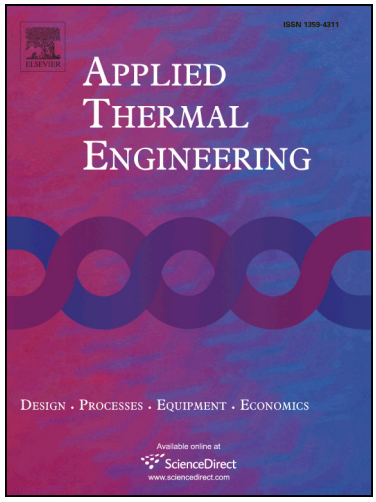

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Automated identification of a complex storage model and hardware implementation of a model-predictive controller for a cooling system with ice storage

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Abstract

Future sustainable energy systems could increase the share of energy converted from fluctuating renewable energy sources by intelligent model-based predictive control of cooling systems with thermal energy storage. This study investigated an experimental cooling system comprising a compression chiller and an ice storage. A runtime-efficient predictive model for partial charge and discharge of ice storage was derived. In addition, techniques for automatic model determination and adaptation were introduced and examined. The experimental setup involved the development and implementation of a model-predictive controller (MPC) to minimize operating expenses under dynamic electricity pricing based on a forward dynamic programming algorithm. The objective function included energy charges, compressor start-up costs, and terminal costs that depended on the state of charge and state of the chiller at the end of the optimization horizon. Three examples of cases validated and compared the advantages of the MPC over an open-loop (day ahead) optimal control concept. The cases examined the influence of temperature and load forecast inaccuracy, and investigated the coping mechanism of the system to sudden updates