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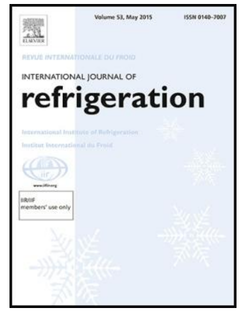

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Optimization and Predictive Control of a Vapor Compression Cycle under Transient Pulse Heat Load

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Highlights

- Critical heat flux avoidance control of vapor compression cycle
- Predictable disturbance rejection
- Model predictive control with disturbance prediction
- Dynamic prediction horizon

Abstract

There are well established control methods to stabilize the vapor compression cycle (VCC) about a given operating point. However, it is challenging to design such local controllers to handle large transient heat flux disturbances, due to complex coupling and constraints, and potential violation of critical heat flux (CHF) which could lead to the damaging dryout condition. Since VCC's are locally stable with relatively slow dynamics, model predictive control (MPC) is ideally suited to address these challenges. MPC solves a constrained receding horizon minimization problem under known transient heat disturbance. The objective function is a combination of the exit evaporator wall temperature, which provides an indication for the onset of partial dryout, energy consumption, and control input effort. This paper presents results from the application of MPC to a VCC testbed in our laboratory. We show that MPC can significantly increase the robustness with respect to transient disturbances by moving the system to an advantageous operating point in anticipation of known disturbances.

Keywords: model predictive control, electronics cooling, vapor compression cycle, critical heat flux

Nomenclature

A, B, B_0, C, D state-space matrices

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