T. Misiura, Postgraduate student
M. Bezrodny, Dr. of Technical Sc., Prof., research advisor
N. Kovalska, language advisor
The National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute"

THE ENERGY EFFICIENCY ANALYSIS OF COMFORT CONDITIONS MAINTENANCE IN THE PRODUCTION AREA WITH THE AID OF AN AIR HEATING AND VENTILATION HEAT PUMP SYSTEM

Nowadays a process of heat pump systems (HPS) design is more complex than just a straightforward selection of a heat pump (HP) with required heat load which meets the heat supply needs. Several factors must be considered when designing a HPS in order to achieve the ultimate goals: a HP efficiency enhancement and a general reduction of energy consumption.

The most promising direction of HPS application in the sense of energy efficiency is their integration with ventilation and air heating systems of facilities that include large volume premises [1, c. 57]. The introduction of a HP in such systems significantly increases their energy efficiency since the exhaust air heat is utilised in order to preheat the supply air [2, c. 78]. The purpose of the current study is to analyse the energy efficiency of an air heating and ventilation HPS with a variable partial exhaust air recirculation and depending on the ambient air parameters. The system designed to maintain comfort conditions in a production area with an excessive moisture generation inside during a cold period of year is shown in fig. 1.

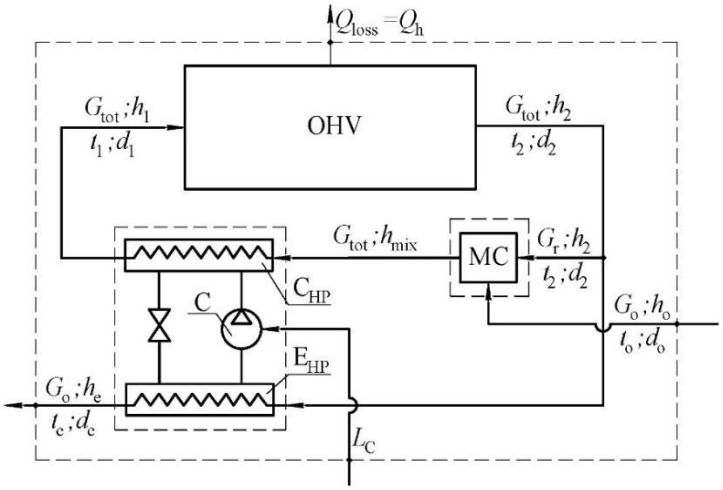

Fig. 1. A general design of an air heating and ventilation heat pump system with a partial exhaust air recirculation: C_{HP} – a heat pump condenser; E_{HP} – a heat pump evaporator; C – a compressor; MC – a mixing chamber; OHV – an object of air heating and ventilation.

A theoretical model of this system has been developed, and a numerical analysis of its thermodynamic efficiency has been performed. It is determined that

an additional heating of the supply air to compensate for heat losses can be estimated using a simple coefficient (i.e. coefficient *K*) which is proportional to the temperature difference of air inside and outside a premise and which is defined by the premise constructional properties along with its required air exchange rate.

The results showed that the exhaust air recirculation coefficient required to maintain comfort conditions inside a premise does not depend on the air heating properties, but only on the properties of the ambient air and the set indoors parameters. This air heating and ventilation system for premises with excessive moisture can ensure the maintenance of the given conditions indoors during the cold and the warm period of year only up to a specific critical temperature of the ambient air which depends on its relative humidity and the set indoors parameters. The system must operate in an air conditioning mode after reaching this temperature.

The calculated values of external energy specific costs were obtained for the current HPS. These values characterise energy efficiency of the system's operation depending on the ambient air parameters. The results show this system to be highly energy efficient in a wide range of both ambient air and premise parameters. This is associated with the favourable temperature conditions for a HP operation, which provide high values of COP (i.e. coefficient of performance), and the exhaust air heat utilisation due to a partial recirculation.

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