

The Hybrid Model Optimization of the Chiller Infrastructure and Its Preliminary Experimental Results

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Background

The control of compressor speed in refrigeration systems is vital for optimizing energy consumption and enhancing HVAC performance. By dynamically adjusting the compressor motor speed, operations can align with current cooling demands, leading to significant energy savings and improved system efficiency. Effective speed control results in stable temperature regulation and reduced noise levels while extending equipment lifespan and lowering maintenance costs.

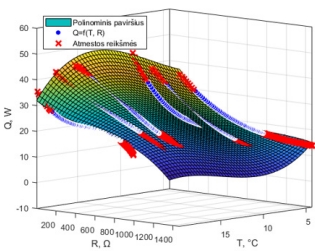
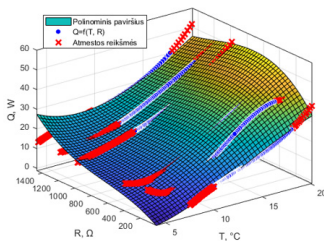


Fig. 2: object model, used for the development of the algorithm

Table 1. Results with applied algorithm compared with stable speed cases

	R0	R1	R2	R3	R4	R5	R(T)
Tank cooldown time in 18-10 °C interval, min	950	690	640	600	630	590	530
Consumed electrical power in 18 - 10 °C interval, kWh	0.594	0.489	0.501	0.510	0.549	0.521	0.428
Average COP in 18-10 °C interval	0.489	0.582	0.583	0.541	0.513	0.531	0.640

Results

The implementation of this control algorithm resulted in energy consumption reductions of 15% to 40% and efficiency improvements of 8% to 20% compared to fixed-speed operations. Additionally, cooling times improved by 11% to 79%, comparing the worst and best fixed-speed results within the studied temperature ranges.

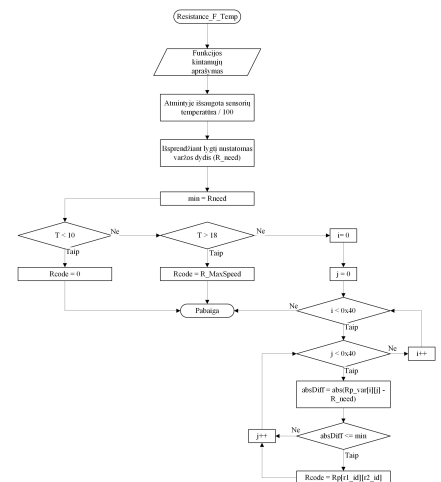


Fig. 1: Compressors' speed control algorithm

Goal

Conducted in spring 2024 at Kaunas University of Technology, this research explores various types of compressors and their control algorithms. The primary goal is to develop a control algorithm for a laboratory cooling system's compressor to boost efficiency. Tests evaluated compressor performance at predefined constant speeds, revealing a clear correlation between speed, refrigerated space temperature, and compressor efficiency.

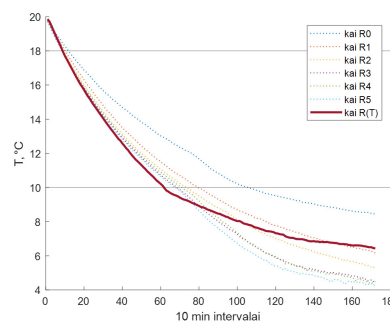


Fig. 3: change in tank temperature with applied algorithm, compared with stable speed cases

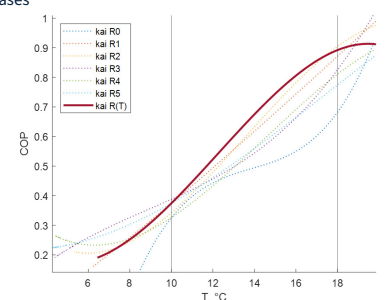


Fig. 4: change in COP with applied algorithm, compared with stable speed cases