
Thermochemical heat storage: influence of zeolites' structure and composition on water sorption capacity, kinetics and heat density

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To decrease the dependence on fossil energy sources (expensive, limited and polluting), the solution is to orient development towards the use of renewable energies, which can be implemented in more environmentally friendly solutions. Solar energy is the most abundant renewable energy source. Unfortunately, solar energy is intermittent; consequently, the need to bridge the gap between energy supply and energy demand remains a challenge. For this reason, identifying, developing, and optimizing the energy storage technologies is the entryway to a renewable energy-based economy.

Systems based on thermochemical heat storage have the advantage of presenting negligible heat loss during storage and a higher heat density. The solid storage material is at the heart of such thermochemical heat storage systems, and it must possess certain specific properties, such as a high energy density and a high affinity for the sorbate, water (to ensure the exothermic chemical reaction involved in the heat releasing step).

Zeolites are one of the best choices for large-scale and long-term applications, due to their high heat storage density and stability to several hydration/dehydration cycling [1]. Zeolites are aluminosilicate-based porous materials that might present good affinity for water, enabling to adsorb water molecules on their large internal and external surface area. Even if zeolites have been already applied in several thermochemical heat storage prototypes, fundamental knowledge on the influence of the compensating cation, the zeolite type, the pore opening and the pore volume, still need further investigation.

For this reason, FAU-type zeolite (X, Y, EMC-1) [2] and LTA-type zeolite (frameworks with different Si/Al) exchanged with different compensating cations (at different contents) will be synthesized, fully characterized (textural and structural properties) and tested for determining their thermal properties and heat density. The hydrophilic character of the different zeolites will be deeply investigated and correlated with the different physico-chemical properties determined by complementary characterization techniques. Selected samples will be tested in hydration/dehydration cycles for verify their stability. Particular attention will be addressed to the study of the water adsorption kinetics as a function of the zeolite composition and pore structure. Finally, the influence of mechanical shaping of the zeolite powder on the water adsorption kinetics and capacity will be investigated in adsorption test performed in dynamic and static conditions.

[1] S. Bennici, T. Polimann, M. Ondarts, E. Gonze, C. Vaultot, N. Le pierrès - Long-term impact of air pollutants on thermochemical heat storage materials - *Renewable & Sustainable Energy Reviews*, **117** Article 109473, (2020)

[2] Z. Tahraoui, H. Nouali, C. Marichal, P. Forler, J. Klein, T.J. Daou, Influence of the compensating cation nature on the water adsorption properties of zeolites, *Molecules*, **25**(4), 944, (2020).