Key Compact Storage tanks

Technology Comparison and Outlook

Dr. Henner Kerskes

University of Stuttgart
Research and Testing Centre for Thermal Solar Systems (TZS)
Institute for Thermodynamics and Thermal Engineering (ITW)
Pfaffenwaldring 6, 70550 Stuttgart
Email: kerskes@itw.uni-stuttgart.de
Internet: www.itw.uni-stuttgart.de
The goal is clear!

A 100 % renewable energy supply in the near future

The challenge is not the energy production

- The challenge is the energy storage
  - Electrical energy storage
  - Thermal energy storage

Thermal energy storage is a key technology for solar thermal systems
Thermal Energy Storage

Future requirements on thermal energy storage

• large storage capacity
• modular design
• high storage density
• low heat losses
• applicable for short term - and long term heat storage
State of the Art

Solar Thermal heating
Water based storage systems

Future prospects:
Compact and highly efficient storage based on new storage technologies
Thermal Energy Storage Mechanism
Solrico Technology and Market Survey

Question: “How would you estimate the market potential of the following technologies in your national / key solar market?”.

Around 370 solar thermal system suppliers answered this question in the ISOL Navigator Survey December 2013.

General: up to 50% of ST manufactures are aware that new technologies show a relevant market potential.

Market potential of different solar thermal technologies

- Solar-driven sorption chillers
- Collectors made from polymers
- Tanks based on phase change material
- Thermo-chemical heat storage tanks

Solrico Technology and Market Potential Survey

Market potential of tanks based on phase change material / latent heat storage

- China (25) - China manufacturer see real opportunity for latent heat storage.
- Spain (20) - Spain, USA and Great Britain give the technology a chance.
- USA (16) -
- Great Britain (17) -
- Italy (21) -
- Germany (38) -
- India (23) -
- Austria (12) -
- Turkey (13) -
- Poland (10) -


Most of German manufactures are still hesitant.
Solrico Technology and Market Potential Survey

Market potential of thermo-chemical heat storage tanks

- thermo-chemical heat storage is a very new (maybe unknown) technology
- however in every country already some manufacturers attest huge potential
- every third manufacturer in Spain believes in thermo-chemical
- further development and demonstration is necessary to increase confidence in the technology

Mechanism of latent heat storage

- Water (sensible heat)
- Paraffin
- Sodium acetate
- Sodium sulfate

- Storage capacity [kWh/m³] vs. temperature [°C] / temperature difference [K]
Latent Heat Storage

**Company**
Icebear Energy (formal Power Tank)
Institute for energy efficiency
Switzerland
www.latentspeicher.com

**Storage material**
paraffin
melting point: 40 / 50 / 60°C

**application**
short and mid term
solar thermal heating,
Combined Heat and Power (CHP)

more than 15,000 cells sold

Source: Icebear Energy
Latent Heat Storage

Company
H.M. Heizkörper GmbH & Co. KG
Germany
www.muhr.net

storage material
sodium acetate
Melting point: 58°C
storage capacity per cell: 50 kWh

tank material
stainless steel
cylindrical

application
solar thermal heating,
Combined Heat and Power (CHP)
short and mid term

Source: H.M. Heizkörper GmbH & Co. KG
Latent Heat Storage

Company
SUNEX S.A.
Poland
www.sunx.pl

storage material
sodium acetat
melting point: 55°C
Storage capacity per cell: 8 kWh

tank material
galvanised steel (2mm)
rectangular shape

application
solar thermal heating
short term

Source: SUNEX S.A.
Phase Change Material - Water
Latent Heat Storage

Company
Consolar Solare Energiesysteme GmbH, Germany
www.consolar.de

storage material
water
melting point: 0°C
storage volume: 0.5 m³

tank material
polymere
rectangular shape

application
heat pump
short term storage

Source: Consolar GmbH
Latent Heat Storage

Company
isocal HeizKühlsysteme GmbH
Germany
www.Isocal.de

storage material
water
melting point: 0°C
storage volume: 10 – 18 m³

tank material
earth buried concrete
no insulation

application
heat pump
long term storage (weeks)

Source: isocal / ITW
Mechanism of thermo-chemical heat storage

How a chemical reaction can be used for energy storage

- solid/gas-reactions very suitable for thermo-chemical storage
- For example salt hydrates (Magnesium sulfate)

1. charging (dehydration): heat supply to split hydrates

\[
\text{MgSO}_4 \cdot 7\text{H}_2\text{O} + \text{Heat} \rightarrow \text{MgSO}_4 + 7\text{H}_2\text{O}
\]

2. storing: separation of reaction components

3. discharging (hydration): gain heat of reaction

\[
\text{MgSO}_4 + 7\text{H}_2\text{O} \rightarrow \text{MgSO}_4 \cdot 7\text{H}_2\text{O} + \text{Heat}
\]
Advantage of thermo-chemical heat storage

• high storage density

<table>
<thead>
<tr>
<th></th>
<th>storage density</th>
<th>factor</th>
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<tbody>
<tr>
<td>water*</td>
<td>60 kWh/m³</td>
<td>1</td>
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<tr>
<td>latent</td>
<td>50 - 120 kWh/m³</td>
<td>1 – 2</td>
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<tr>
<td>adsorption</td>
<td>120 - 180 kWh/m³</td>
<td>2 – 3</td>
</tr>
<tr>
<td>reaction</td>
<td>200 - 600 kWh/m³</td>
<td>4 – 10</td>
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</table>

* bei \( \Delta T = 50 \, \text{K} \)
Advantage of thermo-chemical heat storage

• high storage density
• loss free heat storage
• separation of power and capacity
  ➔ scalability

➔ crucial factors for long-term energy storage and high temperature storage

➔ disadvantage: high regeneration temperature (120 – 180°C)
## Comparision of Technologies

<table>
<thead>
<tr>
<th></th>
<th>hot water</th>
<th>latent heat</th>
<th>thermo-chemical</th>
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<tr>
<td><strong>storage density</strong></td>
<td>O</td>
<td>+</td>
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<td><strong>heat losses</strong></td>
<td>O</td>
<td>+</td>
<td>++</td>
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<tr>
<td><strong>modularity</strong></td>
<td>O</td>
<td>+</td>
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<td><strong>scalibility</strong></td>
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<td>+</td>
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<tr>
<td><strong>short term</strong></td>
<td>++</td>
<td>++</td>
<td>O</td>
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<tr>
<td><strong>long term</strong></td>
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<td>+</td>
<td>++</td>
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<tr>
<td><strong>market readiness</strong></td>
<td>++</td>
<td>O</td>
<td>-</td>
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<tr>
<td><strong>future potential</strong></td>
<td>O</td>
<td>+</td>
<td>++</td>
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Conclusion and Outlook

- Hot Water Stores are state of the art

  What about new storage technologies?
  Most of solar manufactures seem to be conservative for new technologies
  However awareness of PCM and TCM technologies increases

- PCM storage
  - some products on the market
  - paraffin and sodium acetate storage for space heating
  - ice storage in combination with heat pumps
Conclusion and Outlook

- Thermo-chemical energy storage
  - many national and international research activities
  - new storage materials and innovative system design are under development and tested in laboratory or pilot scale
- new knowledge and important experiences gained
- technical feasibility has been proofed in many projects

In addition to sensible heat, the technology of latent heat and thermo chemical energy storage are a very promising solution for the future of solar heating and cooling, CHP, ....
Thank you
for your attention

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