TECHNISCHE UNIVERSITÄT DRESDEN

SUMMER OF EXCELLENCE

DRESDEN concept

School of Engineering Sciences

Liquid-metal thermal energy storage for Concentrated Solar Power (CSP) and Alkali Metal Thermal to Electric Converter (AMTEC)

MOTIVATION

In the framework of the German nuclear phase-out, new technologies are under investigation that provide clean, efficient, and economically viable renewable energies. A possible candidate is AMTEC (**A**lkali **M**etal **T**hermal to **E**lectric **C**onverter), a high-temperature electrochemical cell which converts heat directly to electricity. The combination of **C**oncentrating **S**olar **P**ower (CSP) using liquid metal as heat transfer fluid and AMTEC clusters provides an increased overall efficiency to the plant, while an enlarged profit / cost ratio is expected too. A well-defined thermal energy storage is essential in such a combined power system not only to enlarge the lifetime of the components, but also to provide the grid with a load and frequency balancing capability.

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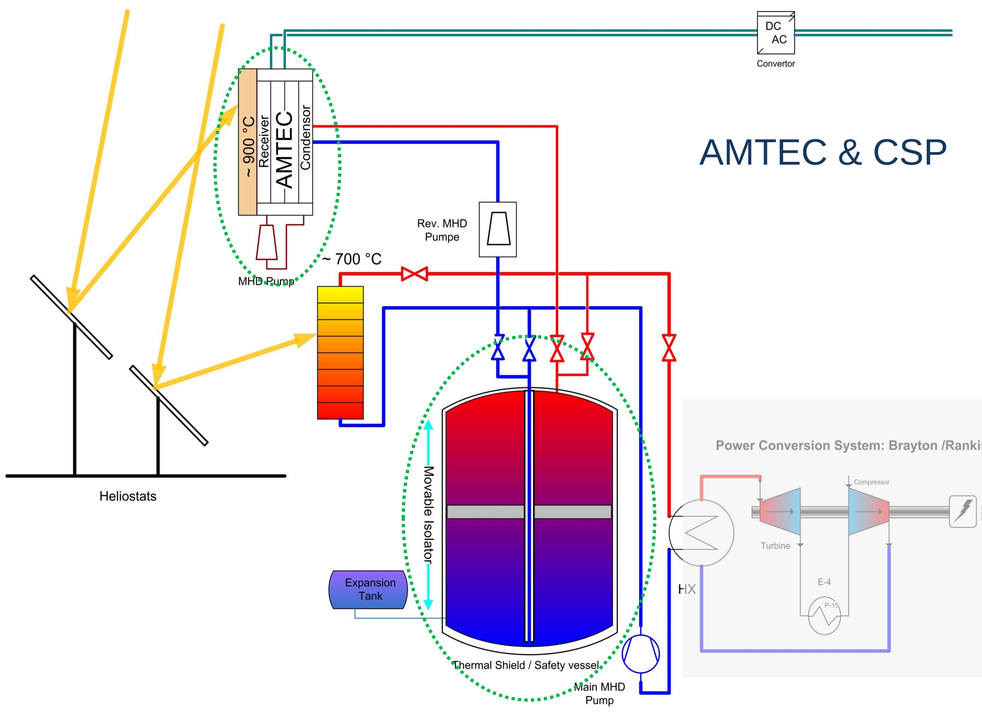
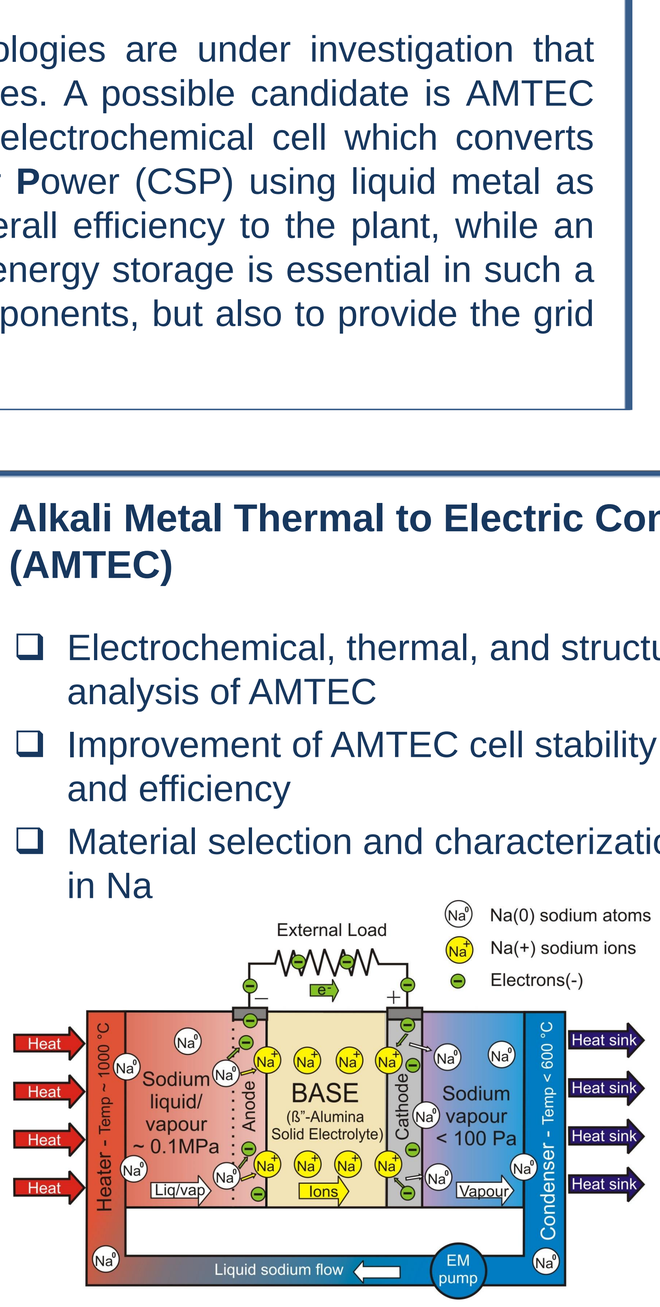
Visionary CSP plant with AMTEC as topping system



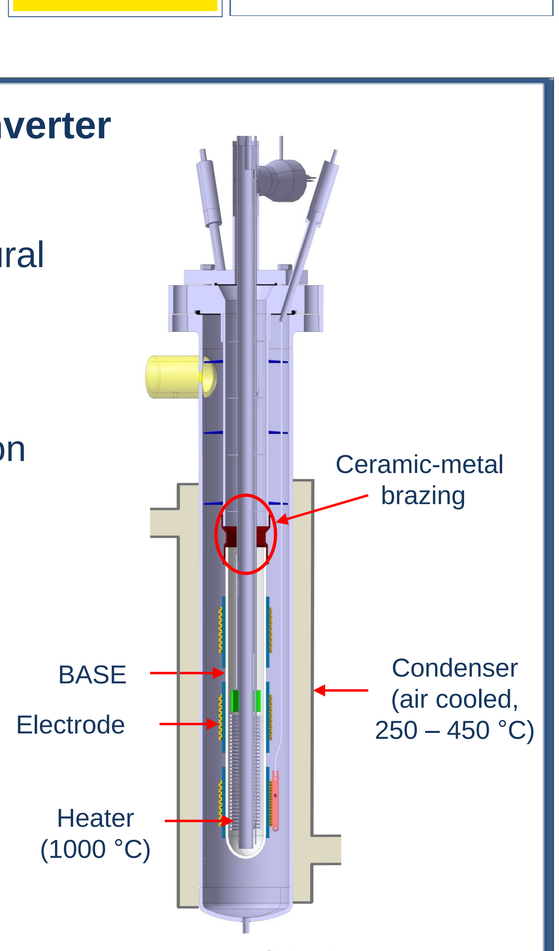
Flow diagram of a Tower CSP Plant with AMTEC as a topping system (Hering et al., E2C Maastricht, 2012)

Alkali Metal Thermal to Electric Converter (AMTEC)

- ❑ Electrochemical, thermal, and structural analysis of AMTEC
- ❑ Improvement of AMTEC cell stability and efficiency
- ❑ Material selection and characterization in Na



Operation principle of AMTEC

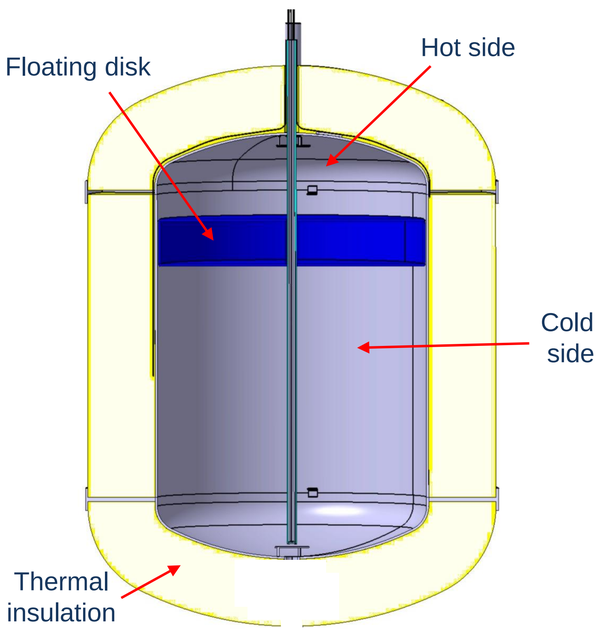


AMTEC test cell

Liquid metal thermal energy storage (thermocline single tank)

(Hering et al., EPJ, 2012 and Schubert, 2012)

- ❑ Single storage tank
  → Simplified insulation and piping
- ❑ High temperature thermocline (700 – 550 °C)
  → Separation hot – cold zone
  → Floating disk filled with Ar and radiation shields
- ❑ Expansion tank attached at lower temperature
  → Conventional materials
- ❑ Safe design
  → Double wall protects from leakage
- ❑ Thermal insulation
  → Cavity between insulation walls



Main research topics:

- ❑ Structural analysis of the storage tank
  → Stresses on the disk-driving pipe
- ❑ Thermal analysis of the storage tank
  → Reduction heat losses through radiation shields
- ❑ Stability and deformation of the floating disk due to density difference at different elevations
- ❑ Dynamics of load/unload flow conditions for fast charge/discharge scenarios

MAIN GOALS

Based on the experience in liquid metal and AMTEC technology at KIT, an AMTEC test facility is being constructed and first measurements will be made in the end of 2014. Concurrently a small prototype of the thermocline tank is planed to be integrated in the **Ka**rlsruhe **So**dium **La**boratory (KASOLA) next year. The work is part of the energy material research within LIMTECH- Alliance and HEMCP, both projects are sponsored by the Helmholtz-Association of Large Research Centers (HGF).

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CSSI combined storage system INTEGRATION