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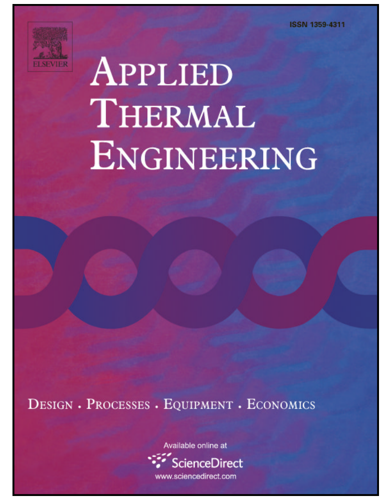

Experimental Study of Water Solidification Phenomenon for Ice-on-Coil Thermal Energy Storage Application Utilizing Falling Film

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Highlights

Thermal Energy storage is used to store energy during off-peak load for later use.

Phase Change Materials storage is the most effective method for storing energy.

New strategy for cold thermal storage (CTS) management of peak loads is presented.

Liquid Falling film was utilized to enhance the heat transfer coefficient of CTS.

Cold thermal storage application presented as best choice for reducing peak loads.

Abstract

In summer season, peak load occurs due to high cooling demand during warmest hours. Thus, cold energy storage systems are used to store energy when it is abundant to reduce electrical energy consumption for cooling during peak load time. Thermal energy can be stored using either sensible or latent heat through phase change materials (PCMs). Ice-on-coil is a common method for thermal energy storage, but its heat transfer rate decreases during charging due to the low thermal conductivity of ice. The system considered here is a dynamic direct ice-making storage unit that utilizes the high heat transfer coefficient of falling film when it falls on the outside of the tube surface in the form of discrete droplets, jets, or a continuous sheet depending on the flow rate. Five parallel circular tubes subjected to different modes of the falling film were tested for formation of ice after being fed internally by cold ethylene-glycol solution. The accumulated ice was measured by recording the changes in weight of the tubing system during the duration of each experiment using an electronic scale. About 1.73 g/m^2.s of ice was formed on the tubing with a starting heat transfer coefficient of 170 W/m^2.K when the falling film was in the jet mode. The information gained here is presented as design factors that can be used to improve the performance of ice-dependent thermal energy storage systems using PCM.

Key words: Energy Storage; Falling Film; Freezing

Nomenclature

A	area, m^2
b	bias limit, -
C_p	specific heat, kJ/kg.K
$\bar{c}$	average thickness, mm
D	diameter, m^2