SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

2012 HIGHLIGHTS

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

THE ISSUE

To reach high solar fractions, it is necessary to store heat or cold efficiently for longer periods of time. At this time, there are no cost-effective compact storage technologies available. 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), sorption materials and thermochemical materials (TCMs) are only available at the laboratory scale, and more R&D is needed before they are available commercially.

OUR WORK

The objective of this joint Task with the IEA Energy Conservation through Energy Storage Programme 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 (PCMs), thermochemical materials (TCMs), and composite materials and nanostructures. It includes activities on 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 with that of experts in solar/renewable heating and energy conservation.

PARTICIPATING COUNTRIES

Australia
Austria
Belgium
Denmark
France
Germany
Italy
Japan
Netherlands
New Zealand
Slovenia
Spain
Sweden
Switzerland
Turkey
United Kingdom
United States

This is a joint effort with the IEA Energy Conservation through Energy Storage Annex 24.

Task Date 2009-2013

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KEY RESULTS OF 2012

Material Development

The performance of new sorption materials was investigated through the collaboration between three German institutes, the Fraunhofer ISE, the ZAE Bayern and the Technical University of Wildau. Next to novel sorption materials, like Metal Organic Frameworks (MOFs), commercially available materials also were evaluated. A principal problem encountered in the case of the commercially available samples was the hydrothermal stability of these materials. Unfortunately, all the evaluated materials showed strong degradation within only 20 cycles.

In addition to the novel class of MOFs, in close collaboration with the KIC (National Institute of Chemistry, Ljubljana), a small-pore microporous aluminophosphate was evaluated for solar energy storage with promising results. Comparative measurements were performed on these materials and on two selected reference materials (zeolite 4 ABF and 13XBF). First results are promising, however, there are still differences between the various measurement apparatus and methods visible. The transformation of the data into a proper thermodynamic model, in this case according to Dubinin, shows a good correlation between thermogravimetric measurements, but a strong deviation compared to volumetric measurements (see Figure 1). Further investigations are necessary.

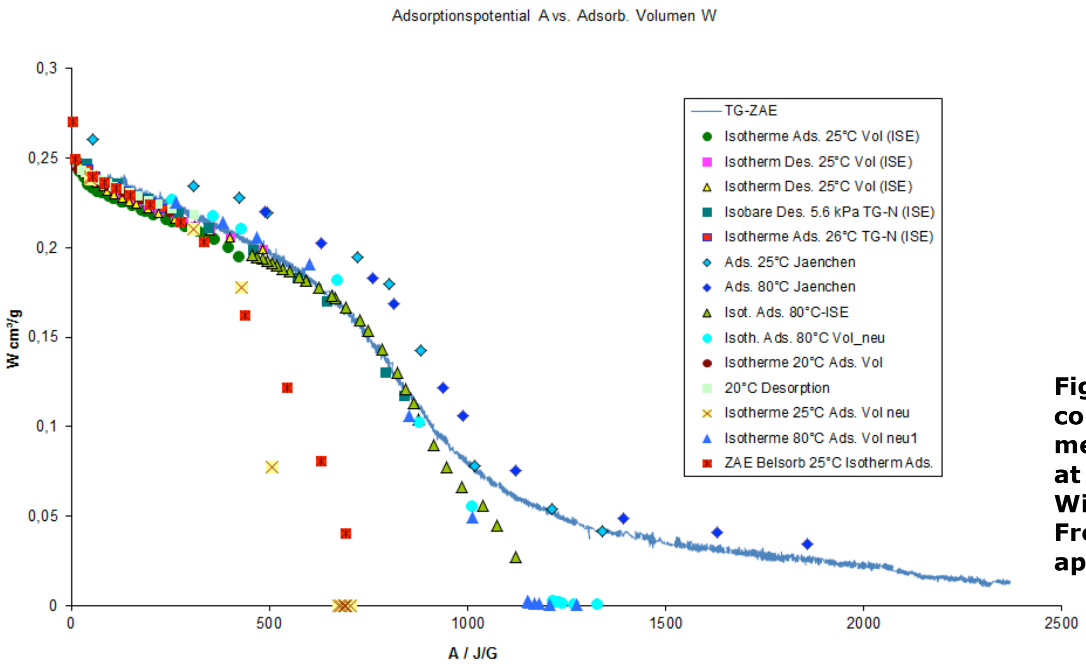


Figure 1. Overall comparison of measurements performed at different labs (TH Wildau, ZAE Bayern, ISE Freiburg) with different apparatus.

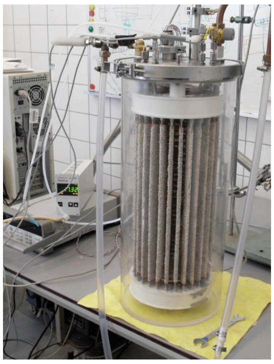
Prototype Reactors for TCM Storage

Several institutes have conducted work on new types of reactors for Thermochemical Energy Storage. The active volume of this generation of reactors is in the order of several tens of litres, making it possible to see the effects of using larger quantities of the active thermochemical storage material.

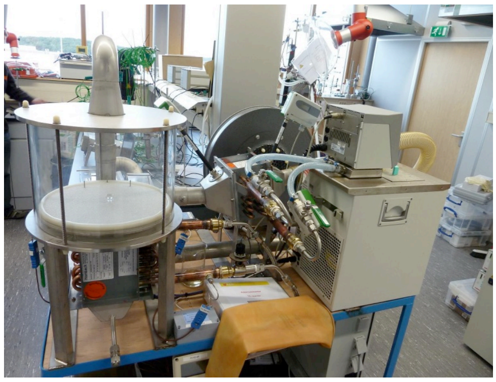
The Netherlands. TNO is working on finned heat exchanger geometry, with the sorption material attached to the surface of the fins. ECN is developing an open (atmospheric) sorption reactor, in which the sorption material forms a steady bulk.

Switzerland. EMPA has topped-up their one-stage liquid sorption reactor with a second stage. This enables the generation of higher temperatures from the thermal storage.

Austria. ASiC is working on a completely new reactor type for storage purposes that has the active material transported slowly trough a rotating drum.

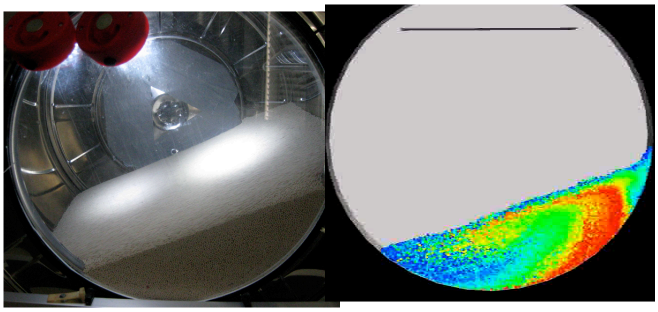


TNO's prototype sorption reactor with solid sorption material attached to the fins of the heat exchanger.



ECN's bulk type open sorption prototype reactor.

EMPA's liquid sorption reactor with two separate stages.



ASiC's slow rotating drum and a simulation image of grain movement in the drum.

These are only a few examples of the research and development work of the participating experts in the Task. In 2012, the group assembled the most important publications about Compact Thermal Energy Storage R&D and this wealth of information can be found on the Task website: http://task42.iea-shc.org/publications.