# Use of heat pumping units in heat supply systems

**Khusanov Hamid Gulyamovich**
Candidate of technical sciences, docent of the department "Heat and gas supply, ventilation and service", Samarkand State Architectural and Civil Engineering University

**Yakubov Ulugbek Kutfidinovich**
Doctoral student of the department "Heat and gas supply, ventilation and service", Samarkand State Architectural and Civil Engineering University

ABSTRACT

The main advantages of heat supply systems with non-traditional energy sources are associated with a reduction in energy costs in the life support systems of buildings and structures, the autonomy of life support systems and their environmental friendliness.

Keywords: potential heat, heat supply, energy, heat pump

This article is devoted to the study of the possibilities of developing energy from renewable sources in the territory of the Republic of Uzbekistan.

Significant reserves of low potential heat suggest the possibility of its use for heat supply purposes. The use of heat pumping units in heat supply systems can significantly reduce the cost of high-potential heat.

For the period from 2020 to 2030, it is planned to increase primary energy consumption by 25%, and increase the demand for thermal energy by 40-50%.

Provision of heat needs of the population and industry is carried out mainly by centralized systems. The main sources of heat supply are thermal power plants and boiler houses. However, the energy sector of our republic has great prospects for the use of unconventional and renewable energy sources for the needs of heat supply.

The main advantages of heat supply systems with unconventional energy sources are associated with a reduction in energy costs in the life support systems of buildings and structures, the autonomy of life support systems and their environmental friendliness.

According to the Ministry of Energy of the Republic of Uzbekistan, the large potential of renewable energy sources in Uzbekistan can give a serious impetus to the development of an environmentally friendly and "green" economy. The total potential of Uzbekistan for renewable energy sources is 117,984 million tons of energy, its technical potential is 179.3 million tons of energy.

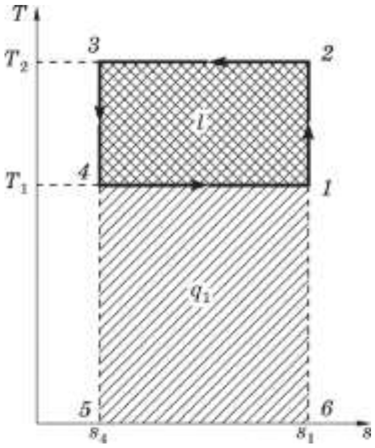
**The potential of renewable energy sources in Uzbekistan**

| Renewable energy sources | Gross potential | Technical potential |
|---|---|---|
| Hydropower | 9,2 million tons of energy | 2 million tons of energy |

| | | |
|---|---|---|
| Wind energy | 2,2 million tons of energy | 0,4 million tons of energy |
| Solar energy | 50 973 million tons of energy | 177 million tons of energy |
| Geothermal energy | 67 000 million tons of energy. | 0,3 million tons of energy |
| Common alternative energy sources | 117 984 million tons of energy | 179,3 million tons of energy |

The use of a heat pump is much more efficient compared to a boiler plant running on natural gas. The use of heat pumping units is advisable in autonomous life support systems of residential and industrial buildings and structures, for the heat supply of individual housing, as well as in combination with a district heating system.

Much attention is paid to the issue of introducing heat pumps into existing centralized heat supply systems. In this case, there are two ways to use the low potential heat from the HEC, the resource of which is significant and increases during the non-heating period. Firstly, it is possible to use process water as a low potential source of heat. Secondly, if the heat pump is installed directly near the consumer, it is possible to use reverse mains water as a low potential source of heat. At the same time, the temperature level of technical and mains water is high enough, which is a prerequisite for the efficient operation of heat pumping units.




In developed countries, 75% of all heat supply systems will use heat pumping units by 2030. In the Republic of Uzbekistan in 2019, the production of organic fuel is 80,873 thousand tons. The total supply is 70993 thousand here. 21,861 thousand tons or 30.8% of the total supply were spent on conversion at power plants and heating installations. Installed capacity – net of power plants - 15,948 MW, including: thermal power plants burning organic fuel (TPP) - 88.0%, renewable energy sources (RES) - 12.0%. Electricity production-gross - 63021 million kWh, including: Thermal power plants - 89.7%, renewable energy - 10.3%. Final electricity consumption - 54175 million. kWh, of which: industry - 32.1%, household consumers - 24.9%, commercial sector and public enterprises - 9.2%, other consumers - 2.2%.

Heat pumps in heat supply systems are designed to increase the heat potential from a low temperature level to a higher one based on the reverse thermodynamic cycle due to energy consumption. A heat pump and auxiliary equipment, such as hydraulic machines, pipelines for the supply and removal of heat carriers, power supply systems, control and regulation, constitute a heat pumping unit. With the help of a heat pump, it is possible to take the heat of the environment, low potential sources of secondary energy resources, for example, from waste water with a temperature of 5 ...1500 C' and transfer it to an environment with a higher temperature, for example, to a heating system coolant.

The ideal cycle of a heat pump, as well as a refrigeration unit, is the reverse Carno cycle, which is shown in figure 1. The reversible isothermal heat transfer process $q_1$ from an external source occurs on part of cycle 4-1 at temperature $t_1$, and the isothermal heat removal $q_2$ - at temperature $t_2$. Compression is carried out adiabatically at constant entropy s = const, and expansion - at $s_4$ = const. The work in process 1-2 is supplied from an external source.

Figure 1. – Идеальный цикл теплового насоса

The specific heat flow supplied in the 4-1 process

$q_1 = T_1 (s_1 - s_4)$ (1)

Graphically, it is depicted in T-s coordinates by the platform 1456 under the line 4-1 of the process. Specific heat flow diverted from the working fluid.

$q_2 = T_2 (s_1 - s_4)$ (2)

Graphically, it is depicted by the platform 2356 longer than 2-3 processes. The specific work (I) expended in the cycle, defined as the difference between the work of compression ($I_c$) and expansion ($I_s$), in thermal units is equal to

$I = I_c - I_s = (T_2 - T_1)\,\Delta S = q_2 - q_1$ (3)

Using the expression (3), the diverted specific heat flow can be defined as:

$q_2 = q_1 + l$ (4)

This value shows the amount of useful waste water, which is equal to the sum of the heat equivalent to the work in process 1-2 and the heat $q_x$.

The energy efficiency of an ideal heat pump operating on the reverse Carno cycle is estimated by the conversion coefficient, or, as it is sometimes called, the heating coefficient.: $\varphi_T = q_2/l$ (5) или

$\varphi_T = \frac{q_1+l}{l} = \frac{q_1}{l} + 1 = 1 - \frac{T_1}{T_2-T_1} = \frac{T_2}{T_2-T_1}$ (6)

From formula (6) follows' that the conversion factor is always greater than one. For example, if an ideal heat pump cycle is carried out, the temperature of the medium $T_x$, which gives off the amount of heat $q_x$, is 278 K, and the temperature of the room heated by this heat is $T_2$ = 298K, then

$\varphi_T = \frac{298}{298-278} = 14{,}9$

The amount of heat "must be" supplied to the heated room, which is 14.9 times higher than the work spent in the cycle. This is also clearly seen from the comparison in the G-5 coordinates of the sites that graphically determine the values of $q_2$ and l.

**Conclusions:** Heat pumping units have a number of economic advantages in comparison with sources of heat supply on organic fuel. These advantages are mainly due to rising and unstable energy prices, global climate change on the planet.

The economic efficiency of heat pumping units is also connected with the solution of technical problems. Reducing the temperature difference of heat carriers in the evaporator and condenser of heat pumps, the use of cheap types of energy to drive the compressor and pumps of transport of low potential heat carriers increase the economic attractiveness of heat pumping plants.

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