Thermochemical Storage System: Compactness Increase due to a Prismatic Shaped Storage Module

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Motivation

Compactness increase and minimization of unused voids for a closed thermochemical storage system due to the development of a prismatic shaped storage module. By using prismatic shaped storage modules the storage density can be increased by at least 20% per module compared to cylindrical vessels.

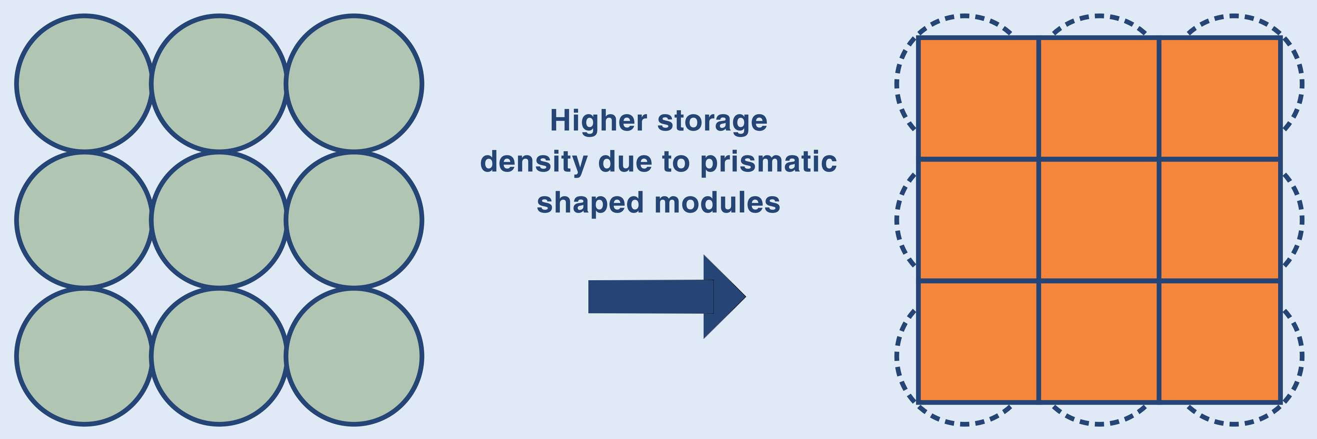

Fig1.: Increased storage density by using prismatic shaped storage modules instead of cylindrical storage modules.

Challenges

In a closed thermochemical storage system, the main challenge of a non-cylindrical design is the vacuum force, which the construction has to withstand. In order to cope with the vacuum force while keeping the wall thickness of the containment small, the internal heat exchanger can be used as a structural support.

Design of the storage module

- 1 Module for 250 liters of Potassium Carbonate (K_2CO_3)
- Fin-Heat exchanger function as structural element
- Fin thickness 0,25mm / Fin spacing of 10mm
- Welded stainless steel containment in which the amount of steel used is in the same order as a comparable cylindrical vessel

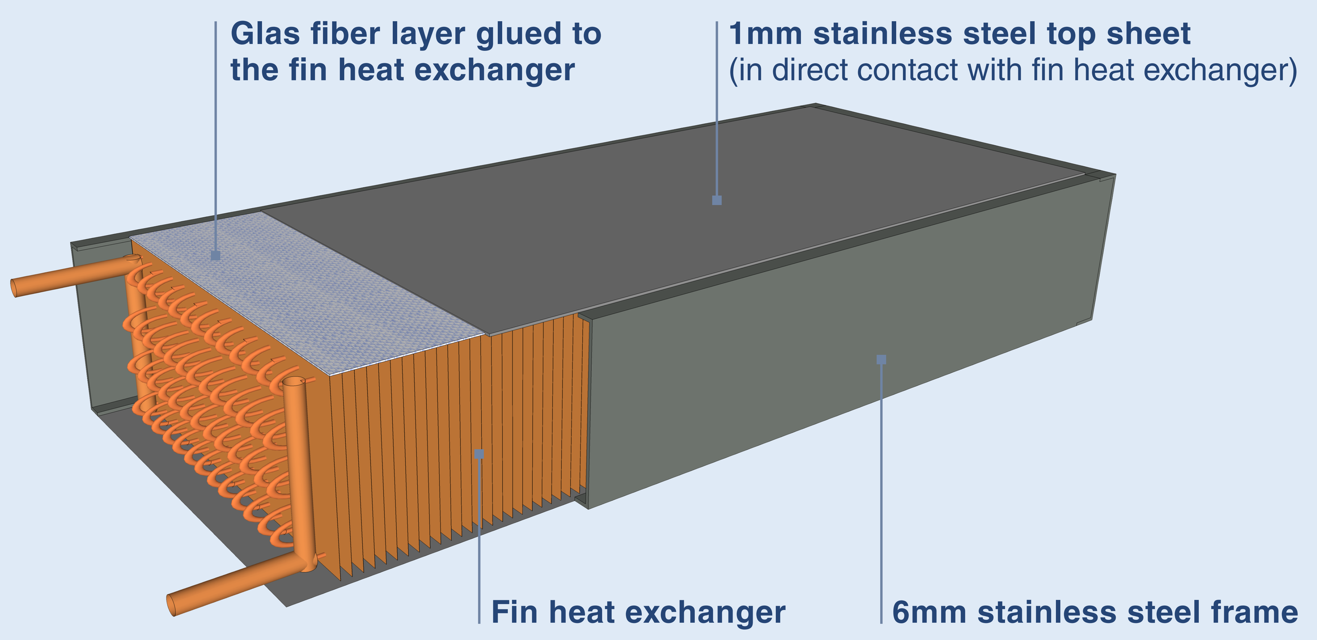

Fig 2.: Cross-sectional drawing of the storage module

Results

- One 250 liter prismatic module for a closed thermochemical storage system build and filled with K_2CO_3
- Storage module implemented in a full scale lab storage system
- Multiple hydration and dehydration cycles carried out successfully
- Average power output measured, depending on temperature levels, between 1235W and 2670W
- Storage density on heat exchanger level measured between 0.436 GJ/m³ to 0.515 GJ/m³

Assembly Process

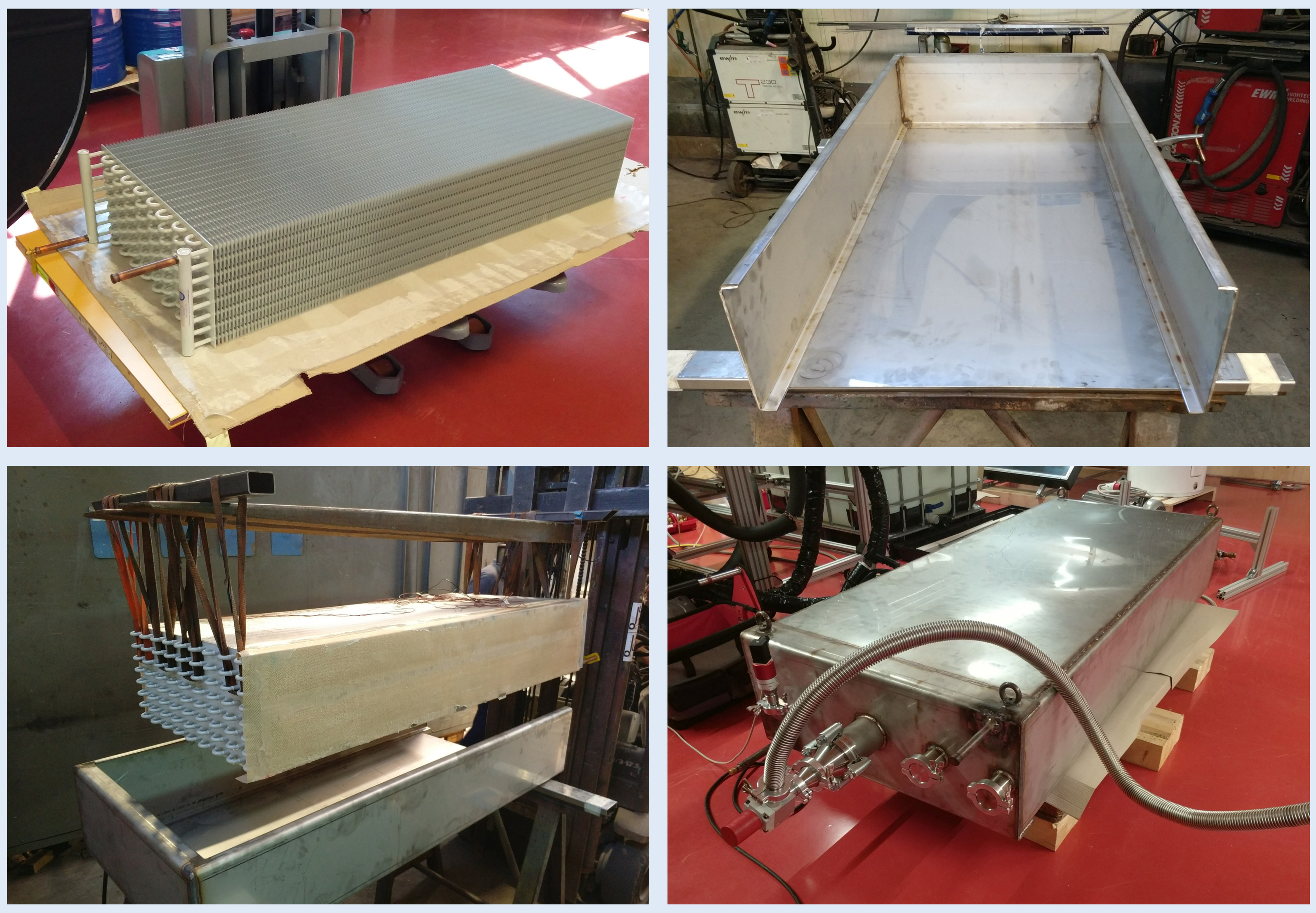

Fig 3.: Assembly process and the final module before testing

Measurement Results

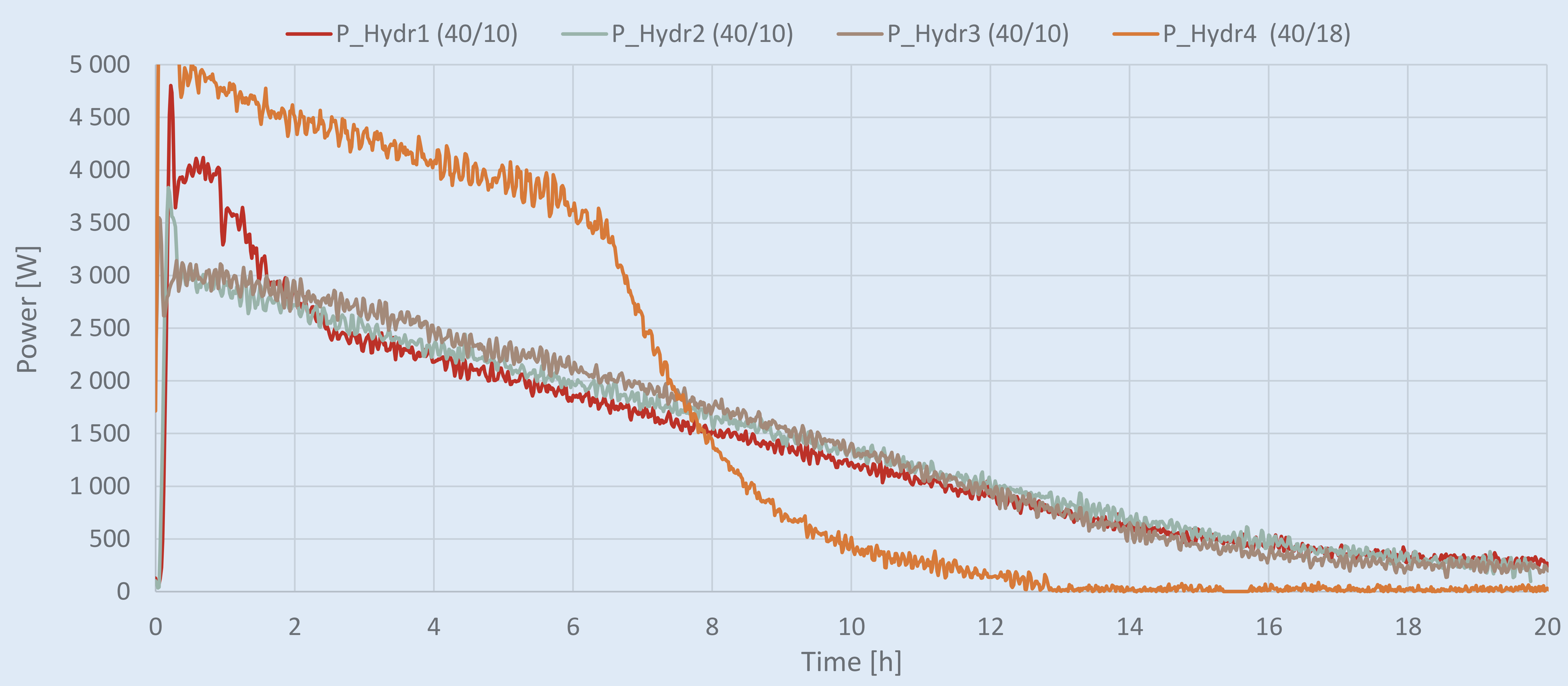

Fig 4.: Measured hydration power output of one 250 litres storage module filled with K_2CO_3. (Evaporation temperature 10°C and 18°C; Module inlet temperature 40°C)

	Avg. Power Output	Energy density (HX level)	Energy density (Module level)
1. Hydration 40°C/10°C	1235 W	0.436 GJ/m³	0.329 GJ/m³
2. Hydration 40°C/10°C	1410 W	0.436 GJ/m³	0.329 GJ/m³
3. Hydration 40°C/10°C	1470 W	0.447 GJ/m³	0.337 GJ/m³
4. Hydration 40°C/18°C	2670 W	0.515 GJ/m³	0.389 GJ/m³

Tab 1: Measured average power output and energy density of four hydration cycles

Partner

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