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# Heat Characteristics of Heat Pump Device for Heat Supply Systems

**Toshpo'latov Islomjon Adiljon o'g'li**

Doctoral student of Tashkent State Technical University named after Islam Karimov

**ABSTRACT**:This article analyzes the current energy efficiency in the process of using renewable alternative energy sources and using secondary energy resources, the main energy parameters of steam compressor heat pumps in heat supply.

**KEYWORDS:** heat pump, condenser, compressor, evaporator, heating coefficient, cooling coefficient.

## I. INTRODUCTION

Today, in the process of using renewable, alternative energy sources and secondary energy resources, energy production and saving of fuel and energy resources are one of the most urgent problems.In our country, the efficiency of methods of producing thermal energy and converting it into other types of energy, along with the increase in the economic level of the region, also has a positive impact on improving the living conditions and culture of the population.Proper use of energy resources will save the country from the energy crisis.It cannot be said that energy resources are currently being used efficiently.Most thermal energy is lost due to improper use of equipment, inefficient use of equipment, and so on.For example, on average, 25 kg of quality coal is burned per capita per day. This figure grows from year to year.Most of the energy used by mankind (90-92%) comes from oil and natural gas. In Uzbekistan, the main source of energy is natural gas, followed by small amounts of oil, coal and potential energy from rivers. [1]
One of the modern devices used in energy-saving is heat pumps, which simultaneously operate on the basis of energy-efficient and environmentally friendly technologies.

## II. MATERIALS AND METHODS

Their energy parameters are important in assessing the efficiency of heat pumps. This article analyzes the main energy parameters of steam compressor heat pumps. The steam compressor heat pump generates 2.5 to 5 kW of heat per 1 kW of electricity. From practice, it is known that the high-temperature mode of a heat pump in a heat supply system is about 40 ÷ 55 $^0$C. Studies show that the use of heat pumps for heat supply and cold supply can lead to savings of up to 70% of primary energy resources.
Changes in the heating coefficient of the following heat pumps have been determined and analyzed. [2]
The energy balance of the heat pump is defined as follows:

$$Q_{con} = Q_{ev} + L_{com} ; \qquad (1)$$

Here $Q_{con}$ is the heat produced in the condenser (condensation heat of the working medium), kW; $Q_{ev}$ - heat from the low-potential medium in the evaporator (heat received by the working element during its boiling in the evaporator), kW; $L_{com}$ is the operation (power) consumed by the compressor in kW.
Heat pump heating coefficient is calculated according to the following formula:

$$\varphi = \frac{Q_{con}}{L_{com}} = \frac{\alpha * T_{con}}{T_{con} - T_{ev}} ; \qquad (2)$$

Where $T_{con}$ - condensation temperature of working medium, K; $T_{ev}$ - boiling point of working medium, K; a is a factor that takes into account energy losses in the heat pump.
Based on the above equations, the dependence of the heating coefficient on the temperatures $T_{con}$ and $T_{ev}$ was determined, as shown in Figure 1.
The results of the calculation show that an increase in Tcon leads to a decrease in the $\varphi$ coefficient. It can be determined that the ideal heating coefficient of heat pumps is $\varphi$= 2,5 ÷ 10. In the real device $\varphi$ = 1,8 ÷ 6,0

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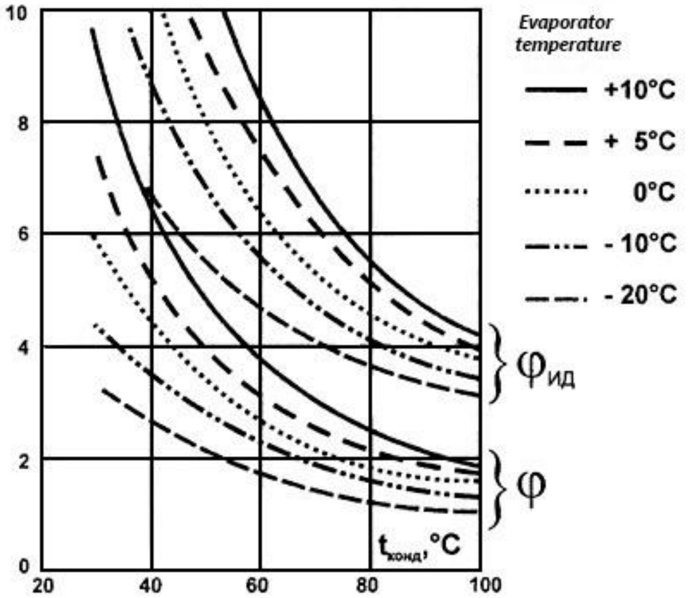


**Figure 1.** The heating coefficient of the heat pump depends on the boiling point and condensation of the refrigerant.

The calculated analysis shows that the more heat generated by condensation of the working medium and transferred to the environment, the higher the heating coefficient of the heat pump.[5] Based on observations, it can be concluded that in the summer mode, that is, in the conditioning mode, at an ambient temperature of + 40 to + 50 $^0$C, the heat exchange between the steam of the working fluid (freon) and the air is significantly reduced and stopped.[9] Therefore, in the condenser part of the heat pump, there is a problem of creating a temperature of 20-30 $^0$C in summer.This condition is observed in the winter mode of the heat pump (heating mode) at an outdoor temperature of -10 $^0$C and below. The energy efficiency of a compressor heat pump is estimated by a heating coefficient (φ). also referred to as φ - heating coefficient or heat transfer coefficient.

$$\varphi = \frac{q_n}{l} = \frac{q_{C_0} + l}{l} = \varepsilon + 1 \quad ; \quad (3)$$

Here e is the cooling coefficient of the reversed Carnot cycle.
If expressed through temperatures:

$$\varphi_F = \frac{T_k}{T_k - T_{C_0}} \alpha \quad ; \quad (4)$$

$\alpha$ - is a coefficient taking into account all losses of the cooling cycle. a = 0.3-0.4.
The exergetic efficiency of the heat pump is calculated by the following formula.

$$\eta_e = \frac{l_{qk}}{l} = \frac{q_k \tau_e}{l} = \varphi \tau_e \quad ; \quad (5)$$

$$q = l_q + a_q \quad ; \quad (6)$$

$l_q$- exergy, $a_q$ –anergy

$$l_q = \frac{q(T - T_0)}{T} q\tau_e \quad ; \quad (7)$$

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$$a_q = \frac{qT_0}{T} = q(1-\tau_e \text{ ;} \quad (8)$$

Here $l_{q-}$ is the specific Exergy of the heat flow in the condenser. φ-coefficient of change of the thermal pump.[6] For an ideal heat pump cycle, $T_к=T$ = T and $TC_o=T_o\eta_{euд}$= 1. The exergetic useful working coefficient (efficiency) of any real device, including a heat pump, suddenly becomes smaller and is an indicator of its perfection.

The main elements of the heat pump include:

1. compressor.
2. condenser.
3. evaporator.
4. control valve.

These devices are connected to each other by a system of sealed pipes in which the working medium circulates.

The difference with the evaporator is increased by:

$$q_{cd} = i_4 - i_5 = i_1 - i_7 \text{ ;} \quad (9)$$

$$q_{co} = i_7 - i_6 \text{ ;} \quad (10)$$

$q_{co}$-evaporator working body temperature;

Decomposable heat in a condenser is the useful heat of a heat pump, which is obtained equal to the next.

$$q_n = i_2 - i_3; \quad (11)$$

Condensatedecomposesinrefrigerator

$$q_{ck} = i_3 - i_4; \quad (12)$$

Internal comparative work performed on the compressor:

$$l_i = i_2 - i_1 = (i_2^1 - i_1) / \eta_i \text{ ;} \quad (13)$$

Comparative operation of compressor motor:

$$l = \frac{l_i}{\eta_{et}} = \frac{(i_2^1 - i_1)}{\eta_i \eta_{et}}; \quad (14)$$

$\eta_i$-internal useful compressor working factor.

We find the coefficient of change of the heat pump (heating coefficient):

$$\varphi = \frac{q_k + q_{si}}{l} \text{ ;} \quad (15)$$

or

$$\varphi = \frac{Q}{N}; \quad (16)$$

At the same time $Q$-total heat capacity, heat capacity released by the heat pump, kW.

N-electric power of heat pump compressor drive, kW,

Mass consumption of working medium circulating in heat pump:

$$G_a = \frac{3,6Q}{q_k + q_{cu}} \text{ ;} \quad (17)$$

Working process of a heat pump is evaluated by exergetic method.

To do this, the equation of the exergetic balance of the device is compiled.

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The exergetic balance equation of the heat pump will look like this:

$$l + lq_{C_0} = lq_u + l_{cu} \sum d_e; \quad (18)$$

Using the exergetic balance equation, exergetics are calculated, which are transmitted in a cycle in all elements of the device and extracted from it. With the results of the exergetic analysis, work will need to be done to improve the energy efficiency of the heat pump. [3,7]

**Exergetic useful heat pump operating factor.**

$$\eta_{enn} = \frac{(q_u + q_{cu})\tau_{eco}}{l + q_{co}\tau_{eco}}; \quad (19)$$

Exergetic analysis of heat pumps shows that when creating comfortable conditions $m_x = +18^0 C$ in the room, it can be considered that an exergetic useful working factor gives a higher efficiency than 1. [4, 8]

## III. CONCLUSION

In summary, an exergetic analysis of steam compressor heat pumps to date shows that when creating comfortable conditions of 18 $^0$C, the indoor temperature can be considered high, since the efficiency of the exergetic is higher than 1. This, in turn, can be considered in accordance with the plan of measures for the development of our country's economy using modern alternative sources of energy.

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