HEAT PUMP. HOW MUCH ELECTRICITY DOES A GEOTHERMAL HEAT PUMP CONSUME?

Yakubov Ulugbek Kutfiddinovich
Assistant of the Department "Heat and Gas supply, ventilation and service"

Annotation: Energy sources for heat pumps can be sunlight, heat from air, water, and soil. The process is based on a physical process by which certain substances (refrigerants) are able to boil at low temperatures.

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Heat pump. Many people ask the question "How much electricity does a heat pump consume? First, the electricity consumption directly depends on the climate and thermal characteristics of the building. Secondly, the hourly consumption in December at -16 °C and the hourly consumption in October at +10 °C on the street are completely different.

Example. Two objects have approximately the same area of the house. The first one has a thermal geothermal pump with a capacity of 17 kW, the other one has a thermal geothermal pump with a capacity of 30 kW (a swimming pool is planned to be added to the house, so the heat pump is installed with a power reserve). The maximum hourly electricity consumption (according to the passport) of a heat pump with a thermal capacity of 17 kW is 5 kW of electricity. Heat pump 30 kW — 9 kW of electricity. But the electricity consumption per month turned out to be less in a house where a 30 kW heat pump is installed, although it would seem that according to the passport it consumes more electric energy. And all because the house, where a more powerful heat pump is installed, is better insulated, respectively, has less heat loss and, accordingly, requires less heat.

In order to find out how much electricity the heat pump consumes approximately, multiply the nominal (according to the passport) electricity consumption by 24 hours and by 180 days. The result obtained in this way may differ from the real one by more than 2 times.

The consumption of electric energy per month is already a more informative indicator, but the months are also different. Over the past 10 years, the average temperature in October is +9,5 °C, in February -3,6 °C. Therefore, the most informative indicator is the annual (seasonal) consumption of electric energy.

How can I still calculate the electricity consumption of a heat pump? Everything is very simple — it is enough to divide the amount of heat required per year (heating season) by the conversion coefficient (COR) of the heat pump.

In order to find out the required amount of heat for heating a house per year, you need to know:

- Heat loss at home.
- Data on climatology.

The following calculation is one of the many methods that exist. New regulatory documents regularly appear, which change the calculation method. It is important to understand that this calculation cannot be accurate, since everything depends on the current climate, which, unfortunately, is unpredictable. Therefore, the figures obtained as a result have a purely informative function, for understanding approximate volumes.

The annual consumption of thermal energy for heating is determined by the formula:

$Qa.r. = z\ Po\ Q\ ((t_{in} — t_m) / (t_{in} — te))$, kW*h

where:

Po — duration of the heating period, day (176 hours);

z — operating time of the heating system per day, h (for residential buildings 24 hours);

T_m — average outdoor air temperature for the heating period;

T_e — the estimated outdoor air temperature for the design of heating and ventilation, °C (-22 °C);

T_{in} — estimated internal air temperature of heated buildings, °C (comfortable temperature +22 °C).

Q — building heat loss in kW.

To calculate the heat loss of a building, it is necessary to use a difficult technique using a huge number of formulas. You can also use special software. However, if you, when building a house, do not neglect the requirements of the DBN regarding the required thickness of the insulation, then it is highly likely that the heat loss of the house is from 50 to 90 Watts per one meter of a square building. Based on our experience in calculating heat loss, we came to the conclusion that the specific value of 75 Watts per square meter is as similar as possible to reality. Thus, the house with an area of 250 sq. m. has a heat loss of 19 kW.

From the formula described above, you can deduce the annual heat consumption per year. Therefore, the annual heat consumption for heating is 40,000 kWh (thermal energy). Now, it is enough to divide this figure by the SOR of the heat pump in order to find out the annual (seasonal) electricity consumption of the heat pump.

It is assumed that you have correctly approached the heating system based on a heat pump, and you have a low-temperature heating system designed.

The maximum temperature of the coolant in such a heating system is 45 °C. This temperature should be applied to the pipes of the Underfloor heating, so that at -22 °C outside, in the room it was +22 °C.

At -10°C, it is no longer necessary to supply a coolant with a temperature of 45°C. It is enough to supply a coolant with a temperature of 41 °C, so that the air temperature in the room is +22 °C. And this is an important point, since the SOR at a coolant temperature of 45 °C differs from the SOR at a coolant temperature of 41°C.

For heat pumps, one degree of coolant temperature changes the heat pump litter by 2,5%.

Let's assume that the SOR of the heat pump we selected at parameters 0/45 is 3,54. Thus, the SOR at parameters 0/41 will be 3,9 (10% higher). Using the heat loss recalculation formula, we calculate the average heat loss for each month (we do not use warm months).

$$Qm = ((t_0 — t_m) / (t_0 — t_{in})) * Q, kWt$$

Thus, it can be seen that in January, the average hourly heat loss is 10,9 kW, since the average temperature in January is -3,4 °C. And so on.

It can be seen that in January the average temperature of the coolant in the heating system is 39°C. In October, it is enough to supply a coolant with a temperature of 34 °C to the underfloor heating to maintain the air temperature at +22 °C.

This means that the litter of our system will change with the change in the temperature outside. We will output the average values of SOR for months.

Now we will output the average litter for the heating season — 4,27.

We divide the annual heat consumption by the waste of the geothermal heat pump, we get the electricity consumption of the heat pump for the year (heating season).

40000 / 4,27 = 9367 kWh of electric energy is needed per year to heat a building with an area of 250 m^2, and to maintain the air temperature in the building at +22 °C.

Inference: The performance coefficient of heat pumps, due to their characteristics, reaches 3-5 units. This means that when 100 watts of electrical energy is consumed by the device during operation, consumers receive approximately 0.5 kW of heating power.

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