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ENERGY SAVING WITH THE USE OF A HEAT PUMP SCHEME IN HEAT ENGINEERING

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A number of thermo-technical elements in metallurgy, mechanical engineering and other heat-and-technological complexes operate under sharply alternating thermal conditions, and the thermal loads per element in the nominal mode do not ensure the level of heat flux density reaches the initial boiling point q_{bp}. In extreme conditions (when the element comes into contact with a liquid metal or slag melt, changes in the mode of heat release in the working space, etc.), the density of the heat flux increases several times and exceeds the critical value q_{cr}. The transition to film boiling mode disrupts the hydrodynamics of the cooling cavity, reduces the efficiency of the cooling system, and can lead to the failure of an element due to a violation of its density.

The use of an evaporative cooling system under these conditions requires the supply of cooling water with minimal under heating, within the saturation temperature. This makes it possible to reduce the required density of the heat flux of the boiling point q_{bp} to 0.1-0.2 MW/m^2, with an under heat of 1000K, q_{bp} = 3.0 ÷ 3.5 MW/m^2 is required under these conditions. But with a decrease in heating from 1000K to 0^{0}K, q_{cr} decreases from 3.7 to 1.7 MW/m^2, while at a tenfold increase in q in extreme conditions the system goes into a film boiling mode

The transition of the heat sink system to the convective cooling regime at ordinary temperatures of 20-400^{0}C does not make it possible to use the low-potential heat of the waste water in the closed-cycle water supply circuit with the heat exchanger. The use of a heat pump under these conditions allows to raise the temperature potential of the utilized heat or at least to achieve its stabilization. When calculating the thermodynamic cycle of a heat pump system from the condition of obtaining a stable temperature of the heat carrier - hot water with a temperature of + 650^{0}C after the heat pump (HP) and effectively cooling the agent (water) circulating through its evaporator to + 200^{0}C, the operation of the HP with the conversion coefficient φ = 3.2 ÷ 3.4, at the same time, when the temperature of hot water rises to + 950^{0}C, the value of the conversion coefficient is reduced to the level φ = 2.5÷2.7. It should be borne in mind that in the implementation of low-potential waste heat by means of heat pumps with electric drive, the expediency of such is determined by the ratio between the saved amount of heat from the operation of the heat pump (heating capacity HP) and the amount of heat expended in the electric power system, which can be conventionally assumed 350 g.r.f./(kWh). In this case, even without taking into account the efficiency of the heat source to be replaced by the heat pump (usually this efficiency is assumed within the range 0.88-0.92), the boundary value of the transform coefficient of the HP according to the profitability condition is φ = 0.35/0.123 = 2.85. Nevertheless, when using a cooling system with the use of a HP in the power complex of industrial facilities, where the fuel costs for electricity are lower, the values of the heat transfer coefficient can be no less than φ = 2.85, which will allow the proposed cooling system to be estimated as cost-effective.

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