New Possibilities of Heat Storage in Combination with Heat Pumps

22.11.2016
Prof. Dr. M. Rädle, S.Kunkel, L.Erlbeck,
F.Kübel-Heising, S.Sonnick
Institute of Process Measurement Technique and Intelligent Energy Solutions

• 40 employees, including 33 engineers, 3 physisists
• 36 employees financed by third party

Institute: 300m² on HS-Campus, 850 m² rented externally

Raised third party money: >2,5 M€/year,

Cooperating companies: >80

Projektkoordination: BMWi AiF ZIM projects, ranked 1st, about 80 projects

Since 2010 largest institute of an University of applied sciences in Baden-Württemberg
(My) Statement to the Turnaround to Regenerative Energy Production

• The problem of energy production is solved
• Photovoltaic and wind energy will be even cheaper in future
• Own usage of own produced electricity will rise
• Supply and demand of regenerative energy are separated in space and time
• Storages and investment in networks are necessary
Development of Energy Storage in Literature:

Mostly electrical storage development… but..

- 1KWh electr. storage , 500.-€
- 40 KWh water storage , 1000.-€
- 40 KWh latent heat accumulator 1500.-€
Disadvantages of Warm-Water-Storage

• No long term storability
• Not convenient to heat-pumps (pompe a chaleur)
• Only small amounts of heat can be stored in a house
• High temperature rise necessary
• Housing expensive for big units (therefore no seasonal storage)
Example of a Big Water Storage:

Mannheim: 1,4 GWh; 43,000 m³
A Possible Way for Solutions in Single-Family-Houses:

- Heat storage with latent material
- PCM: Phase Change Materials
- Heat stored in melting process
Phase Change Materials – Latent Heat Materials

40- 80 kWh/m³, advantages in small temperatur rises
Well known: Sodium Acetat

Disadvantage: strong undercooling, osmotical pressure
PCM- Heat-Storage (20 cm PCM Layer); Mg-Nitrat/Chlorid, 4-fold Amount of Heat, 56°C, 12 Hours Loading or Unloading
Diffusion Resistive PCM-Sacs in Serial Production (Fasel, Westerwald)
New Technology: Rapid-Loading-Storages

Heterogenphase PCM-Storage:
oil-contact salt hydrate: loading time 2-3 hours
Upscale to Nearly Every Size

\[ m_{\text{PCM}}: 1500 \, \text{kg} \]
\[ Q: \text{ca. } 80 \, \text{kWh} \]
Combination of Heat Pumps with PCM-Storage

Mesa/Bammental; Test Operation since Sept. 2016
Advantages/Disadvantages of PCM-Storages

• constant temperature level
• 40-80 KWh/m³
• material costs 150 – 500 €/t
• In test mode in the moment/ market launch in 2017
• additional costs for oil-circle (fast operation mode)
Areas of Application (Present Salt Mixtures)

- Industrial waste energy: 81-89°C
- Solar storage: 56°C
- Storage for heat pumps: 25°C; 27°C oder 36°C
- Room climatisation: +21°C
- Room cooling: 13°C (under development)
- Ice storage: 0°C
- Cooling food etc.: -21°C (cheapest Material)
PCM in Concrete, 21°C – 27°C Fasel, Westerwald

- Plates, window sills, energy pillars, banches, underfloor heatings,
- Building bricks (heat capacity: 4 cm $\equiv$ 1m of concrete)
Fields of Application…

- Im principle you can all implement into concrete
Modular Prefabricated Houses with Superisolated Walls and PCM-Stabilised Internal Climate (Willie Mayer)
Park Bench, which will not cool down in night
Unlimited Possibilities in Energy Storage

- PCM-Storage usefull for small temperature rises and storage range of 1-2 weeks

- Ideas/Collaboration → m.raedle@hs-mannheim.de
• Thank you for your intention

• Questions? Discussion? Remarks?

m.raedle@hs-mannheim.de