Sorption Collector – Performance Increase of Closed Sorption Storage Systems

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TES4SET Thermal Energy Storage

Motivation

The charge boost process enables to increase the efficiency and energy denstiy of closed adsorption storage systems by

- achieving higher exploitation of the energy storage capacitiy
- decreasing desorption temperatures

Design of the Sorption Collector

- Sydney-type glas pipe
- Zeolite filled in stainless steel pipe and placed in the inner glas pipe
- Steel pipe connected via vacuum connection to other storage components
- Vapour channel in the center of zeolite bed to improve vapour flow
- Hydraulic connections between glas and steel pipe for direct sensible heating

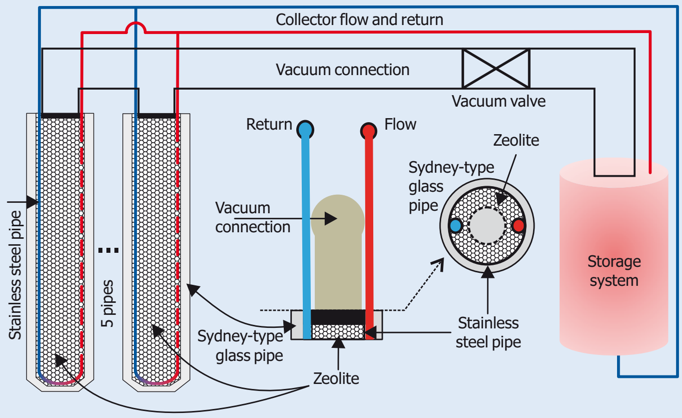

Fig. 1: Design of sorption collector

Operation Principle

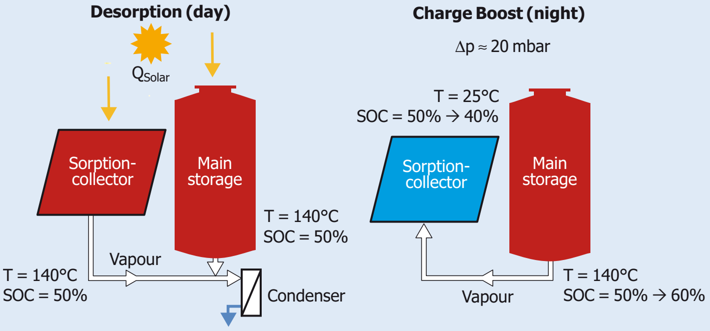

Fig. 2: Principle of sorption collector. SOC indicates the actual state of charge.

- Day:
  - Sorption material in collector is desorbed directly
  - Sorption material in main storage is desorbed indirectly by solar heat from the sorption collector transferred over the hydraulic system
- Night:
  - Sorption material in main storage stays at high temperature, sorption material in collector cools down → pressure drop
  - Vapour transfer from main storage to sorption collector

Advantages Sorption Collector

- Fullfill function of charge boost strorage
- Direct desorption in collector – no thermal losses over hydraulic connections
- Optimal use of empty volume – increase compactness of system
- Passive cooling overnight – enabling efficient application of charge boost
- Additional function of collector without negative influence on the collector performance

Potential

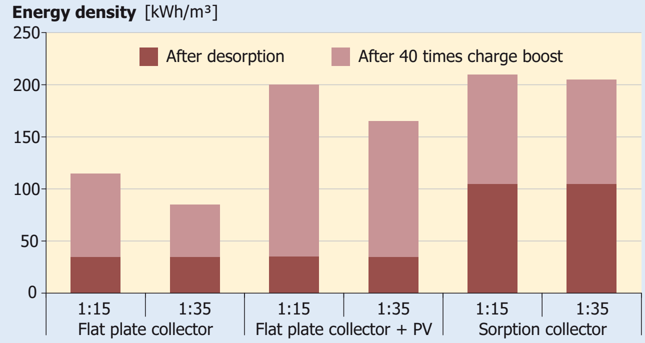

Fig. 3: Results of the calculation of the energy density improvement based on repeating the charge boost mode. The desorption temperature in the storages were assumed with 80°C for flat plat collector, flat plate + PV is 80°C in main storage and 180°C in charge boost storage and sorption collector 140°C. The comparison is based on a desorption only and desorption + 40 charge boost at given temperatures and also contains different mass ratios between main storage and charge boost storage or sorption collector respectivly.

Test Results

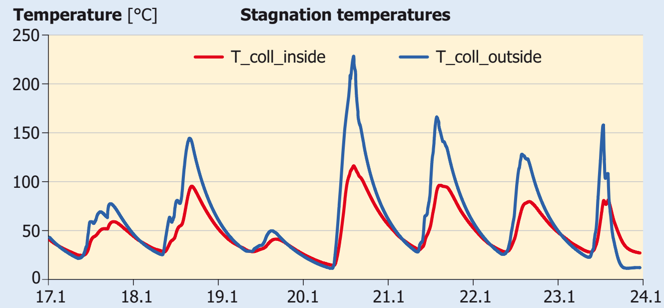

Fig. 4: Measured stagnation temperatures of the sorption collector prototype in a sunny week in January. Stagnation temperature of >220°C measured on the outside of the zeolite-containing pipe and temperatures of 115°C in the zeolite bed during peaks in January. During night, temperature drops to 20–30 °C (ideal conditions to efficiently apply the charge boost mode).

Fig. 5: Picture of the installed sorption collector prototype on the roof of the laboratory in Gleisdorf, Austria

Conclusion

The charge boost process enables a significant improve of the energy density of sorption storage systems. The sorption collector provides ideal conditions to efficiently use the charge boost mode in a day/night cycle. Results show that energy densities of >200 kWh/m³ are possible also at a smaller sized sorption collector. This results in a significant decrease of system volume as well as a decrease in system costs. First test results show high collector temperatures during sunny days and a fast temperature drop during night, which is the ideal boundary conditions for the charge boost.