2009 HIGHLIGHTS

SHC/ECES Task 42/24
Thermal Energy Storage: Material Development for System Integration

THE ISSUE

Particularly for solar thermal systems, thermal energy storage is essential. To reach high solar fractions, it is necessary to store heat (or cold) efficiently for longer periods of time. Until now, no cost-effective compact storage technologies are available to do this. For high solar fraction systems, hot water stores are expensive and require very large volumes of space. Alternative storage technologies, such as phase change materials (PCMs) and thermochemical materials (TCMs) are available on a laboratory scale. However, more research and development is needed before these technologies can be developed into commercial solutions.

OUR WORK

The objective of the joint Task 42/24 *Compact Thermal Energy Storage: Material Development for System Integration* is to develop advanced materials for compact storage systems, suitable not only for solar thermal systems, but also for other renewable heating and cooling applications such as solar cooling, micro-cogeneration, biomass, or heat pumps. The Task covers phase change materials, thermochemical and sorption materials, and composite materials and nanostructures, and includes activities such as material development, analysis, and engineering, numerical modelling of materials and systems, development of storage components and systems, and development of standards and test methods.

The main added value of this Task is to combine the knowledge of experts from materials science as well as solar/renewable heating and energy conservation.

The Task officially started on January 1, 2009, and will last for four years.

PARTICIPATING COUNTRIES

Australia
Austria
Belgium
Denmark
Finland
France
Germany
Netherlands
Slovenia
Spain
Sweden
Switzerland
Turkey
United Kingdom
United States

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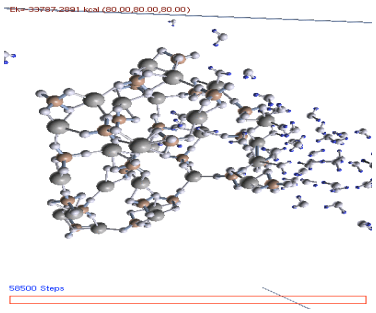
KEY RESULTS OF 2009

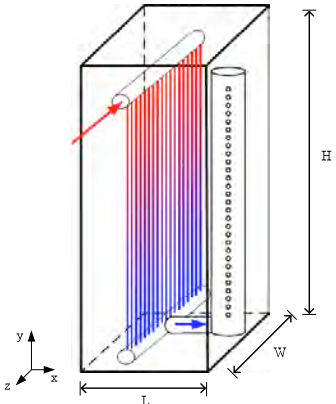
In this first year of the Task, most of the time was dedicated to sharing information on the planned and ongoing projects of the contributing institutes. The presented projects were discussed, and in working groups plans were made for common goals and Task deliverables.



First resulta of numerical calculation of water vapour adsorption by a magnesium sulphate molecule, by a molecular dynamics model.

Material Development

In the field of material development, the activities in materials engineering and processing were grouped into high temperature sensible storage materials, phase change materials and thermochemical materials. For high temperatures, the possibilities for liquid and solid heat storage for solar thermal power or for steel production will be investigated. With PCM, state-of-the-art reports were prepared for four topics: nano encapsulation and solid-solid thermal storage, encapsulation of inorganic PCMs, PCM enhanced insulations for temperature control, and composite PCMs for high temperatures. For thermochemical materials, composite zeolite-salt hydrates are being tested, an overview was completed on different processing techniques, and new methods were explored for the synthesis of silicates and composite salt-hydrate silicate materials.



Design schematic for a single-tank absorption seasonal storage, University of Minnesota.

In the field of material testing and characterisation, work is continuing on an overview of existing standards for thermal storage materials. The overview will serve as a starting point for drafting a standard for round-robin testing of new TES materials.

For numerical modelling of storage materials, work focused on the set-up of multi-scale models for salt hydration reactions, with heat transfer modelling within shape-stabilised PCM and with convection flow modelling in PCM.

In the apparatus and components field, work focused on the design of a reactor for salt-hydrate and with two concepts for heat storage in a tank with liquid absorption material. The design processes used will be input for a repository of reactor designs, the first deliverable of this activity.

Applications

This work is divided into three application areas 1) cooling, 2) heating/domestic hot water, and 3) high temperatures. Experts are considering a long list of applications in the different projects. The plan is to prepare an overview of the applications by mid-2010, including the typical boundary conditions and requirements for each application.

For high temperature applications, three case studies were defined along with the application boundary conditions and requirements — heat storage for a steel factory for process heat at 200 °C and heat storage for solar power.

In addition to the work on materials and applications, a study was initiated on the theoretical limits of thermal energy storage. These limits will be described for the physics, the economics and the technology of thermal energy storage.