SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

2018 HIGHLIGHTS

Task 58 – Material and Component Development for Thermal Energy Storage

THE ISSUE

More than half of our primary energy resources are used to generate heat. Therefore, technologies for increasing the share of sustainable heat sources and for improving the efficiency of thermal systems are of key importance. Thermal energy storage technologies are needed for both – to match the intermittent supply of sustainable heat and cold and to optimize the thermal system performance. Present thermal energy storage technologies based on water perform well, but on a relatively low level of efficiency, particularly for long-term storage. These systems can only be improved marginally thus new materials and systems are needed to enable a breakthrough.

OUR WORK

This joint project with the IEA Energy Conservation through Energy Storage Technology Collaboration Programme (ECES TCP) focuses on furthering the understanding and development of PCM and TCM materials, the development of measuring procedures for characterization and test methods for validating the performance of PCMs and TCMs as well as the development of effective design approaches for specific components.

Task experts from both materials research and storage applications are collaborating on the different levels of the storage system, components, materials and testing, and characterization. The work is divided into two parallel tracks – thermochemical (TCM) and phase-change (PCM) materials.

The main objectives of the Task are to develop and characterize storage materials to enhance TES performance, to develop materials testing and characterisation procedures, including material testing under application conditions, to develop components for compact thermal energy storage systems, and finally to map and evaluate the TES application opportunities concerning the requirements for the storage material.

Participating Countries

Austria
Canada
Switzerland
Germany
Denmark
Spain
France
Italy
Netherlands
Sweden
Slovenia
Turkey
United Kingdom

Task Period	2017 – 2019
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KEY RESULTS IN 2018

Fluidized Bed Storage System

At the Technical University in Munich, Germany, significant progress was made in the development of a fluidized bed CaO/Ca(OH)2 storage system for high temperature (300-600°C) applications. Key achievements are:

- Identifying the best operating conditions for the reaction of CaO with steam to Ca(OH)2 in a pure steam atmosphere.
- Successful demonstration of up to 20 charge/discharge cycles in a small scale (200ml) reactor.
- Finalized construction of a 10kW pressurized fluidized bed pilot reactor (30 l, up to 7 bar and 700 °C, Nitrogen and Steam Atmosphere), see picture.

Cooling with Sorbent

Large thermodynamic power plants need a cold source on the condenser side, whose temperature level influences the efficiency of the plant. Most standard electricity plants use humid towers as cooling systems, that use a lot of water. When the power plants are in hot and arid countries, which is very often the case for concentrated solar plants for instance, this waste of water is not acceptable. The easiest solution is to take ambient air as the cold source, but air temperature varies a lot during the day and can reach temperatures as high as 45-50°C in some hot places.

CEA in France runs the COOLSTO project, that aims at storing the cold and humidity of the ambient air during the nights to cool the air during the day, both thanks to sensible cold storage (for instance stones) and to desorption.

An experimental facility was designed and manufactured to study the concept. The air can have a temperature range of 15-50°C. The solid material is mixed in a packed bed with a uniform composition, glass spheres with a diameter of 16 mm simulate the sensible material and the sorbent is a silica gel from BASF. This sorbent was selected because it is cheap, can desorb at low temperature and its sorbent properties are well known. A series of test is now ongoing, and results from numerical models will be compared with the test results in 2019.

Photos of the storage module before insulation (left), thermocouple in glass sphere (upper right) and bed of glass spheres and silica gel (bottom right).

Novel Prismatic Storage Reactor

In the CREATE project, AEE INTEC (Gleisdorf, Austria) is responsible for the development of a compact thermal storage unit that works with potassium carbonate as compact thermal energy storage material. One of the novelties in the concept is the use of a prismatic containment, in contrast to the normally used cylindrical shape. The interior heat exchanger serves as structure to support the flat walls, resisting the vacuum forces, as the system works under very low pressures.

In 2018, a first prototype of this reactor was built and tested, and the performance and energy storage density were satisfactory. The maximum power that could be withdrawn from this module was about 1.5 kW, which was below the design power. Therefore, the next modules have a larger volume of 330 liters. Three of these modules will be coupled into the system, tested in the laboratory, and then in a demonstration house in Poland in 2019.

The interior heat exchanger is lifted into the prismatic containment.

The first prototype, ready for tests. It contains about 250 liters of salt.