Karlsruhe Institute of Technology

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ATEFA facility for performance evaluation of an Alkali Metal Thermo-Electric Converter (AMTEC)

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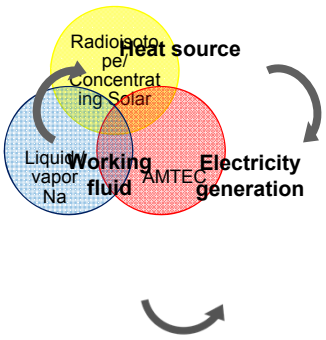
Motivation AMTEC in Space



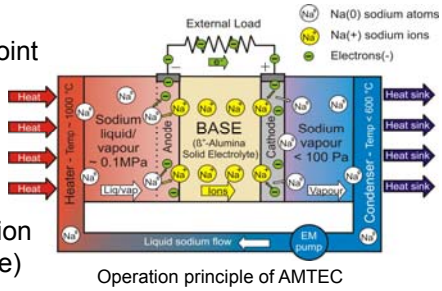
- Flexible heat source
- Direct conversion of heat to electricity
- AMTEC net fuel consumption = 0
- High expected AMTEC efficiency (~ 40 %)
- Static system
- Modular connection

AMTEC technology

- Key process: Na-ionization (Δp across BASE)

$$Na \rightarrow Na^{+} + e^{-}$$

- Issues:
  - Ceramic-metal joint
  - Electrode sputtering
  - Overvoltage losses
  - Power degradation (BASE, electrode)



Operation principle of AMTEC

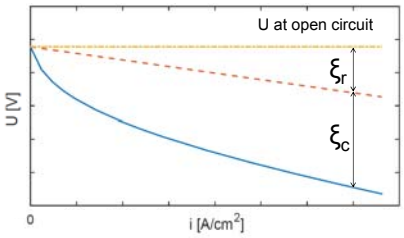
AMTEC Test Facility (ATEFA)

- Facility for efficiency and performance evaluation of AMTEC
- Sodium system (800 °C, 1.5 bar)
- Argon system controls: p_{Na} , $\dot{m}_{Na}$
- Safe design (handling of Na)
- Ceramic-metal joint developed for 800°C
- Electrode-sputtering achieved (TiC, TiN, Mo)
- Data acquisition and control system finished
- Automatic operation during steady state

Variable	AMTEC @ INR 1993
V	0.4 – 1.2 V
I	0.5 – 1.5 A/cm²
P	0.5 – 1.5 W/cm²
$\eta_{present}$	~ 20 %
T_{Na}	600 – 1000 °C
p_{Na}	1 Pa – 0.1 MPa

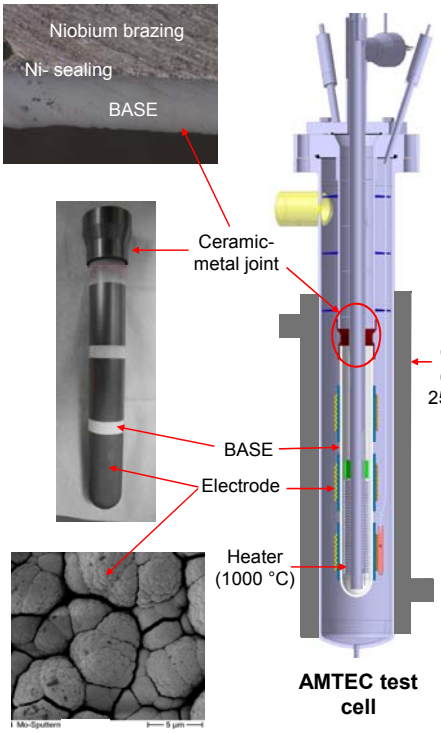
Overvoltage losses in AMTEC

The overvoltage losses can be separated into ohmic losses ξ_r (20%) and polarization losses in the cathode ξ_c (80%).



Characteristic curve of AMTEC

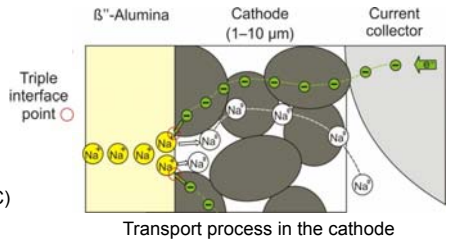
ATEFA facility



AMTEC test cell

The power density limiting parameters in the cathode are:

- Length of triple-phase line
- Na-transport
- Electrical resistance



Transport process in the cathode

And depend mainly on the morphology:

- Internal resistance of the cell
- Cathode:
  - Grain size
  - Porosity
  - Thickness
- Current collector structure