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Analysis Of Energy of Heat Pump Heating System with The Environment

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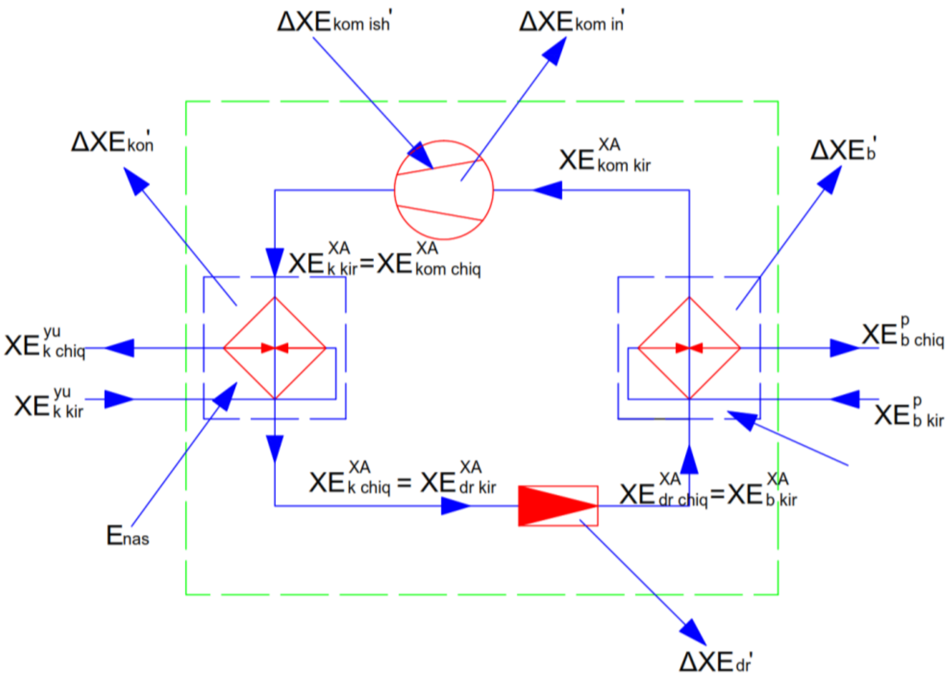
Annotation: The article analyzes the energy generated by the external energy receiver in a heat pump heating system as a result of the system's interaction with the environment until the thermodynamic equilibrium is established, and defines this energy as X energy. The state of this energy is studied in 'lim.

Keywords: X energy, heat pump, condenser, evaporator, compressor, choke, chlodagen, efficiency, enthalpy

Today, in the context of declining global reserves of hydrocarbons in developed and developing countries, the practical use of alternative energy sources as one of the most important factors in sustainable economic development and competitiveness is one of the most pressing issues of the era . being carried out. One of the important directions in this regard is the use of heat pumps based on renewable energy sources for individual households in rural areas. The creation of efficient heat supply systems is a requirement of the period. Since the heat pump heating system has a large amount of energy flow, which differs both in quality and quantity, The only measure of the evaluation we can obtain is the X energy of this work. We can look at this energy as an interaction with the environment by an external energy receiver until its thermodynamic equilibrium is established.

The mathematical model of X energy flows in a heat pump heating system allows not only to evaluate the efficiency of the whole installation but also to analyze the heat exchange of individual heat carrier flows in each processing device in the system.

The functional diagram of a heat pump heating system (Figure 1) shows the X energy flows entering the elements of the heating system.



(Figure 1) Functional diagram of a heat pump heating system

In the functional scheme of the heating system, the following symbols are adopted

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$XE^{p}_{b\,kir}$; $XE^{p}_{b\,chiq}$ - X energy of low-potential heat carrier (water) in the inlet and outlet areas of the evaporator, respectively, kJ / kg.

$XE^{yu}_{k\,kir}$; $XE^{yu}_{k\,chiq}$ - Exergy X energy of high-potential cooling water in the inlet and outlet areas of the condenser, respectively, kJ / kg.

$XE^{XA}_{kon\,kir}$; $XE^{XA}_{k\,chiq}$ - X energy of the coolant (chlodagen) in the inlet and outlet areas of the condenser, kJ / kg.

$XE^{XA}_{kom\,kir}$; $XE^{XA}_{kom\,chiq}$ - - X energy of the coolant in the inlet and outlet areas of the compressor, kJ / kg.

$XE^{XA}_{dr\,kir}$; $XE^{XA}_{dr\,chiq}$ - X energy of the coolant in the inlet and outlet areas of the throttle, kJ / kg.

$\Delta XE_{b}{}'$ - X energy loss in the evaporator, kJ / kg.

$\Delta XE'_{kom\,ish}$ - loss of X energy in the compressor under the influence of friction, kJ / kg.

$\Delta XE'_{kom\,in}$ - X energy loss in the compressor, kJ / kg.

$\Delta XE'_{kon}$ - X energy loss in the capacitor, kJ / kg.

$\Delta XE'_{dr}$ - X energy loss in the throttle, kJ / kg.

The total thermal X energy of a low and high potential heat carrier (water) is expressed as follows:

$XE_i = G_i \cdot e_i$ (1.1)

Where G_i - heat transfer fluid consumption, kg / s;
e_i - specific X energy of the liquid flow at the appropriate temperature, kJ / kg

The specific X energy of the fluid flow, kJ / kg, is determined as follows.

$$e_i = \tau_i \cdot h_i$$

where τ_i- - the thermodynamic function of the cooling water flow, determined by the formula

$$\tau_i = 1 - \frac{(273 + t_{t.m})}{T_i}$$

Here, $t_{t.m}$ the temperature of the external environment °C;
T_i - temperature of the liquid at a certain point °C;
h_i - enthalpy of the medium at a given point, kJ / kg.

The X energy of a low-potential heat carrier (water) is as follows.

$XE^{p}_{b\,kir} = G_p \cdot e^{p}_{b\,kir} = \tau^{p}_{b\,kir} \cdot h_4$ (1.2)

Here, h_4 - enthalpy of xlodgen before evaporator, kJ / kg;
$\tau^{p}_{b\,kir}$ - Thermodynamic function of low-potential chlodagen at the entrance to the evaporator.
$\tau^{p}_{b\,kir} = 1 - \frac{(273+t_{t.m})}{T^{p}_{b\,kir}}$, (1.3)
$T^{p}_{b\,kir}$- temperature at which the low- potential xlodgen enters the evaporator, K
Conclusion $XE^{p}_{b\,chiq} = G_p \cdot e^{p}_{b\,chiq} = \tau^{p}_{b\,chiq} \cdot h_1$; (1.4)

$\tau^{p}_{b\,chiq} = 1 - \frac{(273+t_{t.m})}{T^{p}_{b\,chiq}}$; (1.5)

Here $h_1$is the enthalpy of chlodagen after evaporation, kJ / kg;

$T^{p}_{b\,chiq}$ - evaporator temperature of low-potential chlodagen, K
Similarly, the X energy of a high-potential heat carrier is as follows.

$XE^{yu}_{k\,kir} = G_{yu} \cdot e^{yu}_{k\,kir} = \tau^{yu}_{k\,kir} \cdot h_{2a}$ (1.6)

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Here, $h_{2a}$is the enthalpy of xlodgen before the evaporator, kJ / kg, where the thermodynamic function of the low-potential coolant entering the condenser is as follows.

$$\tau_{k\,kir}^{yu} = 1 - \frac{(273+t_{t.m})}{T_{k\,kir}^{yu}}; \qquad (1.7)$$

Here $T_{k\,kir}^{yu}$is the temperature at which the high-potential chlodagen exits the heat pump heating system, K.

The thermodynamic function of the X energy of the chlodagen before and after the compressor is expressed as follows.

$$XE_{kom\,kir}^{XA} = G_{XA} \cdot e_{kom\,kir}^{XA} = \tau_{kom\,kir}^{XA} \cdot h_1\,; \qquad (1.8)$$

$$\tau_{kom\,kir}^{XA} = 1 - \frac{(273+t_{t.m})}{273+t_1}\;; \qquad (1.9)$$

$$XE_{kom\,chiq}^{XA} = G_{XA} \cdot e_{kom\,chiq}^{XA} = \tau_{kom\,chiq}^{XA} \cdot h_{2a}\,; \qquad (1.10)$$

$$\tau_{kom\,chiq}^{XA} = 1 - \frac{(273+t_{t.m})}{273+t_{2a}}\;; \qquad (1.11)$$

The energy of chlodagen for the remaining areas of the heat pump heating system, for the condenser

$$XE_{kon\,kir}^{XA} = XE_{kom\,chiq}^{XA}; \qquad (1.12)$$
$$XE_{kon\,chiq}^{XA} = G_{XA} \cdot e_{kon\,chiq}^{XA} = \tau_{kon\,chiq}^{XA} \cdot h_3; \qquad (1.13)$$
$$\tau_{kon\,chiq}^{XA} = 1 - \frac{(273+t_{t.m})}{273+t_3}\;; \qquad (1.14)$$

for the throttle

$$XE_{kom\,chiq}^{XA} = XE_{dr\,kir}^{XA}\,; \qquad (1.15)$$
$$XE_{dr\,chiq}^{XA} = G_{XA} \cdot e_{dr\,chiq}^{XA} = \tau_{dr\,chiq}^{XA} \cdot h_4\,; \qquad (1.16)$$
$$\tau_{dr\,chiq}^{XA} = 1 - \frac{(273+t_{t.m})}{273+t_4}\;; \qquad (1.17)$$

To develop a mathematical model of X energy flows, it is necessary to define the concepts of "product X energy" and "heat X energy". "Product exergy" includes X energy produced by a high-potential heat carrier in a condenser and an intermediate heat exchanger. the "heat X energy" consists of the water vapor in the evaporator, the X energy given for the cycle in the heat pump heating system, and the X energy given to the refrigerant during the compression process.

The total X energy of a heat pump heating system using a heat carrier is as follows

$$\left(XE_{b\,kir}^{p} - XE_{b\,chiq}^{p} + XE_{b\,kir}^{XA} - XE_{b\,chiq}^{XA} - \Delta XE_{b}{}'\right) + \left(XE_{kom\,kir}^{XA} - XE_{kom\,chiq}^{XA} + \Delta XE_{kom\,ish}' - \Delta XE_{kom\,in}'\right) + \left(XE_{kon\,kir}^{XA} - XE_{kon\,chiq}^{XA} + XE_{kon\,kir}^{yu} - XE_{kon\,chiq}^{yu} - \Delta XE_{kon}'\right) + \left(XE_{dr\,kir}^{XA} - XE_{dr\,chiq}^{XA} - \Delta XE_{dr}'\right) + E_{nas} = 0\;\;; \qquad (1.18)$$

"Product "Product Exergy" is equivalent to the following;

$$XE_{b\,kir}^{p} + XE_{kon\,kir}^{yu} + \Delta XE_{kom\,ish}' + E_{nas} = XE_{b\,chiq}^{p} + XE_{kon\,chiq}^{yu} + \Delta XE_{b}{}' + \Delta XE_{kom\,in}' + +\Delta XE_{dr}' \;; \qquad (1.19)$$

Here E_{nas} X of the pump power

$$E_{nas} = N_{ss} + N_{is} + N_{ch}\,; \qquad (1.20)$$

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Here the N_{ss}, N_{it}, N_{ch} power of the pump to actuate the high-potential coolant, heat-carrying fluid, and liquid waste storage tank waste, Vt.

The X energy loss in the sections of a heat pump heating system can be expressed by the following equation.

$\Delta XE_b{}' = \tau_b^p (h_1 - h_4) - [(h_1 - h_4) - (273 + t_{t.m})(t_4 - t_1)]$; (1.21)

$\Delta XE_{kon}' = (h_{2a} - h_3) - (273 + t_{t.m})(t_{2a} - t_3) - \tau_b^p (h_{2a} - h_3)$; (1.22)

$\Delta XE_{dr}' = (273 + t_{t.m})(t_4 - t_3)$; (1.23)

$\Delta XE_{kom\ ish}' = \frac{(h_{2a} - h_1)}{\eta_{kom} \cdot \eta_{ed}} - (h_{2a} - h_1)$; (1.24)

$\Delta XE_{kom\ in}' = (273 + t_{t.m})(t_{2a} - t_1)$; (1.25)

Here η_{kom} , η_{ed} is the efficiency of the compressor and its electric motor.

The X energy of the cooling water at each individual point is determined taking into account the ambient temperature, so the limit values are determined in the calculation. The advantage of X energy balance is that it takes into account the effect of heat.

In this case, the "heat X energy" is as follows

$E_{is}' = \Delta XE_{kom\ ish}' + E_{nas}$; (1.26)

The efficiency of X is equal to

$\eta_{Xe} = \frac{XE_{b\ chiq}^p + XE_{k\ chiq}^{yu}}{\Delta XE_{kom\ ish}' + E_{nas}}$; (1.27)

The resulting X energy model allows the detection and analysis of energy flows of a heat pump heating system , as well as the detection of energy effects in the system.

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