Next Generation Car – Coupled Thermochemical Reactions for Preheating Vehicle Components

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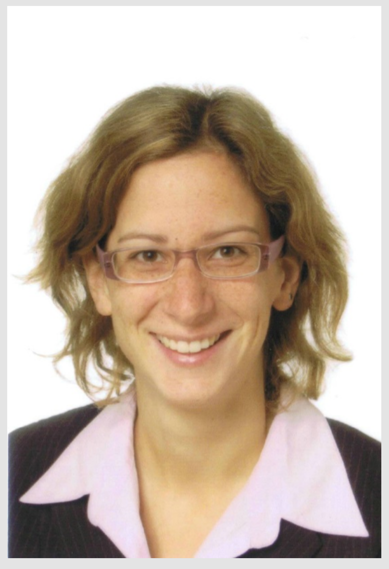

Operation Principle

$$MH_{x+y} + \Delta H \leftrightharpoons MH_x + \frac{y}{2} H_2$$

- endo-/exothermal reaction of metal hydride with hydrogen
- closed system: thermally driven hydrogen exchange between two metal hydrides, no hydrogen released or required (Fig. 1)

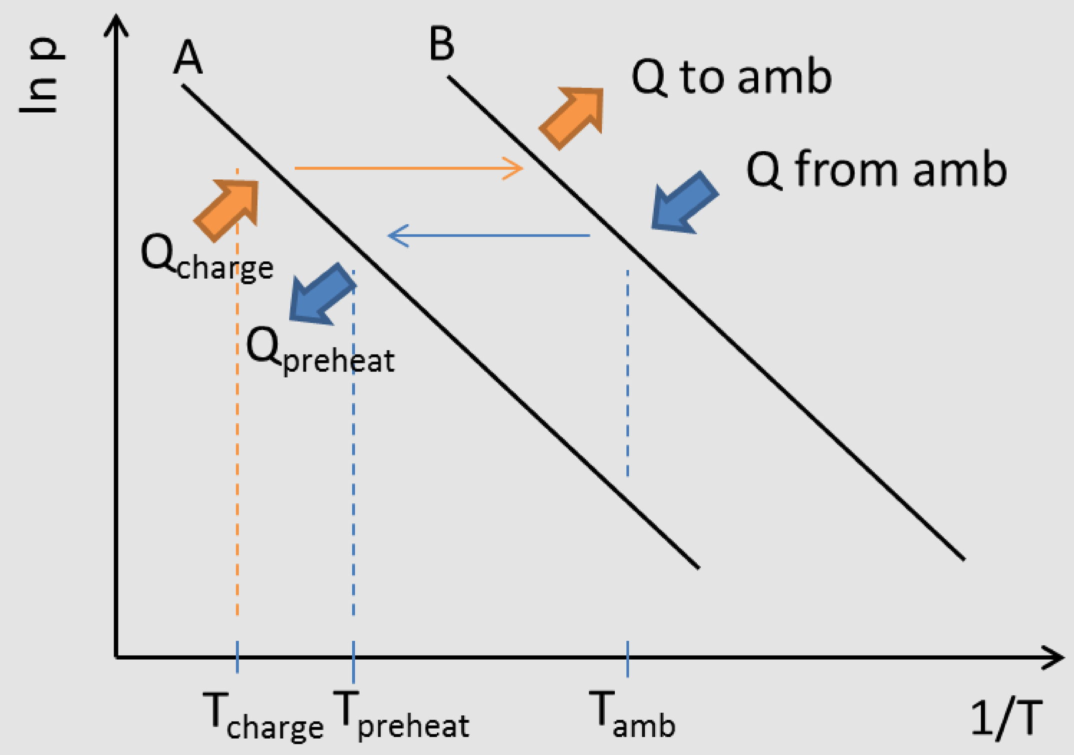

Figure 1. Van't Hoff plot of two different metal hydrides A and B.

Advantages of proposed thermal energy storage

storage **free of loss** as long as required (storage as chemical potential)

heat generation from ambient temperature **on demand**

usage of waste heat => **cooling effect** at peak load phases

high thermal power values possible

generation of both **heat and cold** at the same time

low charging temperature and still **high energy density** of 600 kJ/l_{MH} (150 kJ/kg_{MH})

Experimental Results [1]

- high thermal power tube bundle reactors
- 960 g of $LaNi_{4.85}Al_{0.15}$ (for heat generation)
- 615 g of Hydralloy C5 (for cold generation)
- experiments at temperature as low at -20°C

$$P = \dot{m}_{HTF}\, c_{p,HTF}\, (T_{HTF,out} - T_{HTF,in})$$

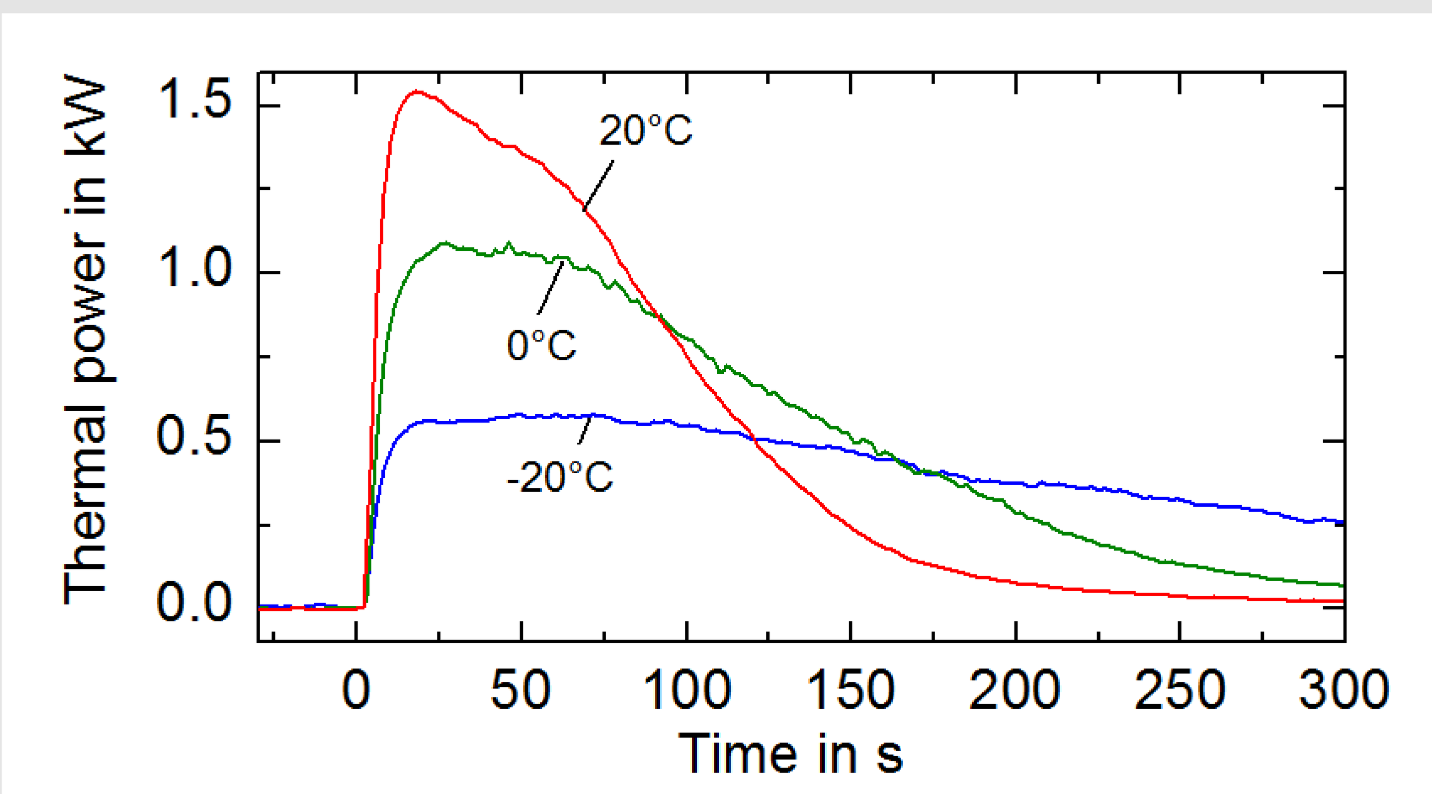

Figure 3. Thermal power over time at different ambient temperatures.

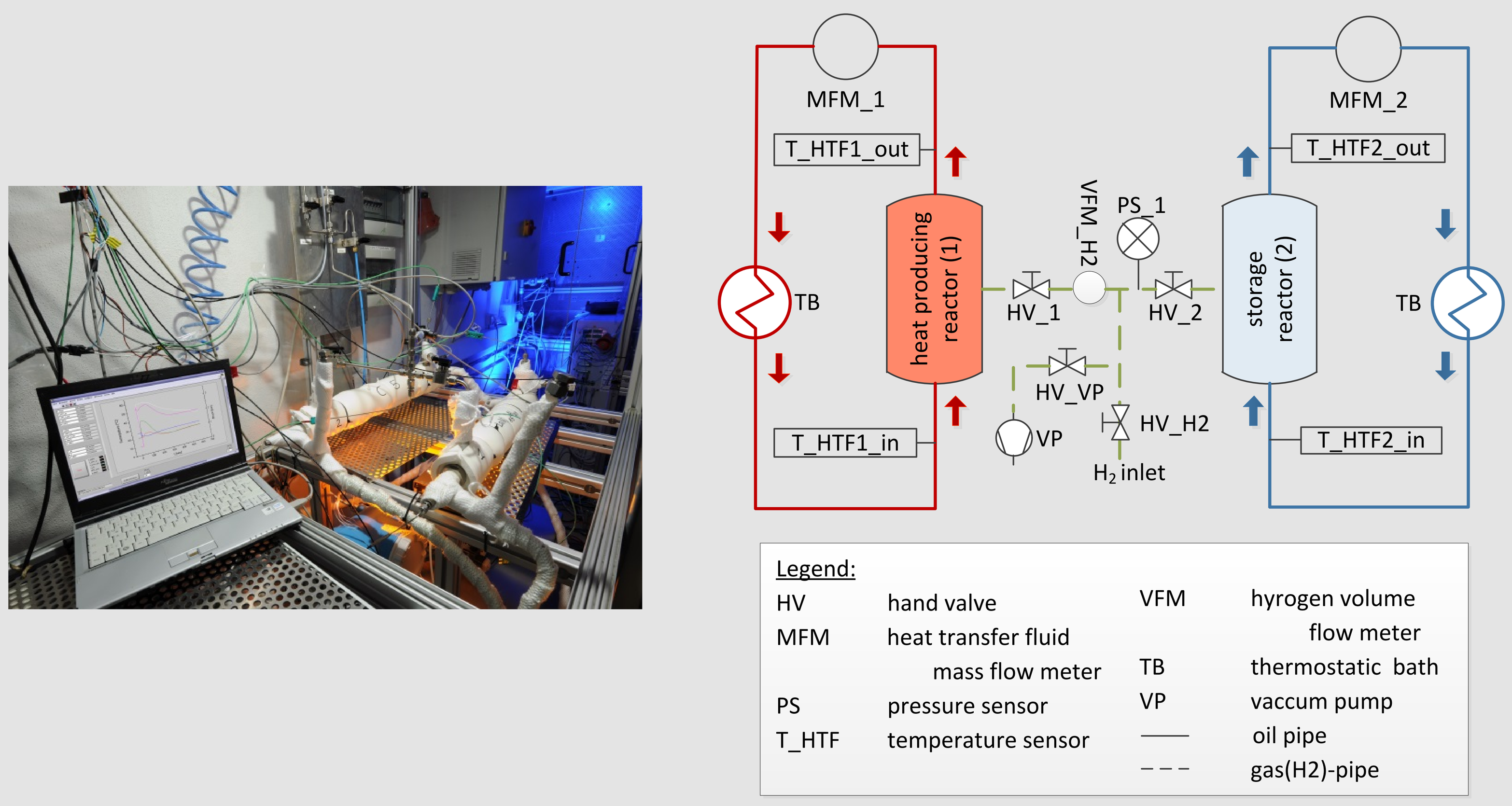

Figure 2. Picture and layout of test bench and the reactors.

Highest thermal power with metal hydrides at low temperatures:
2.4 kW/l_{MH} (0.6 kW/kg_{MH}) @ -20°C
6.4 kW/l_{MH} (1.6 kW/kg_{MH}) @ +20°C

[1] M. Dieterich, I. Bürger, and M. Linder, "Open and closed metal hydride system for high thermal power applications: preheating vehicle components," *Int. J. Hydrogen Energy*, pp. 1–13, 2017.

DLR Deutsches Zentrum für Luft- und Raumfahrt