Editorial

Modeling, Optimization and Testing of Thermal Energy Storage Systems and Their Integration in Energy Conversion Processes

Giorgio Cau *, Mario Petrollese and Vittorio Tola

Department of Mechanical, Chemical and Material Engineering, University of Cagliari, 09124 Cagliari, Italy; petrollese@unica.it (M.P.); vittorio.tola@dimcm.unica.it (V.T.)

* Correspondence: gcau@unica.it; Tel.: +39-070-675-5715

This book contains the successful invited submissions [1–8] to the Special Issue of Energies “Modeling, Optimization and Testing of Thermal Energy Storage Systems and Their Integration in Energy Conversion Processes” on the subject area of “Thermal management”.

The development and the optimal integration of efficient energy storage systems is fundamental for the proper exploitation of renewable energy sources and for enhancing energy efficiency in the domestic, commercial, and industrial sectors. In this regard, thermal energy storage systems could play a key role thanks to a wide range of applications, different technologies available today (based on sensible heat, latent heat, and so on), and relatively low costs.

The investigation of new heat storage materials, the implementation of even more efficient configurations of thermal energy storage systems as well as their integration in energy conversion processes have been gaining interest from the research and industrial sector in recent years, but a further effort in modeling, simulation, optimization, and testing activities is required.

This Special Issue wanted to collect original research contributions related to innovative thermal energy storage systems development and their integration in innovative processes. The list of applications of these innovative processes included, but were not limited to:

- concentrating solar power (CSP),
- combined cold, heat and power (CHP, CCHP),
- compressed air energy storage (CAES, ACAES),
- power-to-X,
- waste heat recovery,
- carbon capture utilization and storage (CCUS),
- solar cooling.

The response to the call for this Special Issue was good, with the following statistics:

- Publications: (8);
- Article Types: Review Article (0); Research Article (8).

Authors’ geographical distribution (affiliation of authors):

- Belgium,
- Canada,
- Denmark,
- Germany,
- Italy,
- Malaysia,
- Pakistan,
- Saudi Arabia,
- the UK.
Figure 1 summarizes type of storage (direct or indirect, single or double tank), storage medium, thermal energy storage (TES) system modeling and applications of storage systems in the published papers.

As can be seen from Figure 1, various types of storage systems (mainly indirect with single tank) characterized by different storage media have been presented in the Special Issue. Mainly 0-D and 1-D simulation models have been developed to analyze TES systems.

The use of thermal energy storage to face the intermittent nature of solar energy has been mainly analyzed in this Special Issue. In this regard, Tascioni et al. [1] numerically investigated the potentiality and the optimal energy management of an innovative Latent Heat Thermal Energy Storage (LHTES) in a small-scale concentrated solar combined heat and power plant. Cinocca et al. [2] proposed a small-scale concentrated solar power plant integrated with an ORC and a packed-bed TES section, using alumina rock as the storage medium and air as heat transfer fluid, to provide a continuous energy production. Sattar et al. [3] investigated the potentiality of using suspended nanoparticles of various materials to improve the absorption efficiency of water in a Direct Absorption Collector in solar applications. Cameretti et al. [4] proposed a solar field equipped with a two-tank TES system integrated with a micro gas turbine fed by hydrogen or syngas.

The adoption of TES in residential applications was another viable and cost-effective application, which is analyzed by three papers of this Special Issue. In detail, Tola et al. [5] carried out numerical simulations for performance prediction of an LHTES system based on a packed bed of encapsulated PCM, designed to store the surplus thermal energy produced during the weekend by a heat pump fed by a photovoltaic plant. Hemmatabady et al. [6] proposed a dynamic exergoeconomic assessment to evaluate various options for integrating a borehole thermal energy storage (BTES) system into district heating and cooling (DHC) grids in heating dominated regions. Fong et al. [7] analyzed the application of a PCM material as a thermal smoothing device in heat exchangers by using a computational fluid dynamics approach. The authors evaluated the ability of the heat exchanger to smoothen out temperature variations within the cold stream outlet, while the hot stream is subject to oscillating inlet conditions.

Finally, the performance of a TES system in a particular cryogenic application, such as liquid air energy storage, was investigated by Morgan et al. [8], in which a comprehensive modelling and experimental validation of a packed bed regenerator, using gravel as storage media, was carried out.
**Funding:** This research received no external funding.

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** Not applicable.

**Conflicts of Interest:** The authors declare no conflict of interest.

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