

SOFC/GT hybrid demonstrator

- Pressurized 30 kW_{el} SOFC with emulated gas turbine (GT)
- To be coupled with 3 kW_{el} GT investigated by Institute of Combustion Technology of DLR

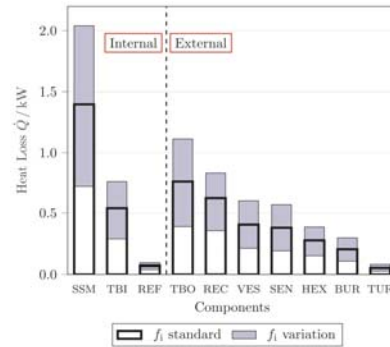
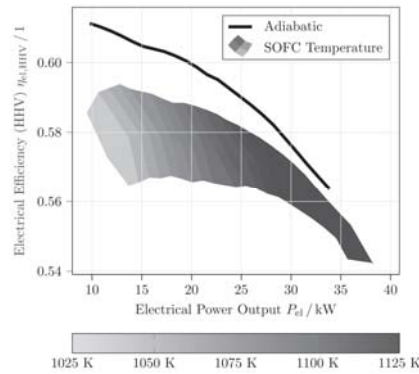
Challenges

- Integration of components in and around pressure vessel
- Operation points and range thermal insulation dependent
- Experimental complexity due to component/controls restrictions



Heat transfer influence on operation

- Component heat losses affect not only efficiency, but operation strategy
- Adiabatic maximum power limited by mass flow restriction of compressor (cooling air)
- Non-adiabatic lower efficiency curve limited by min. cell voltage
- Largest heat losses from stack module, tubes and feedthroughs

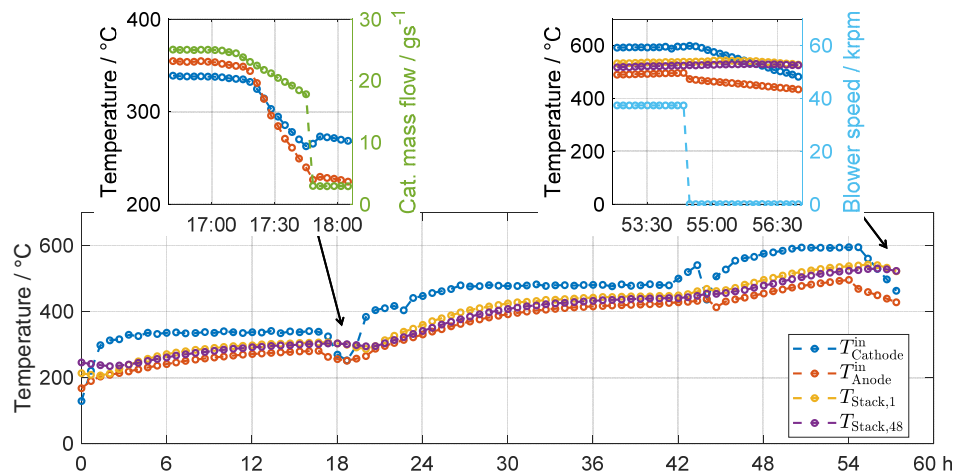


BUR: Burner
HEX: Heat Exchanger
REC: Recirculation
REF: Reformer
SEN: Sensor Compartment
TUR: Turbine
TBI: Internal Tubes
TBO: External Tubes
VES: Pressure Vessel

Figures: Steilen, Applied Energy 211 (2018) 479–491

Commissioning results

- Components working as designed and according to single component tests
- Automation control loops configured during commissioning (differential pressure, cathode gas inlet temp., ...)
- Natural gas supply for cathode gas heater interrupt at $T_{stack} \approx 350 \text{ }^\circ\text{C}$
 - automated emergency shutdown worked as intended
- High temperature anode off-gas blower breakdown at $T_{stack} \approx 550 \text{ }^\circ\text{C}$
 - Failure due to unexpected thermal expansion of casing



Outlook

- Re-integration of recirculation blower for system start-up and final commissioning
- Characterization of SOFC system with emulated GT and optimization of the control loops
- Revision of hybrid power plant system design and system details
- Development of hybrid power plant interfaces and merge of control concepts and units
- Start-up of combined hybrid power plant with SOFC and gas turbine

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