Technology: Thermochemical Heat Storage by Chemical Reaction

GENERAL DESCRIPTION

Mode of energy intake and output

Heat-to-heat

Summary of the storage process

Thermochemical processes based on reactions between gases and solids are fundamentally similar to sorption processes. Thermal energy causes a chemical compound to decompose, which releases the gaseous reaction partner. Bringing the reactants back together triggers the exothermic reverse reaction, i.e. the heat that supplied the original reaction is released again. The portion of thermal energy that is stored chemically can therefore be conserved losslessly. The main difference to sorption processes is the chemical phase change - a new compound is formed. This process takes place for a given reaction system and gas pressure at a constant temperature. Thermochemical energy storages can therefore be adapted to specific applications through the choice of, both, the gaseous reaction partner and reaction material.

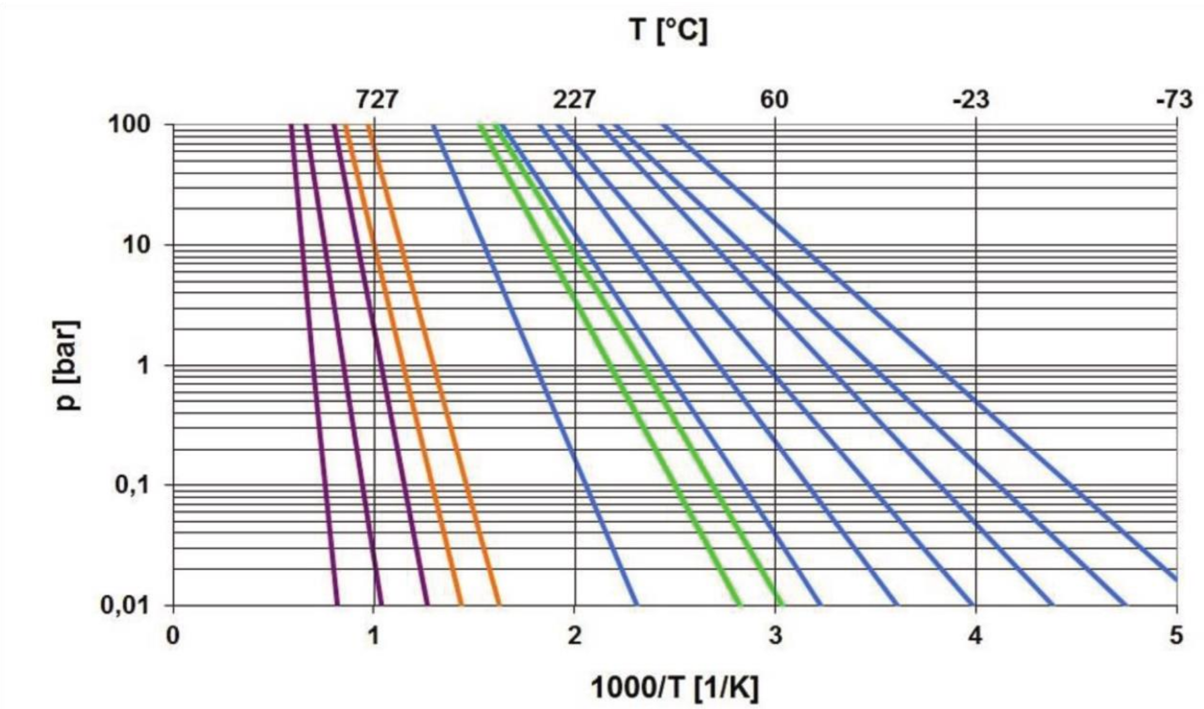

Figure 1: Selected gas-solid reaction systems used for thermochemical storage: oxygen with various metal oxides (purple), water vapour with salts or metal oxides (orange and green), hydrogen with various metal hydrides (blue) (© DLR)

As the reaction temperature depends on the gas pressure, the storage's temperature level may be changed by varying the pressure. A special feature of thermochemical storage is therefore its capacity to operate as a combination of heat pump and storage. They can discharge heat at a higher temperature than they were charged at. This capability exists in all thermochemical reaction systems depending on the process conditions.

Focus on provision of power or energy

Provision of energy, heat valorisation

Suitable fields of application

Solar thermal power plants, industrial waste heat recovery, power plant engineering, building services including seasonal storage

State of development/commercial availability

TRL 3-4

Current research mainly focuses on:

- Development of customisable and simplified reactor concepts (= mass and heat transfer)
- Concepts for integration, particularly of the gaseous reaction partner
- Stabilisation of the reactive bulk/structure, e.g. pelletising, granulation, etc.
- Selection and further development of storage materials with regard to thermodynamics, kinetics, and cycling stability

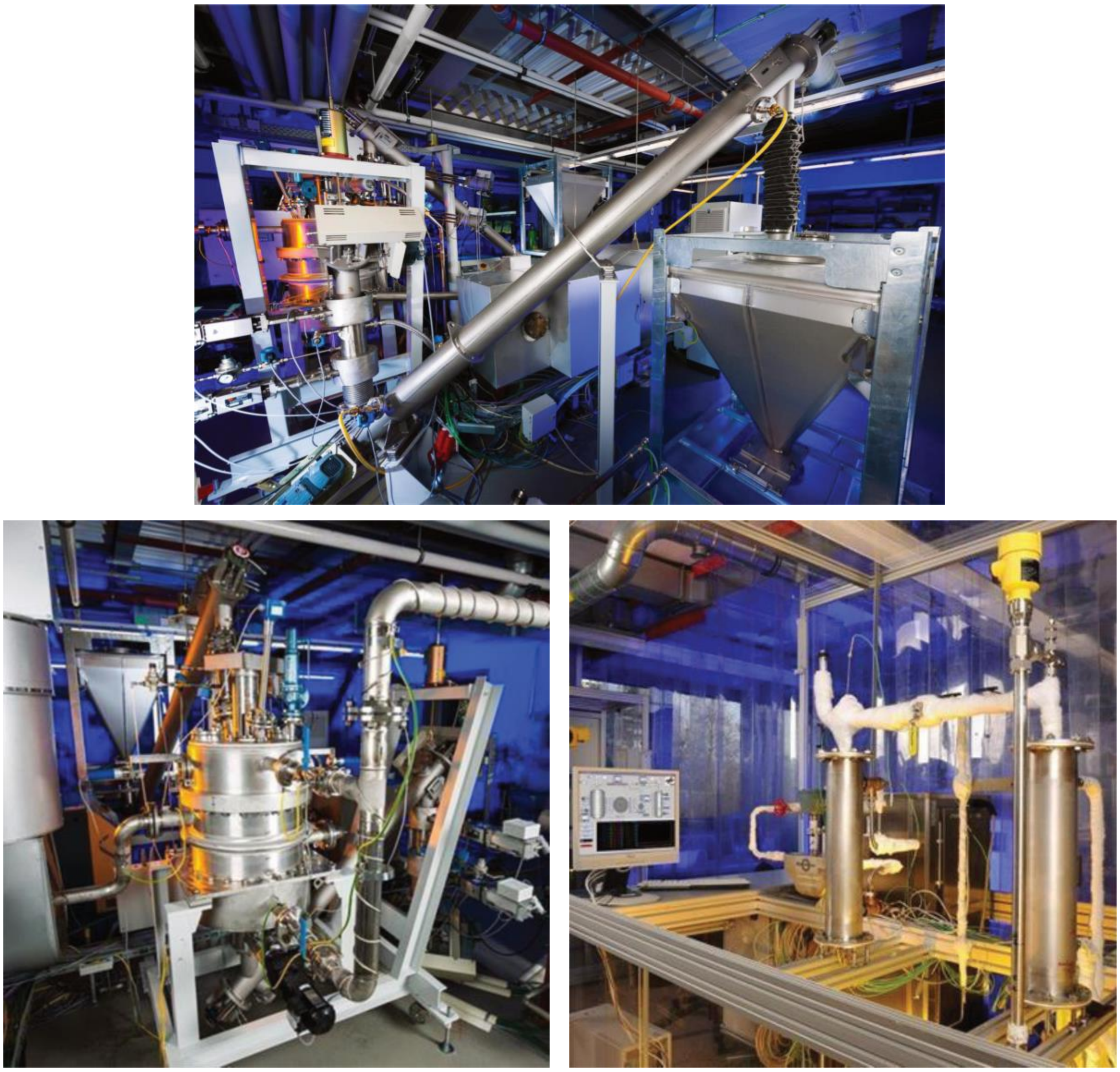

Figure 2: Laboratory installation for thermochemical high-temperature storage (10 kW/100 kWh) (t., l.), experimental setup for thermal valorisation of waste heat at temperatures > 140 °C (1 kW) (r.) (© DLR)

TECHNICAL SPECIFICATIONS

Specific energy storage density	kWh/m^3 100-400	kWh/t 100-400
Specific power density	kW/m^3 depends on reaction	kW/t depends on reaction
Typical/feasible storage size	kWh_{out} depends on reaction	kW_{out} depends on reaction
Storage efficiency	depends on reaction	
Storage duration	hours-weeks	
Response time	minutes	
Service life (maximum)	depends on reaction	
Loss per time in %	depends on reaction	

ECONOMIC SPECIFICATIONS

None so far, only R&D