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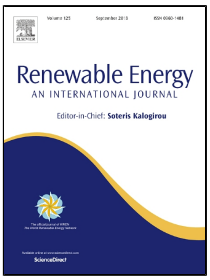

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Numerical analysis of a latent heat thermal energy storage system under partial load operating conditions

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Abstract

One of the features that should be considered when designing a thermal energy storage (TES) system is its behaviour when subjected to non-continuous (partial loads) operating conditions. Indeed, the system performance can be sensibly affected by the partial charging and discharging processes. This topic is analysed in the present study by means of a two-dimensional axisymmetric numerical model implemented in COMSOL Multiphysics. A latent heat TES system consisting of a vertical concentric tube heat exchanger is simulated to investigate the effect of different partial load operating conditions on the system behaviour.
The effects of different heat transfer distributions and evolutions of the solid-liquid interface, are evaluated to identify the optimal management criteria of the TES systems. The results showed that partial load strategies allow to achieve a substantial reduction in the duration of the TES (up to 50%) process against a small decrease in stored energy (up 30%). The close correlation between the energy and the duration of the TES cycle is also evaluated during the discharge using detailed maps related to the melting fraction. These maps allow for the evaluation of the most efficient load conditions considering both charging and discharging processes to satisfy a specific energy demand.

Keywords: Phase change material (PCM), Thermal energy storage (TES), Partial loads, Latent heat, Numerical simulation

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