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Abstract

Heat transformation systems like thermally driven adsorption chillers and heat pumps are a very promising approach towards an efficient use of energy as well as an effective climate protection through reduced CO_2 emission of conventional heating and cooling devices.

With regard to current market entrance of this technology, the work schedule of this project was focused on the stability of currently available materials like silica gels and zeolites, recently developed materials like aluminophosphates (AlPOs) and silica-aluminophosphates (SAPOs) and novel materials like metal-organic frameworks (MOFs) under both cyclic and stationary hydrothermal stress.

As an outcome of a previous work, several open questions regarding hydrothermal and mechanical stability of sorption materials and compounds still exist. Thus, a new treatment procedure was developed, with regard to the planned usage of these adsorbents e.g. as thermal storage materials subjectto comparatively few adsorption/desorption cycles, up to heat pumps where as many as 50’000 cycles over the estimated service life are demanded..

As thermal stress acting upon the adsorbent differs for the various applications, different methods and test conditions were defined and consequently addressed in this work.

A final aim was to isolate and understand the degradation mechanism in order to simulate and develop fast aging procedures. This was the most ambitious and hard to tackle aim of the project.

As result of the performed analyses, stable materials under cyclic hydrothermal conditions for use in water sorption processes could be identified. In addition to cycle tests, specific structural degradation could be observed.

In order to isolate the individual parameters of the degradation mechanism, a systematically applied set of experiments was conducted.

The combination of high temperature, high humidity and high pressure lead to very strong degradation of all samples. Furthermore, clear gradations were found under reduced conditions. Thus, a typical “switching temperature”, depending on the material class was identified, from which the degradation progressed significantly faster.

In summary, the dominant parameters for a structural damage under exposition to water vapor for a variety of materials are shown in this study. Furthermore, new issues came up which require further investigations.