Proposal for Work Program

New Annex on *"Transportation of energy by utilization of Thermal Energy Storage Technology"*

1. Introduction

A key component in a sustainable energy system is to be able to use thermal energy from various sources at a consumer located at a distance from theses sources. For this purpose, the thermal energy has to be transported from one place to another. This could be achieved by using thermal energy storage technology. Depending on the distance, the storage medium could either be pumped through pipelines or for longer distances the TES itself could be transported on a truck or a train. The crucial properties of the TES for the technical and economical feasibility are the storage capacity per volume and weight and the possible charging and discharging power, which affects the possible number of storage cycles per time.

Phase Change Slurries for Energy Transportation

Recently, interest in multifunctional fluids for ***energy storage and transportation*** has gained much attention as they may be highly useful in re-locating e.g. industrial waste heat from source to demand. These fluids are often called Phase Change Slurries (PCS). With such fluids, the gap in time and distance between a heat source and a heat demand has the potential of being managed in a cost-effective way, a key issue that must be mastered before sustainability in the energy system can be fully obtained. Numerous future-oriented technologies may be supported by this technology like high-efficient cooling of fuel cells, electronic devices, and elementary particle detectors, etc.

Presently, the technology is tested for a few applications. For example, small quantities of phase change materials are created in industrial processes and immersed in carrier fluids. A new technique is to encapsulate PCM in microcapsules with diameters of only a few microns. Since 1996 the "Working Party on Ice Slurries of the International Institute of Refrigeration (IIF/IIR)" co-ordinates research and industrial activities in the field of water/ice suspensions, which define a subgroup of the PCS. They are used as secondary refrigerants and help to phase out chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) and, therefore, contribute to a reduction of ozone depletion and global warming.

The recent increased interest in PCS technology, as compared to decades ago when the technology first emerged, is presumably due some important changes in "boundary conditions". Examples are:

- increased activities in combating global warming and establishing a sustainable energy system;
- increased number of commercially available storage systems;
- for air-conditioning and refrigeration, an increased concern for HFC:s and a willingness to cut peak power demand;

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- advances in available materials;
- improved knowledge on how to master sub-cooling.

Mobile Thermal Energy Storage – transporting by truck or train

If the distance between thermal energy source and the consumer is for economical reasons to long for pipelines, the TES itself has to be transported on the street or on the track. For applications like the utilization of waste heat from industrial processes at distances over a few kilometers up to about 50 km, activities have been discussed among research institutes and companies in Japan and Germany.

In Germany for example the company "Transheat" has installed a demonstration plant, where waste heat of about 180 °C is charged to a PCM storage, which is transported from the factory to a office building some 30 km away by truck. The system is economical interesting, because there is a high demand for heating and cooling (by absorption chillers), which allows a high number of charging and discharging cycles of the storage.

In Japan the transport of salt solutions concentrated by waste heat for liquid desiccant cooling systems is under discussion. The high prices for district heat in Japan could lead much faster to economical interesting systems compared to Europe.

Other thermal energy storage technologies, like solid or liquid sorption process are interesting due to their high possible storage capacity. The influences of the changed "boundary conditions" on these systems could be as positive as for the PCS systems. In this context a revitalized discussion on sensible heat storage systems could be valuable.

2. Scope and objectives

The general objectives of the proposed annex on Transportation of Energy by Utilization of Thermal Energy Storage Technology are to identify state-of-the-art for using different technologies for energy storage and transportation, to broaden and co-ordinate the knowledge within the field, and to disseminate information. In particular, research on high capacity storage materials and high thermal power charging and discharging technologies that are easy to implement in an energy transport system will be encouraged, along with research on system aspects where heat sources are linked to the customer's need and where these links' impact on system design is assessed. Potential cost-effective applications must be identified.

At the end of the annex, present activities within the field are expected to be better co-ordinated, and initiatives for new activities have been taken.

3. Suggested Operating Agent

As operating agent for the proposed new annex Sweden, through KTH (Dr. Viktoria Martin) is suggested.

4. Work Program – Main Activities and Time Schedule

Phase 0: January – June 2004

- Invitation to participate
- Kick-off workshop in e.g. Japan – establishing participants and their combined goal with the annex

Phase 1: July-December 2004 (Task Definition Phase)

- Finalize Annex Objectives, Goals and Work Plan with ExCo
- Collecting information on ongoing activities in the area
- Finalizing Financing Plans for participants
- Establishing collaboration activities
- First Workshop and Expert Meeting

Phase 2: January-June 2005

- Compile State-of-the-Art high capacity TES technologies
- Identify potential applications, including heat/cold sources and "customers"
- 2nd Workshop and Expert Meeting

Phase 3: July-December 2005

- Applications' evaluations
- Candidate technologies – special material's issues for PCS systems, system issues for sorption systems, design of mobile TES.
- 3rd Workshop and Expert Meeting

Phase 4: January-June 2006

- Establishing desired feasibility studies and demonstration projects – a plan for future IEA activities
- 4th Workshop and Expert Meeting

Phase 5: July-December 2006

- Final Report
- Closing the Annex
- Dissemination of Results
- 5th Workshop and Expert Meeting

5. Activities

- Evaluation of presentation and findings
- Workshops and expert meetings
- Innitiate projects related to:
    - classifying boundary conditions for the application of slurries or TES on trucks/trains
    - identifying cheap and reliable candidate PCS materials,
    - finding appropriate system designs for sorption storage systems

- system technologies that are reliable for a large number of charging/discharging cycles
- applications and potential

6. Major outcomes

The major outcomes of the proposed annex will be:

- increased awareness of the possibilities of efficient energy transportation using advanced thermal energy storage;
- increased activities in the area, e.g. initiation of feasibility studies and demonstration projects regarding energy transportation through TES.
- a solid workplan for continuing annex regarding feasibility studies and demonstration projects