Advanced Materials for Adsorption Heat Energy Storage – Nano-Tailored Silica

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Energy storage is one of the key components for the effective utilisation of renewable sources of energy. This is not limited only to electric energy but can be applied to thermal energy as well since the consumption of thermal energy exceeds the electric energy in general. In this work, I elaborate on the concept of adsorption thermal energy storage (aTES) technology (**Fig. 1**) with the main focus on the storage matrix. The energy in aTES is stored in the form of adsorption potential when the heat is released upon contact/adsorption of the working medium's vapours with the surface of the storage substrate, an identical in principle to the adsorption heat pump. The pressure drop in the system coupled to the vapour adsorption on the substrate drives further evaporation of the working medium, creating an active heat source and heat sink (double-effect operation – cooling/heating). This work shows the analysis and experimental application of some new materials from the group of nano-tailored microporous silica with aluminium doping and composite materials [1]. It is demonstrated on numerical analysis and on an original adsorption isotherm model that the studied materials have the potential to be effectively used in the aTES systems. An experimental down-scaled device shows a good agreement with the theoretical model in terms of absolute energy storage density with COP reaching 0.7 [2]. The pure material's storage density demonstrates values from 500 kJ/kg to 600 kJ/kg on average for the $\Delta T \approx 10$ °C region (**Fig. 2**), and the system's kinetics show promising peak output values around 300 W/kg~500 W/kg; However, the sustainability of the actual energy output is strongly dependendent on the heat exhanger design and bonding method and requires further considerations.

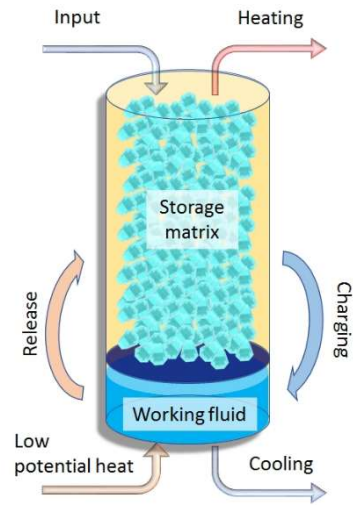

Fig. 1 *aTES thermal battery*

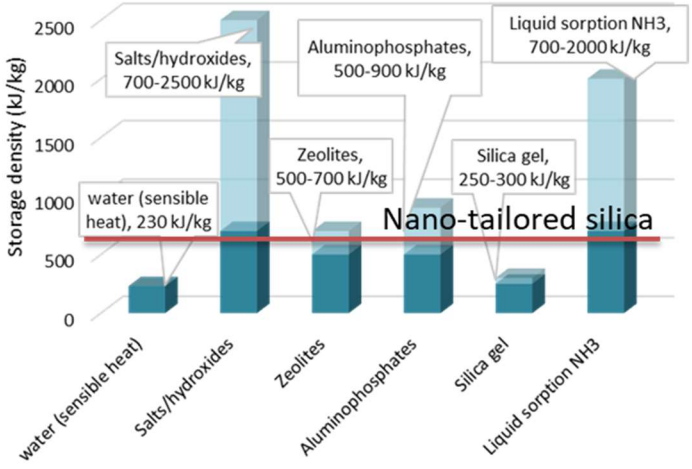

Fig. 2 *Storage density of the nano-tailored microporous silica*

References

[1] Miksik, F., Miyazaki, T., *IMPRES2019*, A302 (2019).

[2] Miksik, F., Ahmed, Y. Miyazaki, T., *14th IIR Gustav-Lorentzen Conference on Natural Fluids*, **2020**,316–320 (2020).