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The calculation features of consecutively switched on condensers at their composite cooling

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Abstract

Realization of the condensers composite cooling system allows stabilizing condensation pressure, to cut power and water consumption on cold production. The calculation technique providing determination of rational condensation pressure in such systems is presented.

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Keywords: composite cooling, condenser unit, water and air cooling, ecology, economy of energy resources, mathematical model, cold producing machine

1. Introduction

The price of electric energy and fresh water is increasing currently, and their consumption affects the cost of the products increasingly [1-5,10,13]. Cold producing machines represent a class of equipment consuming the most of these resources at the enterprises of various branches. The analysis of the cold producing machine operation shows that pressure (temperature) of condensation and a method of condensers cooling affect energy resources consumption the most. The method of cooling condensers with water and air have various thermodynamic and operational characteristics. Some of them change during the operation period. Therefore, applying only one cooling methods it is impossible to achieve the best operational indicators of the cold producing machine. Applying schemes of condensers cooling with water and air combined is connected with their calculation and regulation issues. In this article, the features of the composite scheme for condensers cooling and its calculation are considered.

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2. Study subject

In works [6,11,12,15] various schemes of switching-on heat-exchange apparatus are proposed. The main of them are a consecutive and parallel switching on along the cooled product. Parallel switching-on of the cold producing machine condensers is considered the most preferable since it allows providing low hydraulic losses in a condenser unit, and also solves the problem of a heat-exchange surface flooding by condensate removal from every heat exchanger. The drawback of switching on the condensers in such a way is a high requirement to the hydraulic resistance uniformity of every condenser in parallel, and the need for complete symmetry of the connecting pipelines. Non-compliance with these requirements leads to flooding of the condenser with the smallest hydraulic resistance and decrease in a useful heat-exchange surface. Considering these features, as a rule, identical condensers are used at parallel connection.

At composite cooling of the condensation unit, it is clear that to provide equal hydraulic resistance values for condensers of water and air cooling is quite complicated. Therefore, the scheme of consecutive condensers switching-on (Fig. 1) is to be considered, since it allows neglecting the hydraulic features of heat-exchange apparatus.

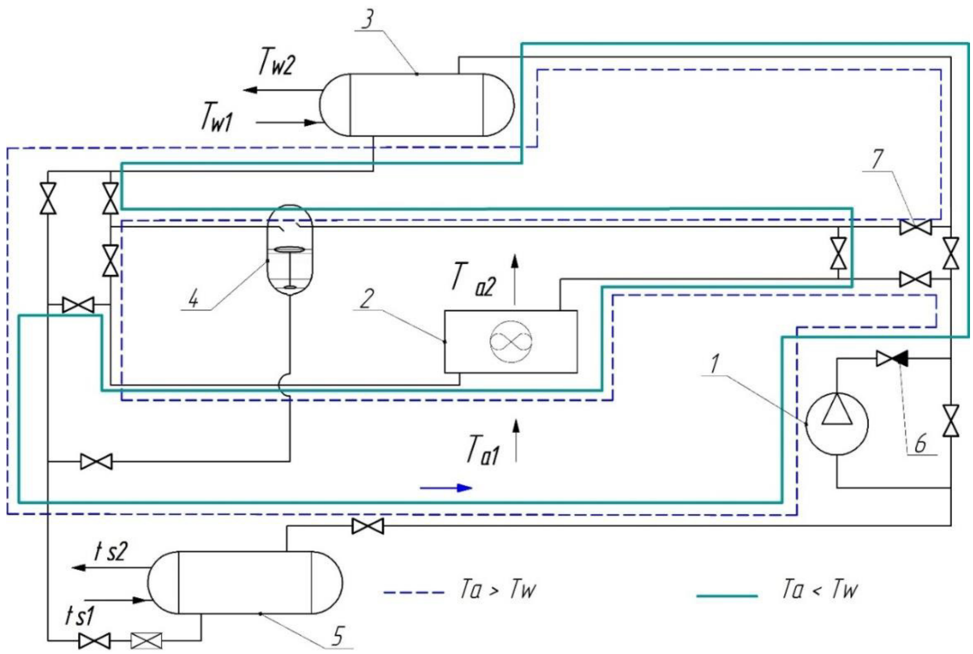

Fig. 1. The diagram of the cold producing machine with a condensation unit of the composite cooling. Patterns of the coolant flow in condensation unit: "from air to water condenser", "from water to air condenser". Ta is the temperature of the cooling air, Tw is the temperature of the cooling water, ts1 and ts2 are the product temperatures at the entrance and the exit of the evaporator, 1 is the compressor, 2 is the condenser of air cooling, 3 is the condenser of water cooling, 4 is the liquid separator.

When condensers are in series, it is necessary to solve a problem of condensate removal after the first condenser along the coolant flow. The need for condensate removal after the first condenser is explained by danger of the subsequent condenser flooding and, also by the essential hydraulic losses along two-phase coolant flow in the condenser [7,11,14,15].

An opportunity to change the sequence of coolant flow in condensers is provided in the diagram of the cold producing machine with condensers in series (Fig. 1), that is demonstrated by a solid line (cooling in water, then in the air condenser) and a dotted one (the inverse sequence).