

Four E Analysis and Multi-objective Optimization of an Ice Storage System Incorporating PCM as the Partial Cold Storage for Air-conditioning Applications

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Abstract

In the present work, an ice thermal energy storage (ITES) system incorporating a phase change material (PCM) as the partial cold storage was modeled for air-conditioning (A/C) applications. The system was analyzed from energy, exergy, economic, and environmental aspects (4E analysis) for charging and discharging processes. Utilizing genetic algorithm optimization technique, multi-objective optimization of the system was performed and the optimal values of system design parameters were obtained. The exergy efficiency and total cost rate were considered as objective functions. The performance of the combined ITES system (with PCM) was compared with a simple ITES (without PCM) system and also a conventional one. The results indicated that the electricity consumption of combined system was **6.7% and 17.1%** lower than that of the simple ITES and the conventional systems respectively. Furthermore, the amount of CO₂ emission produced in combined system decreased by **7.2% and 17.5%** relative to simple ITES and conventional systems respectively. Finally, the extra capital cost associated with using the storage systems in combined system was paid back with savings in electricity in **3.97** years, while it was 3.39 years for simple ITES.

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