

SHC TASK 32: ADVANCED STORAGE CONCEPTS FOR SOLAR AND LOW ENERGY BUILDINGS

Jean-Christophe Hadorn

BASE Consultants SA

Operating Agent on behalf of the Swiss Federal Office of Energy

TASK DESCRIPTION

The main goal of this Task is to investigate new or advanced solutions for storing heat in systems providing heating or cooling for low energy buildings.

The first objective is to contribute to the development of advanced storage solutions in thermal solar systems for buildings that lead to high solar fraction up to 100% in a typical 45N latitude climate. The second objective is to propose advanced storage solutions for other heating or cooling technologies than solar, for example heat pumps or fossil boilers in order to reduce cycling and thus to reduce pollutant emissions due to partial combustion.

The ambition of the Task is not to develop new storage systems independent of a system application. The focus is on the integration of advanced storage concepts in a thermal system (solar, heat pump or boiler) for low energy housing. This provides both a framework and a goal to develop new technologies.

The Subtasks are:

- Subtask A: Evaluation and Dissemination (Subtask Leader in 2005: Switzerland)
- Subtask B: Chemical and Sorption (Subtask Leader : Chris Bales, Sweden)
- Subtask C: Phase Change Materials (Subtask Leader: Wolfgang Streicher, Austria)
- Subtask D: Water (Subtask Leader: Harald Drueck, Germany)

Duration

The Task was initiated in July 2003 and was initially planned to be completed in December 2006. Due to unexpected difficulties in setting up laboratory experiments with new materials and developing new models for heat storage modules, the Task has been extended 12 months until December 2007 in a decision at the 58th Exco meeting in December 2005.

ACTIVITIES DURING 2005

General

In 2005, two meetings gathered more than 20 experts from 8 countries, with a strong participation from 6 countries (CH, S, A, DK, G, SP) and the input from 2 other (F, NL). Unexpected difficulties have been encountered in laboratory testing and in modelling of new storage materials.

Subtask A: evaluation method and dissemination of results

The main activity of Subtask A during 2005 has been the publication of a “State of the art” handbook on short term heat storage. The book is based on 20 contributions from the experts within the Task and also from 3 external well known storage experts. It has been edited by the Operating Agent and printed at the University of Lleida (500 copies). It will be sold through internet at the beginning of 2006 for a price of 35 euros. The content, both scientific and technical, fills a gap in the current literature on thermal storage. We anticipate to sell all copies if the promotion is done worldwide.

The method of comparing the “solar performance” of different designs coming from the 3 other subtasks has not been developed further since 2004. It needs validation against results from projects that could not be made available by all teams during 2005 due to unexpected delays. However, a detailed list of criteria to evaluate projects has been finalised by Subtask A and is available for the future comparison of storage options.

The reference conditions for simulating different options with the same framework has been issued by the Austrian team. It is a useful piece of information for comparing systems, including 4 different climates, 3 different types of houses and various heating and cooling options. A reference “solar combisystem” has also been defined so that all teams can simulate their storage solutions within a similar system. TRNSED of the ref. conditions and the ref. system are available in Beta versions for the Task participants.

The Task web site www.iea-shc.org Task32, has been continuously updated with working documents and is the Task exchange platform with more than 150 documents, presentations at meetings and articles about heat storage.

An electronic Newsletter has been issued in June 2005 and distributed. The December issue is due at the beginning of 2006.

Subtask B: Chemical and sorption storage

Five projects are being investigated and two others could be brought into our Task depending on national financial support.

Sorption storage solutions appear to be complex and more suited to heat pump systems where both heating and cooling could be achieved, than to pure solar systems.

Zeolite is still an option but the driving force needed during unloading is still a limiting factor.

A new idea from Germany for a seasonal storage based on Zeolite (8m³ for a one-family house) has been proposed theoretically in 2005 and will be studied during 2006.

A 1000 kg storage tank filled with silica gel has been installed during 2006 in a combisystem for a solar house in Austria and will be monitored during 2007.

We are lacking chemical projects although some options might be very well suited for long term storage as defined in a Dutch prestudy. Financing storage projects is in all countries a difficult task although all countries recognize the “need for storage” as the number one topic for the development of solar heat in the future !

Subtask C : Phase change materials

Six projects are being developed. Most of them use sodium acetate as the phase change material. Characterisation of the material in different combinations of heat transfer enhancers has been the main work of 2005. The heat transfer coefficient is indeed the limiting factor for a useful PCM storage, and it was shown that the preparation of the samples might induce very different results for the material properties. It is anticipated that this work is also a preliminary work for an international standard on PCM characterisation for heat storage.

Modelling the subcooling effect is also a difficult topic that was addressed by 2 teams. Models are not completely developed, but first results showed that the number of nodes in the discretization process influence strongly the quality of the results.

The Danish team showed in a theoretical study with a simplified model that seasonal storage could benefit from this effect by a 30% reduction of the storage volume if the effect is mastered.

Computational Fluid Dynamics (CFD) tools have also been used to better understand the convection effects in a PCM within a bottle placed at the top of a water tank. Comparisons with a Trnsys model have been undertaken, and show that convection has to be taken into account even in simple models. This is still a challenge.

Subtask D: Water tanks

In 2005, the subtask D issued a report on the possible improvements of water tank storage for combisystems. The trends are: to increase solar energy savings, to better integrate, to improve the thermal performances, to try to use a mixture of water and PCM, to use CFD tools to better understand the thermal behaviour inside the tank, to look for cost reduction (standardised and simpler systems, polymeric materials), to use pressureless tanks.

In a Danish study, three different ways to produce domestic hot water have been studied and lead to recommendations.

In Switzerland, 11 different combisystems were compared and the comparison produce very useful results for better designs. A pressureless design has been worked on.

Germany will present in 2006 a more deep contribution to subtask C since a new project has been financed for the period 2006-2007 with the cooperation of the Kassel University as a new participant.

WORKED PLANNED FOR 2006

Task 32 plan to have models of several storage options during 2006 that could be used within Trnsys with the common framework. Since a prolongation of 12 months was decided in December 2005 at the Exco level, it is anticipated that the goal can be reached, after difficulties in 2005 in assessing material properties.

However it is not known if the chosen solutions can be completely mastered during laboratory

tests and that the models can be fully validated.

The Task 32 handbook will be distributed during the year 2006.

A participation at the Ecostock'06 conference in USA is also foreseen.

LINKS WITH INDUSTRY

An industry day on November 24th, 2005 in the research center of EDF was attended by a few participants from the french industry of storage and from EDF.

REPORTS PUBLISHED IN 2005

- Report A1: State of the art is a book published in Lleida, Spain
- Report A3 Method of comparison and criteria.
- Report B1 Identifications and selection of projects.
- Report B2 Thermal properties and laboratory analysis.
- Report C1 Identifications and selection of projects.
- Report C2 Thermal properties and laboratory analysis for PCMs
- Report D1 Review of advanced concepts and dream systems for tank storage.

REPORTS PLANNED FOR 2006

- Report A2 Boundary conditions and reference conditions.
- Report B3 Laboratory prototypes of storage units.
- Report C3 Laboratory prototypes of storage units.

MEETINGS IN 2005

5th Experts Meeting

May 18-20

Lleida, Sapin

6th Experts Meeting

November 23-25

Fontainebleau, France

MEETINGS PLANNED FOR 2006

7th Experts Meeting

May 29-30

Stockton, USA, in conjunction with Ecostock'06 international conference

8th Experts Meeting

November

Stuttgart, Germany

TASK 32 NATIONAL CONTACT PERSONS

Operating Agent

Jean-Christophe Hadorn jchadorn@baseconsultants.com

Operating Agent of IEA SHC Task 32

on behalf of the Swiss Federal Office of Energy

BASE Consultants SA

51 Chemin du Devin

CH-1012 Lausanne

Austria

Prof. Wolfgang Streicher streicher@iwt.tu-graz.ac.at

Andreas Heinz heinz@iwt.tugraz.at

Peter Puschnig puschnig@iwt.tugraz.at

Institute of Thermal Engineering

Graz University of Technology

Inffeldgasse 25, 8010 Graz, Austria

Waldemar Wagner w.wagner@aee.at

Dagmar Jaehnig d.jaehnig@aee.at

AEE INTEC

Arbeitsgemeinschaft ERNEUERBARE ENERGIE

Feldgasse 19

A-8200 Gleisdorf

Denmark

Simon Furbo sf@byg.dtu.dk

Elsa Andersen ean@byg.dtu.dk

Jorgen Schultz js@byg.dtu.dk

Niels Kristian Vejen nkv@byg.dtu.dk

Solar Energy Center Denmark

Technical University of Denmark

Department of Buildings and Energy

Build. 118

DK-2800 Lyngby

France

Thomas Letz letz@ines-solaire.com

INES

Parc Technologique de Savoie Technolac

50 avenue du Léman BP 258

F - 73 375 LE BOURGET DU LAC Cedex

Laurent Barthel laurent.barthel@edf.fr

EDF R&D - Site des Renardières

Route de Sens - Ecuelles
F- 77818 MORET SUR LOING CEDEX

Germany

Harald Drueck drueck@itw.uni-stuttgart.de
Henner Kerskes kerkes@itw.uni-stuttgart.de
Institut fuer Thermodynamik und Waermetechnik (ITW)
Pfaffenwaldring 6
D-70550 Stuttgart

Hans-Martin Henning hansm@ise.fhg.de
Thomas Nunez nunez@ise.fraunhofer.de
Thermal Systems and Components
Fraunhofer Institute for Solar Energy Systems ISE
Heidenhofstr. 2
D - 79110 Freiburg

Klaus Vajen vajen@uni-kassel.de
Claudius Wilhelms wilhelms@uni-kassel.de
Universitaet Kassel
Institut fuer Thermische Energietechnik
Fachgebiet Solar- und Anlagentechnik
Kurt-Wolters-Str. 3
D- 34125 Kassel

Spain

Luisa F. Cabeza (Mrs.) lcabeza@diei.udl.es
Cristian Solé csole@diei.udl.es
Escola Universitària Politècnica
Universitat de Lleida
Jaume II, 69
SP - 25001 Lleida

Sweden

Chris Bales cba@du.se
Lecturer and Researcher in Environmental Engineering (Energy)
Högskolan Dalarna
Solar Energy Research Center SERC
Dept. of Mathematics, Natural Sciences and Technology
S-78188 Borlänge

Switzerland

Stéphane Citherlet stephane.citherlet@eivd.ch
Jacques Bony Jacques.Bony@eivd.ch
EIVD - School of Engineering
Solar Laboratory and Physics of Building
Route de Cheseaux 1

CH - 1401 Yverdon-les-Bains

Andreas Luzzi Andreas.Luzzi@solarenergy.ch
Peter Vogelsanger peter.vogelsanger@solarenergy.ch
Paul Gantenbein paul.gantenbein@solarenergy.ch
Michel Haller michel.haller@solarenergy.ch
SPF Hochschule für Technik Rapperswil
Oberseestr. 10
CH-8640 Rapperswil

Robert Weber robert.weber@empa.ch
EMPA Duebendorf
Abteilung Energiesysteme / Haustechnik
Ueberlandstrasse 129
CH-8600 Duebendorf

The Netherlands

Klaas Visscher visscher@ecn.nl
Wim van Helden vanhelden@ecn.nl
Marco Bakker m.bakker@ecn.nl
Energy research Centre of the Netherlands (ECN)
P.O. box 1
NL - 1755 ZG Petten