However, this trend has certain perspectives. The main advantage of such schemes to ground source heat pumps are lower capital investment. In addition to natural aquatic environments, there are many relatively warm water bodies and streams, carrying a geothermal or waste anthropogenic heat using a heat pump systems which can significantly reduce the cost of heating.

We have considered the possibility of using low-grade heat of surface watercourses in heating systems based on heat pumps. This approach, that is, the use of heat it streams, it is a special case of the more general problem of the use of heat in surface water heat pump heating systems. However, known to us alone, this topic is not considered, despite the apparent promise of this approach in practice.

The purpose of research - analysis of the possibility of using low-grade heat surface watercourse in the heat pump heating system of the rural house.

Materials and methods of research. For the organization of the selection of heat from the water bodies used a scheme similar to that used in the groundwater heat pump, heat is taken when a large plastic pipe length at which heat transfer medium flows, only in this case, the pipe is laid not in the ground, and the bottom of the reservoir. Such a scheme is clearly justified by the selection of heat from a standing reservoir. For the case of the same watercourse can offer alternative, more effective selection scheme heat (Fig. 1) in which the movement of water in the channel is used for intensification of heat exchange processes, which allows to perform selection system more compact heat (which can play a crucial role, especially in small watercourses), easy to install and more cost-justified.

We chose a heat exchanger in the form of a coil of smooth neorebrënnyh pipe, located in the streambed in the zone of maximum flow rate.

In order to check the practices of the proposed system of selection of heat from a watercourse, to conduct the necessary experiments, measurement and find optimal design solutions was installed an experimental setup.

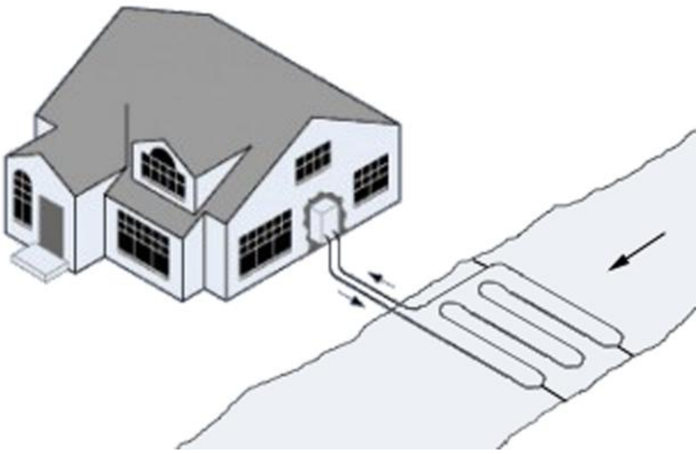

Fig. 1. Selection of low-grade heat from the watercourse of the river with the help of a heat exchanger

Installing a heat pump heating and air conditioning system of a residential building of the water-air heat output 5 ... 7 kW. Selection system is mounted on a heat specially selected ice-water streams. Estimated coefficient of performance (coefficient of performance - COP) during the cold season - 3.5 ... 4.0. As a basis for the manufacture of elements used in series-produced air conditioner (split system air-to-air).

Schematic diagram of the setup is shown in Fig. 2. In addition to the use of special heat exchanger river this experimental setup distinguishes several technical solutions that are not commonly used in the classical heat pump systems, but which give certain advantages and also serve as a subject of study. These decisions, for example:

- The use of variable-speed compressor and circulating pump low temperature circuit;
- Direct heating of indoor air in a heat exchanger, condenser heat pump without intermediate circuit and a closed vent system for the distribution of warm air around the house;
- The ability to connect to the system of additional sources of low-grade heat.

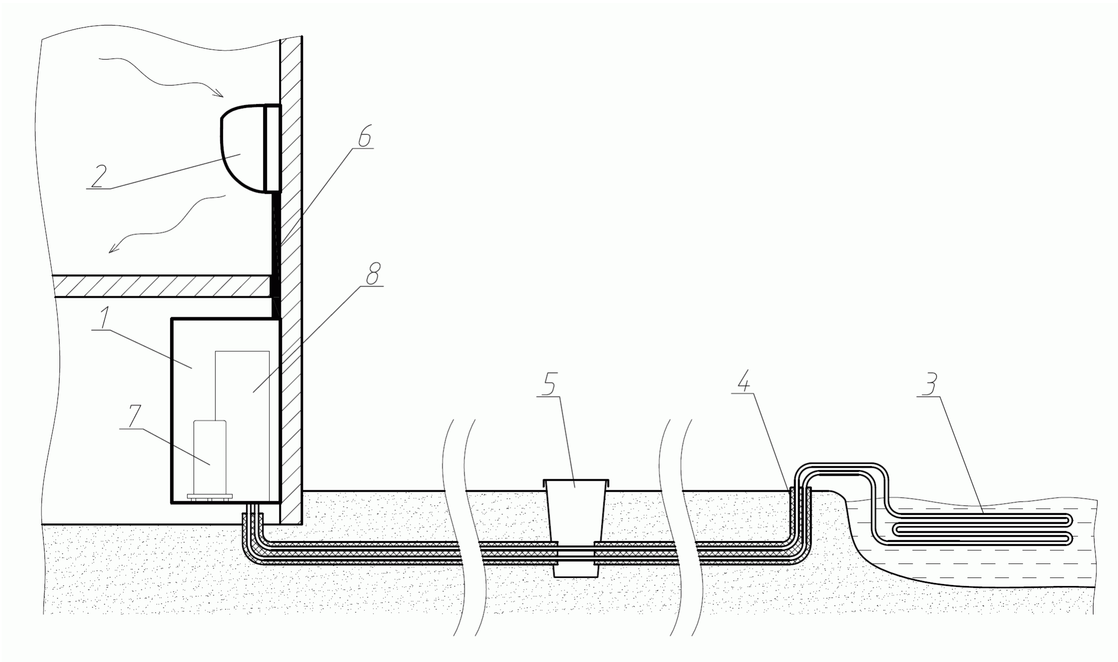

Fig. 2. Schematic diagram of the experimental setup:

1 - external power TN; 2 - the indoor unit TN; 3 - exchanger water-brine; 4 - warmed underground pipeline; 5 - Inspection well, the point of connection of additional sources of NTP; 6 - Refrigerant; 7 - compressor TN; 8 - heat the brine-freon

For this circuit the heat pump efficiency depends on such parameters as the size and configuration of the heat exchanger of the river, the specific type and flow rate, and others. In this case, on the total COP entire system also affects the power needed to circulate the coolant.

To estimate the parameters of TNU and identify ways to improve the efficiency of TN was developed calculation programs in environment MathCAD, which is on the entered data source allows you to simultaneously account for a variety of lengths and pipe diameter coil and the coolant flow rate, and produce results in the form of tables and graphs, on which You can easily determine the optimum configuration for each specific case. Design scheme is based on the basic provisions of the theory of heat and mass transfer in heat exchangers.

When the calculated system design program was used to optimize low-temperature heat exchanger and a river on the whole circuit. These calculations allow to find the optimal balance between the size of the heat exchanger, the cost of water flow and conversion factor setting. In addition, the method can be compiled to calculate the low-temperature circuit for yet Rare types of heat pumps - with variable-speed compressor. The main advantage of these heat pumps - higher COP partial power mode, namely, in this mode - 20 ... 50% of full capacity - VT such work most of the time. In these settings, it is desirable to use as regulated circulating pump (ZN).

When using a variable-speed compressor and circulating pump low temperature circuit value of the optimal water flow will depend on the mode of operation of the plant. In low power mode, it is desirable to also reduced productivity CN, otherwise it would consume an excessive amount of power, reducing the overall COP. The calculations for this case is the dependence of the optimal speed TL on the mode of TN (compressor speed).

The results of research. Below are the comparative characteristics of the heat pump with variable-speed compressor for the cases of regulated and unregulated TL. As can be seen from the first graph (Fig. 3) during operation depending on the detected ZN somewhat reduced heat output unit (if necessary, this can be avoided by including ZN full power), but the total power consumption is reduced even further. As a result, as seen from the second graph (Fig. 4), the value of the transform coefficient increases in a low power mode, which allows, in this case saving heating costs per year to 8% energy compared with unregulated TL coupled with variable-speed compressor . But at the same time, the calculations showed that you can use and unregulated TL. With precise selection of productivity losses are obtained within 3%, although it is somewhat reduced maximum heat output TNU.

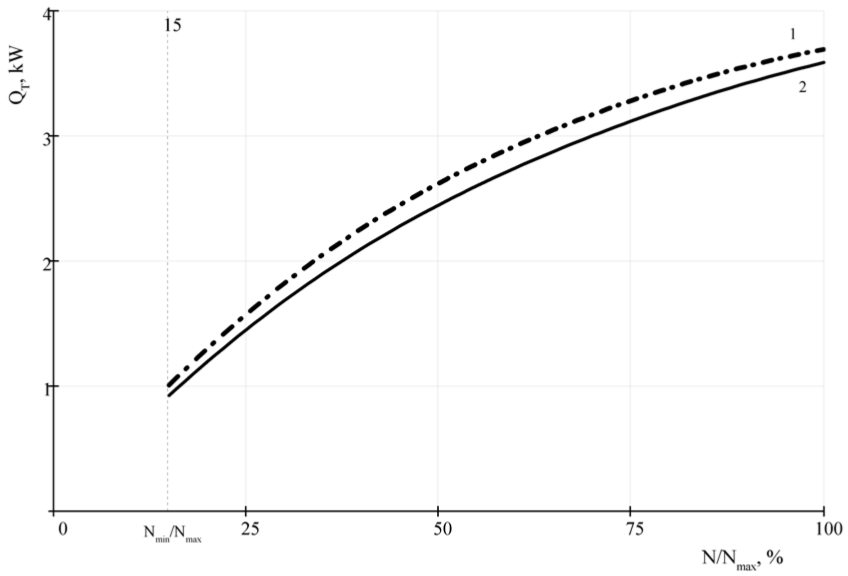

Fig. 3. Heat heat pump at the maximum (1) and optimal (2) coolant flow depending on the operating mode

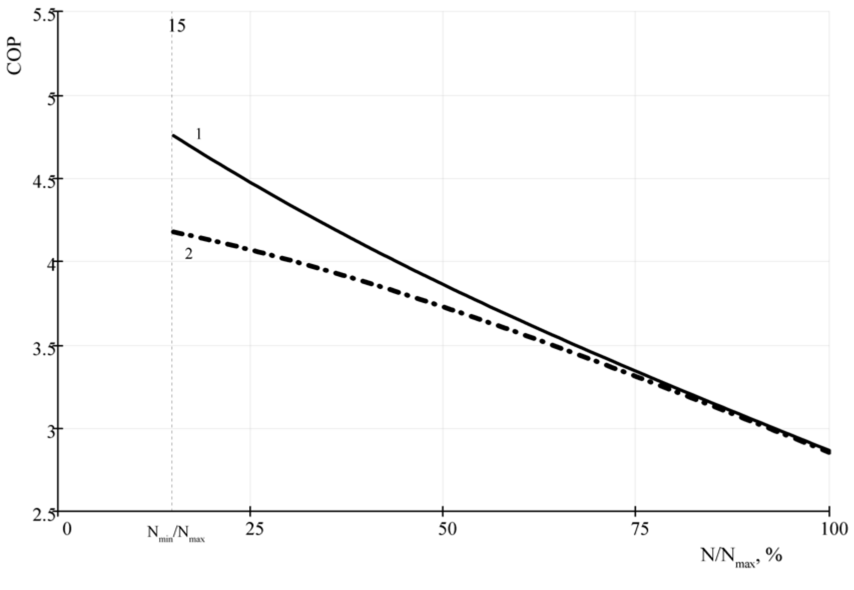

Fig. 4. COP heat pump at the optimum (1) and maximum (2) coolant flow depending on the operating mode

Conclusion

For heating farmhouse is proposed to use heat pump system based on low-grade heat watercourse with a compact heat exchanger open river water-brine in its composition.

Estimated developed a program that allows quickly determine the optimal parameters of low-temperature circuit for the given conditions.

The efficiency of controlling the flow of coolant in the heat pump circuit using a variable frequency drive compressor.