

# EXPERIMENTAL CHARACTERIZATION AND TECHNICAL EVALUATION ON ZEOLITES IN DIFFERENT SIZED SORPTION THERMAL ENERGY STORAGE SYSTEMS

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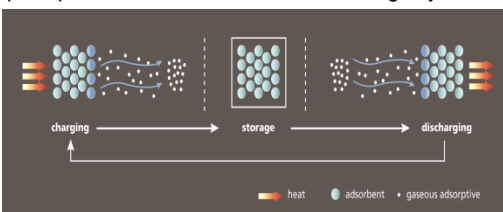
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## INTRODUCTION

The studies reported here are focused on closed sorption thermo-chemical storage systems. The heat storage in such a system can be understood as a discontinuous but cyclic process consisting of charging and discharging modes. The figure below shows a schematic representation of the operating principle of a thermochemical heat storage system.



The possibility of medium to long-term storage with minimal thermal losses, variable temperatures and a high energy storage density are the main advantages of this system compared with sensible and latent thermal storage systems. Areas of application for these heat storages are industrial processes as well as heating systems of buildings. While some research and development activities have been executed in the past [1-3], more advanced adsorption materials and system configurations are still needed for efficient thermal storage at higher temperatures, particularly in the range of 120 - 250 °C in order to have significant potential for industrial applications.

## OBJECTIVES

The main objectives are to:

- characterize and evaluate different zeolites in sorption energy storage systems
- determine the influence of up-scaling on the adsorption behavior of the sorption materials.

## MATERIALS AND METHODS

Experimental investigations were performed on a wide range of zeolites using a lab-scale test rig ( $V = 1.5 \text{ L}$ ,  $T_{VIC} = 30 \text{ °C}/10\text{°C}$ ,  $T_D = 200 \text{ °C}$ ) to measure the temperature distributions, adsorption capacities, energy densities, pressure gradient and hydrothermal stability.

Technical evaluations have also been carried out in different sized test systems to determine the influence of up-scaling from lab-scale ( $V = 1.5 \text{ L}$ ) to semi-technical ( $V = 15 \text{ L}$  and  $50 \text{ L}$ ) and technical storage systems ( $V = 1 \text{ m}^3$ ) on the performance of zeolites. Characteristic features of some of the investigated materials (Köstrolith) are stated in table below.

## REFERENCES

- [1] Bayerisches Zentrum für Angewandte Energieforschung ZAE ([www.zae-bayern.de](http://www.zae-bayern.de))
- [2] Fraunhofer-Institut für Solare Energiesysteme ISE ([www.ise.fraunhofer.de](http://www.ise.fraunhofer.de))
- [3] A. Wille, „preheat – policy reinforcement concerning the storage technologies“, 2006, 1-2

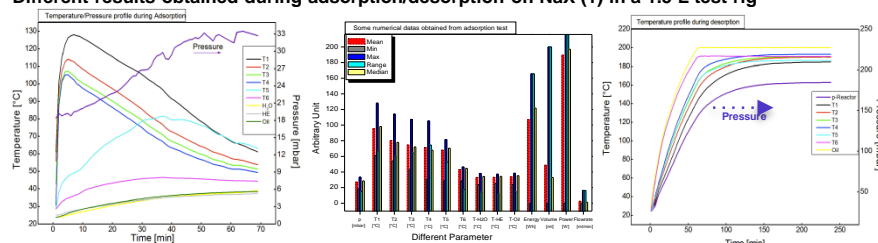
## ACKNOWLEDGMENT

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## EXPERIMENTAL RESULTS

Six adsorption/desorption cycles have been carried out on each of the investigated materials in different sized sorption storage systems. Some exemplary results are presented here.

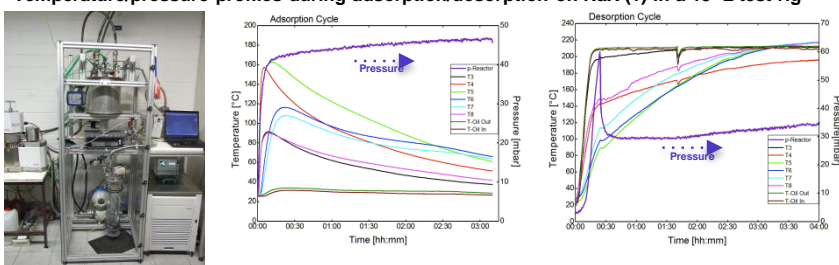
### Different results obtained during adsorption/desorption on NaX (1) in a 1.5 L test rig



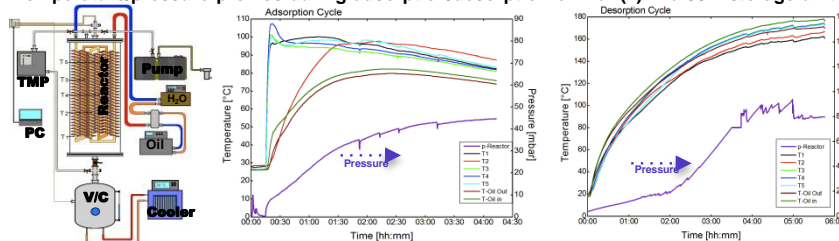
Comparison of the sorption properties of some of the investigated zeolites

Material	SiO <sub>2</sub> /Al <sub>2</sub> O <sub>3</sub> Ratio	Particle Size [mm]	Bulk density [g/ml]	Max T° [°C]	Δh <sub>s</sub> [kWh/kg]	a [g/g]
NaX (1)	2.35	1.6 - 2.5	0.655	118	0.201	0.248
NaX (2)	2.35	2.5 - 3.5	0.687	117	0.208	0.258
NaX (3)	2.35	3.5 - 5.5	0.658	106	0.166	0.140
4ABF	2.00	1.6 - 2.5	0.630	115	0.171	0.210
NaY	5.0 - 5.3	2.5 - 3.5	0.667	101	0.216	0.186
NaMSX (2) + GFG 1200 (10:1)	-	-	-	120	0.201	0.228

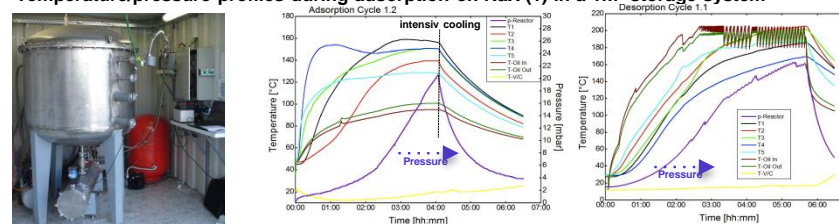
### Temperature/pressure profiles during adsorption/desorption on NaX (1) in a 15 L test rig



### Temperature/pressure profiles during adsorption/desorption on NaX(1) in a 50 L storage unit



### Temperature/pressure profiles during adsorption on NaX (1) in a 1m³ storage system



## CONCLUSIONS

- Different tests were carried out in a 1.5 L lab-scale test rig for pre-selection of suitable materials from a very wide sorption material range
- Some of the tested zeolites exhibit a higher temperature lift. The charging temperatures of those sorption materials exceed 473 K
- The technical evaluation in larger scale (15 L and 50 L semi-technical as well as in 1 m<sup>3</sup> technical systems) reveal quite satisfactory results, even though clear up-scaling effects were observed
- Further performance verification tests will be done in the near future by integrating the technical system with combined heat and power (CHP) plant for higher charging temperatures