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Summary of the doctoral dissertation entitled: Research and optimization of the three-bed adsorption chiller in trigeneration system.

The work deals with the adsorption refrigeration subject to the Polish climate and energy conditions. The possibility of using network heat to supply air conditioning systems in the summer is very attractive from the perspective of the National Energy System and can have a positive impact on the environment. Adsorption refrigeration technology based on silica-gel – water is currently the only commercially available technology that allows the management of district heat, whose temperature in the summer period is usually no more than around 70°C.
The thesis has been proved in the paper: Adsorption chillers can be supplied with heat at a temperature of about 60°C while preserving the COP allowing for a reasonable conversion of network heat to the cold used for air conditioning.
In the theoretical part of the work, thermodynamic limitations for heat-supplied refrigerators were indicated and the limits of sorption technologies were calculated.
Adsorption chiller was modeled based on differential equations with concentrated constants. The refrigerator model does not include losses and can be treated as a reference model for an ideal adsorption cooler using a silica gel water vapor. The results of the simulation were used to optimize the behavior of the actual refrigerator and to assess the efficiency of the device. The results of numerical simulations indicate the optimal temperature of the heat source at 50 – 70°C, which corresponds to the parameters of district heating during the cooling period.
A test stand was designed for a pilot 3-bed 2-evaporator adsorption cooler with a nominal cooling capacity of 2·45 kW. After the construction of the test stand, a one and a half year cycle of research was carried out adsorption chiller. Research has confirmed the possibility of converting district heat into cold, which can be used for air conditioning. During the measurements on the three-bed adsorption chiller, it was found that by modifying only the control software, it is possible to improve the operation of the aggregate, including the COP indicator. It was decided to implementation these changes. The average COP value from all measurements under the control of the new algorithm is 0.56. Modifications to the chiller's operating sequence did not affect the cooling power achieved. On average, the unit consumed 9 kW of heat less (which, with similar cooling power, gives an efficiency improvement of over 7%). In addition, the temperature variation of the heating water and chilled water has been improved, i.e. the oscillation amplitudes of these quantities have been reduced and the hydraulic impacts have been eliminated. The maximum efficiency of the tested device exceeded 0.7 and such efficiency should be expected for refined constructions working for the needs of air conditioning in properly designed cold sources, which are cooled using a cooling tower.
The last element in the work is the environmental effect in the systemic relation. It has been shown that there is a certain optimal proportion of adsorption chillers in the refrigeration mix of the combined heat and power plant, i.e. such that all unused heat is converted. The use of such heat for cooling purposes saves electric power that would be used up in compressor refrigerators. The resulting reserve of electric power, depending on the COP of compressor and adsorption refrigerators, ranges from 5 to 20% of the amount of heat used.

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