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Thermomechanical modeling of PCM in heat storage applications

Francisco Montero-Chacón[1] and Michele Chiumenti[2]

[1] Abengoa Research, C/ Energía Solar 1, 41014, Seville (SPAIN),
francisco.montero@research.abengoa.com, www.abengoa.com
[2] Universitat Politècnica de Catalunya, C/ Jordi Girona 1, Edificio C1, Campus Norte, Barcelona (SPAIN), michele@cimne.upc.edu, www.cimne.com

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One of the main challenges in concentrated solar power (CSP) plants is the storage of the thermal energy. Within this context, phase-change materials (PCM) are a promising approach to store and return the energy relying on their large latent heat [1]. For this reason, new types of PCM-based composite materials have arisen.

This work focuses on one type of composite made of paraffin wax inclusions acting as the PCM. Paraffin waxes have very low conductivity; thus these are embedded in higher conductivity matrices. Then, by means of the finite element method (FEM), the resulting material is subjected to different thermal cycles inducing thermal strains that may affect the performance of the heat exchanger system. This problem has been previously addressed by means of analytical models [2] which are valid for simple geometries. However, these models cannot be applied in the case of more complex geometries as in the case of PCM composites.

Thermal cycling effect is analyzed by means of coupled heat transfer and mechanical FEM analyses in order to characterize the phase change process along with the corresponding thermal strains from the heat transfer process. Different material configurations (e.g. geometrical distribution and volume fraction of the inclusions) of the composite material are taken into account in order to determine the most appropriate solution regarding the thermal performance of the heat exchanger system.

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