

## Simulation based thermal investigation of an SOEC stack

### Description:

SOC (Solid Oxide Cell) technology shows great potential for electrochemically splitting  $\text{H}_2\text{O}$  and  $\text{CO}_2$  into  $\text{H}_2$  and  $\text{CO}$  during co-electrolysis, achieving high efficiencies due to high operating temperatures around  $800\text{ }^\circ\text{C}$ . While steady-state operation mostly maintains stack temperature through exothermal reactions, ohmic heating and heat exchangers, the initial heat-up phase requires energy-intensive electrical gas heating, impacting this technology's high efficiency.

Within the scope of this thesis, a 3D-CFD simulation model will be developed to examine the thermal behaviour of the stack within an insulated „hotbox“ during heating, considering heat losses to the surroundings, temperature gradient constraints within the cell and the effects of exothermal reactions and ohmic heating. The objective of this work is to create a simulation model capable of analysing the heating process and evaluating impact of various control parameters such as electrode flow rates, electric heater power consumption, and ohmic heating sources. The findings will help to improve the control parameters for a stack on the test bench, which will be used for validation as part of the project.

### Content:

- Literature research on the topic (1 month)
- 3D-CAD model development from given SOEC specifications for mesh generation (1 month)
- 3D-CFD model development to analyse SOEC thermal behaviour in co-electrolysis mode (2 months)
- Validation of the model for different operating points and evaluation of the results (1 month)
- Thesis writing (1 month)

**Start:** Any time  
**Duration:** approx. 6 months

### Paid Master Thesis

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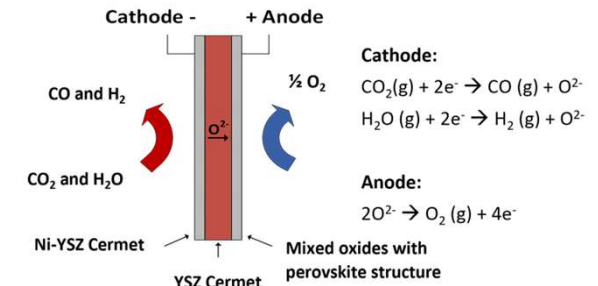


Figure 1: Schematic of an SOEC in co-electrolysis mode

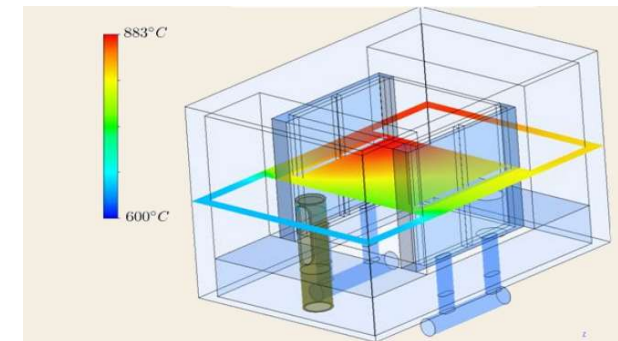


Figure 2: Temperature distribution of an SOEC stack inside a Hotbox. Source: [https://www.ikts.fraunhofer.de/content/dam/ikts/abteilungen/umwelt\\_und\\_verfahrenstechnik/chemische\\_verfahrenstechnik\\_und\\_elektrochemie/modelling\\_support.pdf](https://www.ikts.fraunhofer.de/content/dam/ikts/abteilungen/umwelt_und_verfahrenstechnik/chemische_verfahrenstechnik_und_elektrochemie/modelling_support.pdf)