Adsorptive heat transformation with SAPO-34: diffusion of working fluids water, methanol and ethanol

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Adsorptive heat transformation can be used for energy storage, heat pumps and chillers [1]. For these applications a liquid (often water) is evaporated from a reservoir at low temperatures and then adsorbed in a porous solid adsorbent. The heat of adsorption (at medium temperature level) or the cooling of evaporation at the reservoir is utilized. When saturated, the adsorbent needs to be regenerated with heat at higher temperatures. The efficiency of this process is limited both by the adsorption equilibria as well as by the heat and mass transfer rates. In thin adsorbent coatings on adsorber heat exchangers, heat transfer is not dominating the dynamics anymore, while diffusion processes can play a rate limiting role.

In the WASSERMOD [2] project we are studying the adsorption and diffusion properties of water in SAPO-34 [3], MIL-100 [4] and aluminium fumarate [5], which are promising materials for adsorptive heat transformation applications. This study combines experimental investigations of water diffusion by pulsed field gradient (PFG) nuclear magnetic resonance (NMR) and time-resolved infrared (IR) microscopy with molecular dynamics (MD) simulations [6] and adsorption characterization. These investigations aim towards a better understanding of the water transport processes and the identification of transport resistances in the micropores of the crystalline material itself as well as in thin coatings produced from these materials for application on heat exchangers.

References

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