Thermochemical energy storage for domestic applications

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Introduction

End-use energy consumption of Dutch households in 2016

- 46% dedicated to heating

(Energietrends ECN, 2016)
Motivation

- Mismatch supply and demand
- Energy storage possible solution

Energy consumption and solar irradiation in the Netherlands

(P.A.J. Donkers, 2015)
Heat storage in Salt Hydrates

Salt Hydrate(s) + heat $\leftrightarrow$ Salt(s) + Vapor(g)

- Dehydrate during summer $\rightarrow$ store energy
- Hydrate during winter $\rightarrow$ release energy
Requirements for thermal energy storage in the built environment

- **High storage capacity (5-10 GJ):** storage densities greater than 1 GJ/m³
- **High discharging rates (2.5 kW):** heating rooms
- **High enough temperature lift:** room heating, tap water heating
- **Dehydration temperatures < 150 °C**
- **Cyclability:** #cycli 30 (seasonal heat storage)  
  #cycli > 1000 (micro CHP)
- **Low system costs:** cheap materials
- **Non-toxic:** both material and products
Working principle

Discharging

Charging

reactor vessel
Experimental setup

- Heaters simulate thermal panels
- Reactor is filled with zeolite 13X
- Air humidified with bubble columns
- Total zeolite mass: 168 kg
- Total water uptake: 50 liter
Open reactor vessel and average grain size
Results

- Maximum delivered power: 3.6 kW
- Storage capacity: 50 kWh
Conclusions

- A zeolite 13X pilot reactor is developed to investigate the possibilities of seasonal heat storage in households.
- This setup can store 50 kWh of thermal energy.
- The delivered power is 3.6 kW.
- A temperature step of 20°C is achieved, continuously for 10 hours.
Future work

• Increase energy density

• Increase stability

• Increase temperature step
Thank you for your attention

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