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Participation in IEA SHC/ES Task 67/40



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The authors bear the entire responsibility for the content of this report and for the conclusions drawn therefrom.



Summary

This project addresses the participation in the International Energy Association's Solar Heating and Cooling and Energy Storage Technology Collaboration Platform Task 67/40. The objective of this task is to support the application-oriented development of innovative and compact thermal energy storage (CTES) materials: Phase Change Materials (PCM) and Thermochemical Materials (TCM). This is a continuation of the previous tasks. The main objectives of this task are to have a better understanding of the factors that influence the storage density and performance degradation of CTES materials, to be able to characterize these materials in a reliable and reproducible manner, to have methods to effectively determine the SoC of a CTES, and to have better knowledge on how to design optimized heat exchangers and reactors for CTES technologies.

The task is subdivided into the following subtasks

Subtask A: Material characterization and database

Subtask B: CTES material improvement

Subtask C: State of charge - SoC determination

Subtask D: Stability of PCM and TCM

Subtask E: Effective component performance with innovative materials

This funding enables the leadership of Subtask E for TCM materials. The main objective of Subtask E is to improve the material-component interaction for optimal system performance. This will be accomplished by defining performance parameters and standardized characterization methods, understanding the mechanisms that determine the performance-related interaction between storage materials and components such as heat and mass exchangers, and identifying and applying methods for improved component and material design. The two deliverables of this task are:

1. A document on material-component interaction performance indicators.
2. Definition of realistic application specific performance charts



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1 Introduction

1.1 Background information and current situation

This task is a continuation of the previous tasks 42-29 and 58-33, which included:

- the characterization of new materials in terms of their properties,
- the creation of a database,
- and the development of test procedures in the laboratory and under reference application conditions.

Further emphasis was placed on the interaction between the storage material and the storage component, with the heat and mass transfer taking place in the component or reactor. First results towards reliable power and energy densities have been derived.

Previous activities have achieved substantial progress in the understanding of compact thermal storage materials and systems and have created a strong base of collaborating experts, both in the field of materials and systems applications, from many countries, mainly within Europe, Canada and Japan.

The tasks are carried out as collaborative efforts between two TCPs - "Solar Heating and Cooling" and "Energy Storage". Experts and Executive Committees of both TCPs appreciated this joint character of the tasks as very effective.

Recognized important points in the Task 67/40 work plan are

- maintain and expand the material data base.
- degradation of PCM and TCM materials (change of relevant material properties) should be addressed.
- The State of Charge (SoC) determination as a link between materials research and thermal energy storage system integration is an important prerequisite for the integration of CTES in any (digitalized) future energy system.
- emphasizes must be placed on digitization: How can TES and TES materials development benefit from emerging digital methods and approaches?

1.2 Purpose of the project

The objective of this task is to support the application-oriented development of innovative and compact thermal energy storage (CTES) materials: Phase Change Materials (PCM) and Thermochemical Materials (TCM).

1.3 Objectives

The main objectives of the task are to:

- have a better understanding of the factors that influence the storage density and performance degradation of CTES materials,
- to be able to characterize these materials in a reliable and reproducible manner,
- to have methods to effectively determine the SoC of a CTES,
- and to have better knowledge on how to design optimized heat exchangers and reactors for CTES technologies.



To achieve these objectives, the work is organized into the following Subtasks:

Subtask A: Material Characterization and Database

Subtask B: CTES Material Improvement

Subtask C: State of Charge – SoC Determination

Subtask D: Stability of PCM and TCM

Subtask E: Effective Component Performance with Innovative Materials

Task experts work on common goals within the subtasks, providing input from their own projects to increase the exchange of experience and knowledge and accelerate the pace of knowledge development.

Each Subtask is led by one or more Subtask Leaders who organize the work toward common goals and deliverables. They also organize Subtask meetings to discuss past activities, progress, problems and challenges encountered, and planning for the next period.

The Task is led by two Task Managers who coordinate the overall work, the collaboration and exchange between the different subtasks, and the reporting and dissemination activities. They also report on the progress of the Task to the Executive Committees of the Solar Heating and Cooling TCP and the Energy Storage TCP.

2 Description of facility

This combined SHC and ES TCP Task consist of around 50 participating institutes mainly from Europe, but also including Canada and Australia. The task has half-yearly in person meetings to discuss progress done in the varying subtask activities. In general, the subtasks also follow online meetings for detailed discussion and work on defined deliverables.

The following in person task meeting have been held:

Meeting 1) 27.-29.10.2021, Vitoria-Gasteiz, Spain.

Meeting 2) 04.-05.04.2022, Graz, Austria.

Meeting 3) 29.-30.09.2022, Kassel, Germany.

Meeting 4) 24.-26.04.2023, Halifax, Canada.

Meeting 5) 2.-4.10.2023, Lyon, France.

Meeting 6) To be held on the 22.-24.04.2024, Horw, Switzerland

3 Activities and results

In the past year, a scientific paper [1] has been published on sorption heat storage performance mapping with liquid sorption material. This publication has served for ongoing further discussion on possible adoption for solid sorption materials.

Discussion on comparative realistic sorption heat storage is ongoing. It has been recognized that realistic, application specific, standardized testing procedures are the basis for comparison. In the previous task, a paper a paper to this purpose was published [2]. This is now being analyzed by the subtask E partners for application on their specific sorption heat storage demonstrators.



4 Next steps

In the final step of this task, the subtask E TCM deliverables will be completed and documented as a guideline for sorption heat storage research and system development. The deliverables are:

1. Document on material – component interaction performance indicators.
2. Realistic application specific performance chart definition.

5 National and international cooperation

This work is inherently international, with partners from:

Australia, Austria, Canada, Denmark, France, Germany, Italy, Netherlands, Portugal, Slovenia, Spain, Sweden, Switzerland, and United Kingdom.

6 Publications

For the subtask E TCM, the following scientific paper has been published in 2023

1. Fumey, B., Weber, R., Baldini, L., “Heat transfer constraints and performance mapping of a closed liquid sorption heat storage process”, Applied Energy, Volume 335, 2023, 120755

Other task publications are:

2. IEA SHC Task 67 Highlights 2022, https://task67.iea-shc.org/Data/Sites/1/publications/IEA-SHC-Task67-2022_Highlights-Final.pdf
3. IEA SHC Task 67 Technology Position Paper, [https://task67.iea-shc.org/Data/Sites/1/publications/IEA SHC Technology Position Paper Compact Thermal Energy Storage June2023.pdf](https://task67.iea-shc.org/Data/Sites/1/publications/IEA_SHC_Technology_Position_Paper_Compact_Thermal_Energy_Storage_June2023.pdf)

7 References

[1] Fumey, B., Weber, R., Baldini, L., “Heat transfer constraints and performance mapping of a closed liquid sorption heat storage process”, Applied Energy, Volume 335, 2023, 120755

[2] Fumey,B.;Baldini,L. Static Temperature Guideline for Comparative Testing of Sorption Heat Storage Systems for Building Application. Energies 2021, 14, 3754.
<https://doi.org/10.3390/en14133754>