CHARACTERISTICS OF THE COMPRESSOR FOR A HEAT PUMP OF AN AIR HANDLING UNIT

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EXTENDED ABSTRACT

OVERVIEW

Energy consumption in buildings is increasing every year. The main consumers in buildings are heating, ventilation and air conditioning (HVAC) systems, which consume half of the energy consumed by the European Union (EU), of which a lot is lost due to inefficient use [1]. It is HVAC systems that require new solutions that open opportunities for creating more efficient products that directly contribute to the achievement of the strategic goals of the EU and Lithuania to reduce energy consumption, use renewable energy sources and improve energy efficiency. The use of heat pumps for heating systems in buildings is not new, but their use in ventilation systems is less common. Recently, the situation has begun to change, more and more manufacturers of ventilation units (e.g., FläktGroup, Mandik, Dantherm A/S, Komfovent, VENTS) offer air handling units with built-in heat pumps [2]. The energy conversion modes of such devices are permanently changing in accordance with the constant change of the outdoor air state (temperature, humidity). Flexibility, the ability to rationally respond to permanently changing ambient air parameters is an important feature of the choice of operating mode of energy transformers and its control. The overall seasonal efficiency of the air handling unit depends on it. The main component dictating the operating mode of the heat pump is the compressor. The change in its operating characteristics should be defined by the functional purpose of the heat pump. At each outdoor temperature, the compressor must have a specific combination of pressure ratio and flow rate. Theoretical models and experimental studies of heat pump compressors are presented in the scientific literature, in which the issues of compressor operation efficiency are analysed. However, these works are more focused on the operating parameters and efficiency of the compressor, little attention is paid to the thermodynamic cycle of the heat pump and its demand. No attempt is made to follow the specific needs of changing the cycle with a compressor. The issue is viewed from the perspective of design solutions, not from the optimal demand mode. This work is aimed at finding out what should be the characteristic of the compressor that effectively operates in the heat pump of the air handling unit, corresponding to the given operating character of the heat pump. More precisely, its specific evolution of the cycle with changes in the outside air temperature.

METHODS

The article analyses the processes of energy transformations in the air handling unit (AHU), the main energy transformers of which are heat pump (HP) and heat exchanger (HRE). HP consists of condenser (CN), evaporator (EV), compressor (CM) and throttle valve (TV). Along with two fans (supply – Fs and exhaust – Fe) and the aforementioned ventilation heat recovery exchanger (HRE) we have an AHU. The interaction parameters of these components under typical AHU operating conditions are analyzed in this work. In the context of this study the characteristic operating conditions include states of the ambient and ventilated room air and HP refrigerant states, primarily characterized by temperatures.

Thermodynamic processes (primarily heat transfer, transfer rates) of heat exchangers (HRE, CN, EV) of an air handling unit are considered similar. The combination of energy balance equations for these heat exchangers reflects the thermodynamic operation of the air handling unit.

From a numerical point of view, the properties of the selected refrigerant are important, but it is assumed that their influence on the processes in the air handling unit is not more special than in other cases of the reverse cycle. The refrigerant R410A is used in this study.

9 variants of air handling units with different combinations of specific heat flow rates (Ak) of heat exchangers (CN, EV) were selected for the analysis.

RESULTS

The change in the compressor characteristic is determined by the functional purpose of the heat pump; at each outdoor temperature (T_e) it must have a certain combination of pressure and flow rates of refrigerant.

The results presented in the article show the dependences of the high- and low-pressure ratios of the heat pump operating cycle of all the considered air handling unit variants on the relative flow rate of the refrigerant. These curves reveal the performance characteristics of the heat pump compressor at specific condenser and evaporator specific heat flows.

CONCLUSIONS

A parametric analysis has been performed. The algorithm applied to it makes it possible to determine the required change of isotherms of the operating cycle of the heat pump depending on the outside air temperature, the characteristics of the accompanying compressor, the possibility of its combination with heat exchangers of heat pumps.

Keywords: air handling unit with integrated heat pump, compressor characteristics, variable outdoor temperature

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