

Fakultät Verfahrens- und Chemietechnik
Institut Prozessmesstechnik und innovative Energiesysteme

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 externaly
- **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



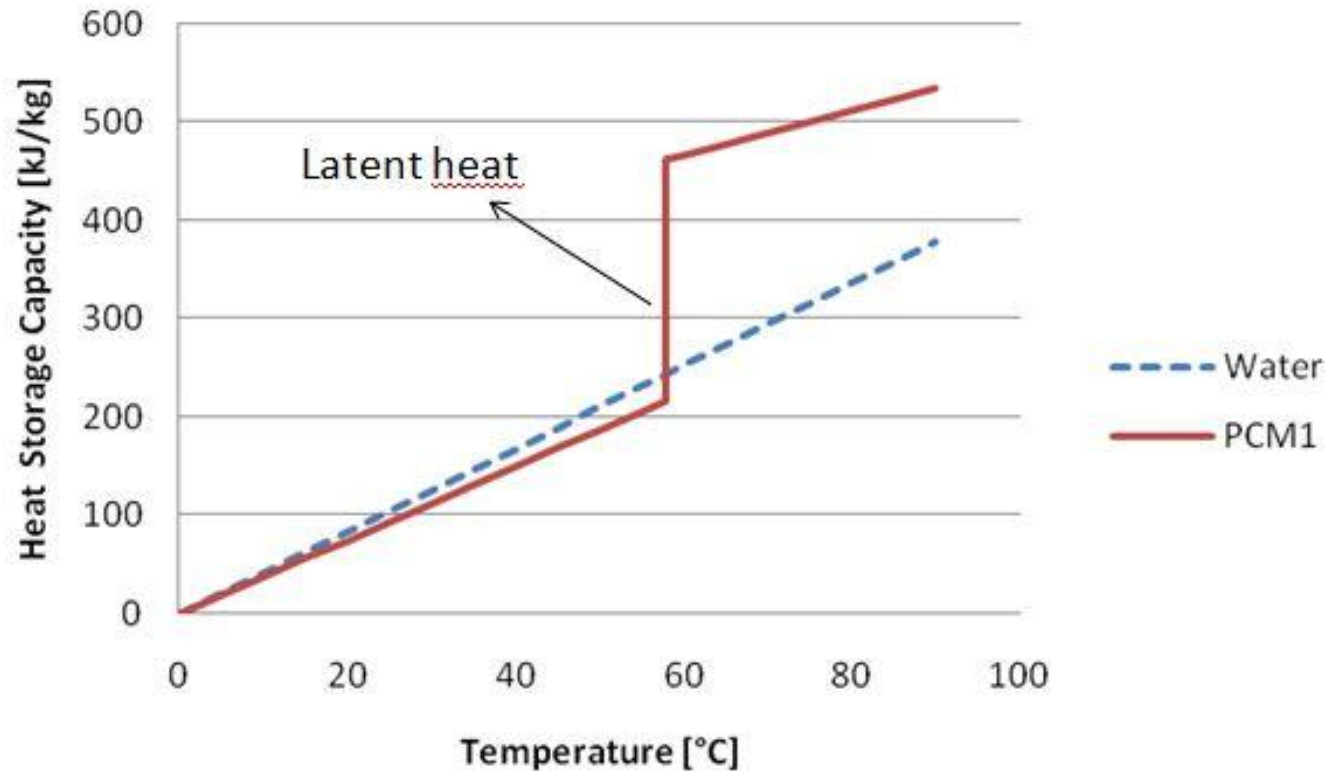


A Possible Way for Solutions in Single-Family-Houses:

- 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

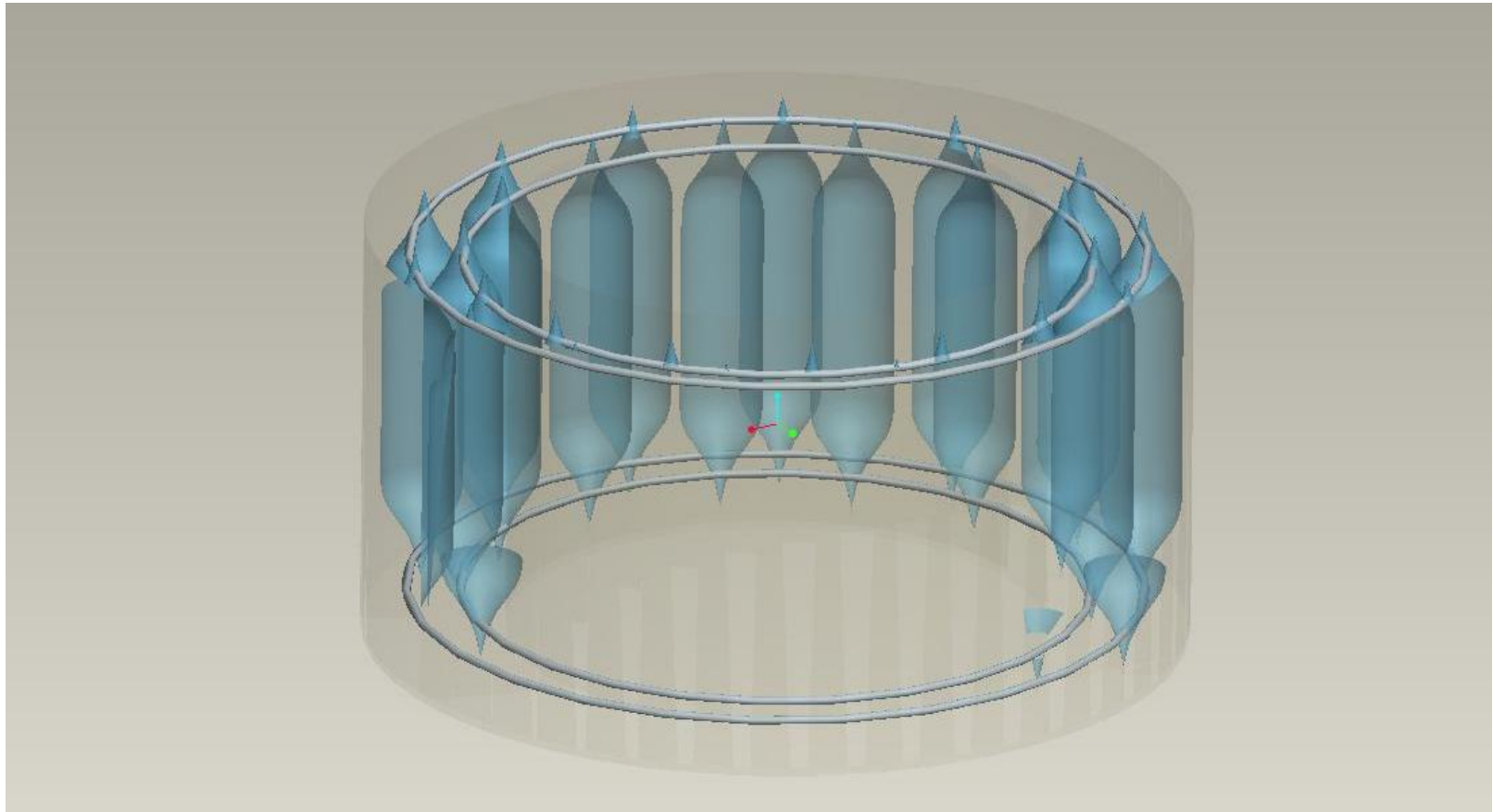


PCM- Heat-Storage (20 cm PCM Layer); Mg-Nitrat/Chlorid, 4-fold Amount of Heat, 56°C , 12 Hours Loading or Unloading





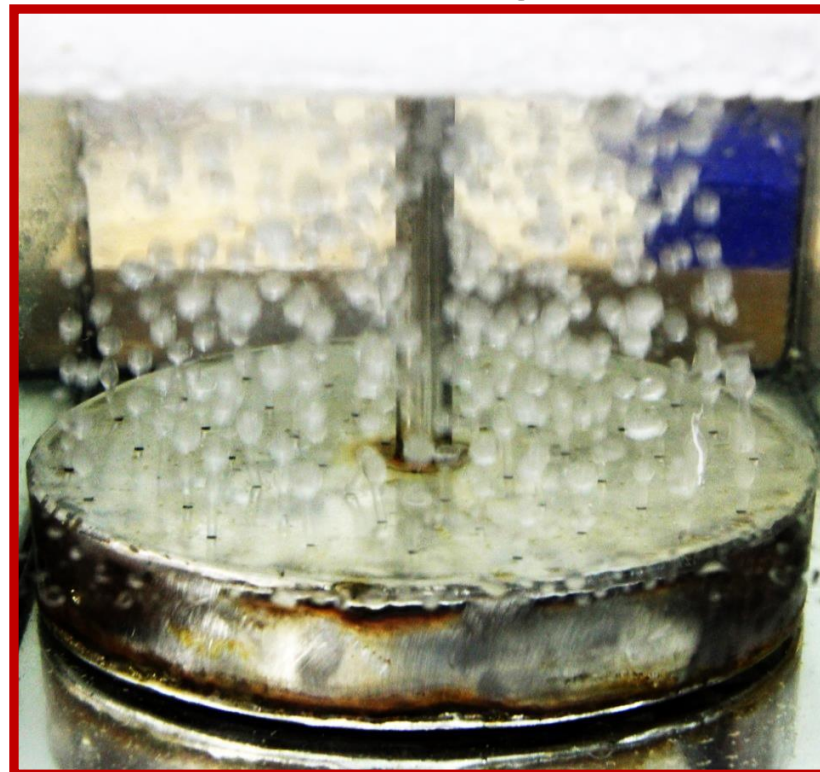
Diffusion Resistive PCM-Sacs in Serial Production (Fasel, Westerwald)





New Technology: Rapid-Loading-Storages

Heterogenphase PCM-Storage:
oil-contact salt hydrate: loading time 2-3 hours



Upscale to Nearly Every Size



m_{PCM} : 1500 kg

Q : ca. 80 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 \triangleq 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