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Water vapor transport in porous salt hydrate particles in view of energy storage

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Due to a mismatch in energy production and energy demand a loss free method of storing energy is required. One class of materials suitable for this are salt hydrates. Salt hydrates release energy in the form of heat when subjected to water vapor by incorporating this water inside the crystal lattice (hydration/discharging). When subjecting the hydrated material to heat water is removed from the crystal lattice (dehydration/charging).

For effective use of salt hydrates inside a reactor bed mm-sized porous particles are required instead of powder, due to a high pressure drop over a powder bed. Since the pore structure influences water vapor transport and hydration, understanding the precise transport processes is critical.

The internal pore structure can be affected by several factor such as manufacturing conditions, morphology changes during cyclic loading and (re-)crystallization during hydration and dehydration.

First, it will be shown that the hydration of salt hydrate particles is diffusion limited. The porosity is the main parameter for tuning the effective diffusion coefficients for water vapor transport and power output as described in Aarts et al. (2022).

Next, the influence of cyclic dehydration/hydration and geometrical changes on the changes in pore structure and water vapor transport will be elucidated.

Lastly, it will be discussed how this influences the power output and performance as energy storage material for a single particle as well as a complete reactor bed.

Participation

In-Person

References

J. Aarts et al., "Diffusion limited hydration kinetics of millimeter sized salt hydrate particles for thermochemical heat storage," J. Energy Storage, vol. 47, no. November 2021, p. 103554, Mar. 2022, doi: 10.1016/j.est.2021.103554.

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