Thermochemical energy storage for residential applications

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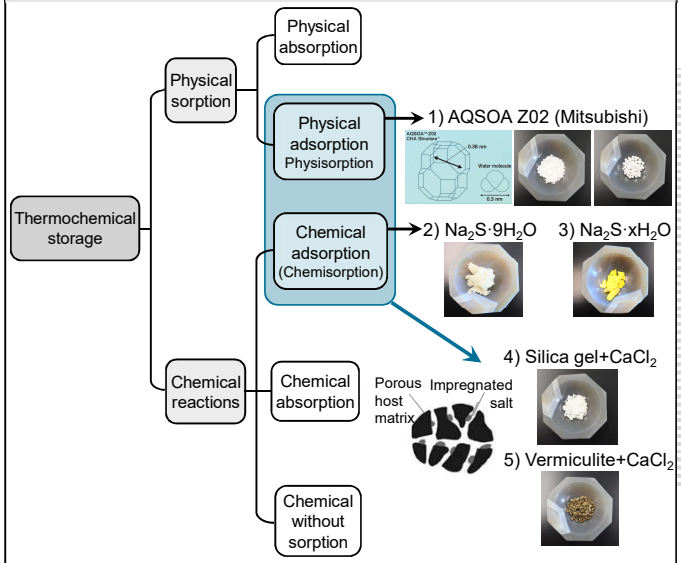
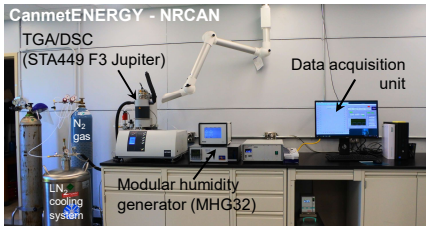
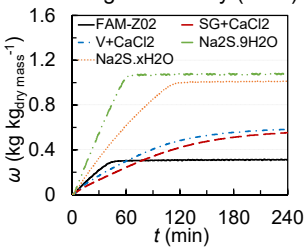
Screening thermochemical materials

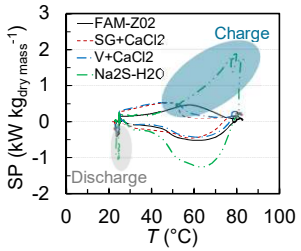


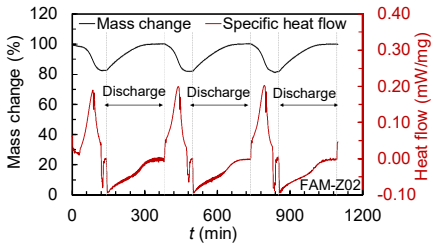
Characterization of sorption material candidates

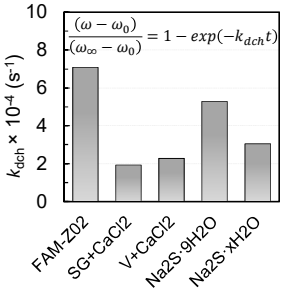
Thermogravimetric analysis (TGA) / Differential scanning calorimetry (DSC)

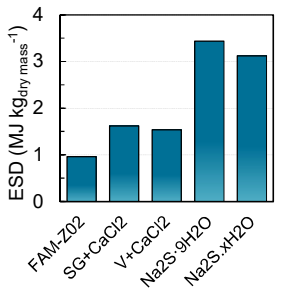






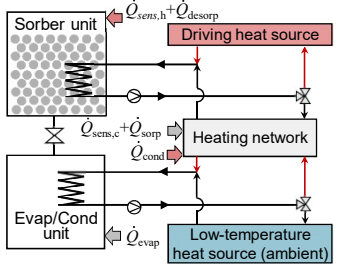


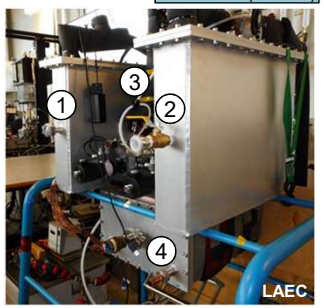




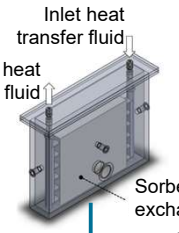
- FAM-Z02 showed the highest discharging rate (7×10^{-4} s^{-1}).
- Although Na_2S-H_2O provided the highest specific power (SP) and energy storage density (ESD), there were evidences of outgassing of H_2S, which made it unsafe for residential environment.
- Among the rest of sorbent candidates, highest discharge SP (0.431 kWkg^{-1}) was for FAM-Z02 and highest charge SP (0.541 kWkg^{-1}) was for vermiculite+$CaCl_2$.
- Silica gel+$CaCl_2$ showed ESD of 1.6 MJkg^{-1}.
- Due to the low volumetric ESD of vermiculite+$CaCl_2$, the best candidate was silica gel+$CaCl_2$.

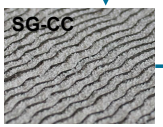
Lab-scale sorption energy storage

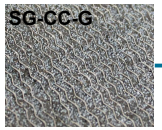




① Sorber beds
②



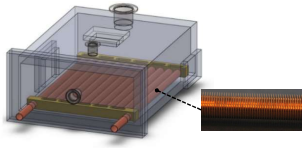




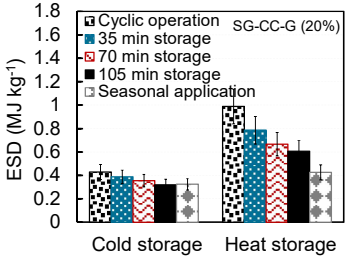
	Composition	m_{ads} (kg)	k_{ads} (Wm^{-1}K^{-1})	$c_{p,ads}$ (MJm^{-3}K^{-1})
Silica gel + $CaCl_2$ (SG-CC)	55% B150 silica gel 30% $CaCl_2$ 15% PVA	1.302	0.098 ± 0.002	0.42 ± 0.06
Silica gel + $CaCl_2$ + graphite flakes (20%) (SG-CC-G)	42% B150 silica gel 23% $CaCl_2$ 15% PVA 20% graphite flakes	1.513	0.231 ± 0.006	0.45 ± 0.03

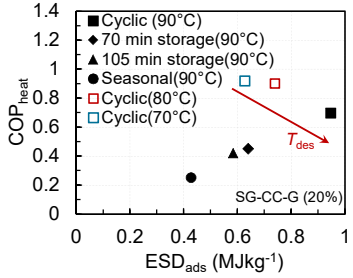
③ Condenser

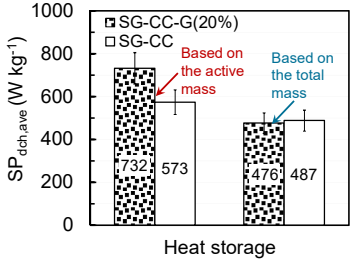
④ Custom-built capillary-assisted low-pressure evaporator



Hot Disk Thermal Constants Analyzer (TPS 2500 S)







- ESD$_{heat}$ of 1.1 GJm^{-3} was achieved for the lab-scale silica gel+$CaCl_2$ storage.
- ESD$_{heat}$ decreased from 1.03 for cyclic operation (no storage-time) to 0.43 MJkg^{-1} for seasonal applications.
- Adding 20% graphite flakes to silica gel+$CaCl_2$ increased the initial specific power (SP) from 1.25 kWkg^{-1} to 1.30 kWkg^{-1} for the first 10 min. However, the averaged SP of the composite without graphite was higher due to its more active sorbent material.