Test Module 09
Temperature Sensitivity

(Version 6.2, 9 May 2017)

Objective and Scope

The purpose of this test module is to investigate the influence of the cell/stack nominal operating temperature on the cell/stack performance. The parameters that have a predominant role in this test module are: stack environment temperature (oven and pre-heaters) and current.

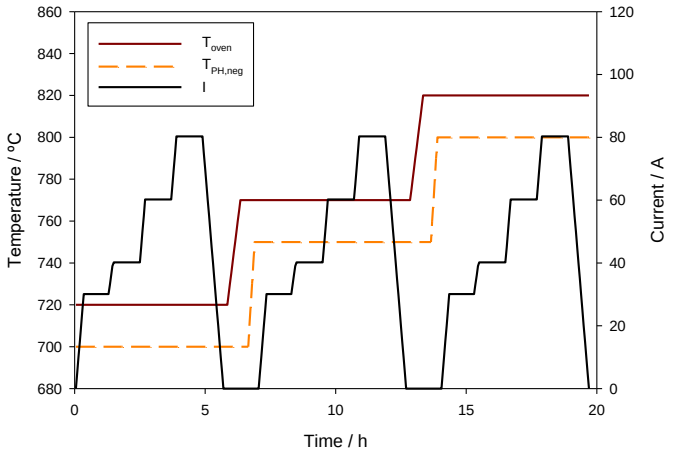
This test procedure has no specific target application. However, this test module describes a general characterization method that can be used in research and development of the SOC and for quality assurance in cell and stack production.

Main Test Input Parameters (TIPs)

Static TIP	Variable TIP
Flow rates of inlet gases (f_{in})	Current (I)
Composition of inlet gases ($x_{i,\,in}$)	Temperature of the oven (T_{oven})
Pressure of outlet gases (p_{out})	Temperature of pre-heater (T_{PH})

Test Procedure

The cell/stack temperature ranges under investigation, the current load levels, the number of individual test steps and the test operating conditions, have to be defined before the test. The tested cell/stack temperatures have to be chosen considering the allowable operating conditions specified by the cell/stack manufacturer. Based on these parameters the test point matrix can be prepared.



Example of test procedure

Critical Parameters and Parameter Controls

It is recommended to measure the cell/stack temperature at a fixed location which should be as close as possible to the geometric centre of the cell/stack. Since usually it will not be possible to place a thermocouple (or similar) in the heart of a stack, it is suggested to measure the temperature in direct contact with the centre of the end plate(s) of the cell/stack assembly. For stack tests, if possible, it is recommended to use two temperature sensors, one at the top and one at the bottom end plate and take the arithmetic average of the two values. If direct measurement of the cell/stack temperature is not possible, the oxidant outlet temperature should be taken as reference, measured as close as possible to the cell/stack outlet.

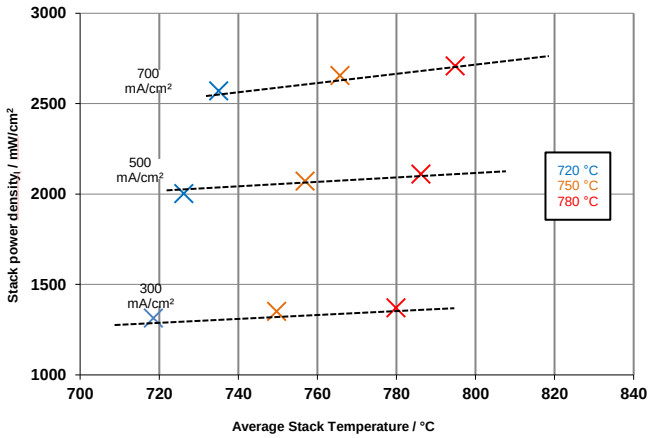
Changes in the cell/stack temperature caused by electrical load variation have to be considered. However, compensating changes in the cell/stack temperature caused by electrical load variation may be unfeasible, so that the *nominal* cell/stack temperature shall be taken at a given current density (either OCV or a nominal current density).

Main Test Output Parameters (TOPs) and Derived Quantities

TOP	Derived Quantities
Voltage of cell/RU/stack (V)	Current density (j)
Temperature of gas streams at cell/stack inlet/outlet (T)	Electrical power density ($P_{d,el}$)
Temperature of cell/stack (T)	Pressure drop of gas stream (ΔP_{gas})

Data Post Processing and Representation

The figure below is an example of how to correlate graphically the TIPs and TOPs of this test module. In this particular example graph represents the results to an analogous case, where the current and the oven temperature are the variable TIPs, while $f_{neg/pos,in}$ are static TIPs. More particularly, the three temperatures studied were $T_{cell/stack}$ = 720, 750 and 780ºC; the current densities requested to the short stack were: 300, 500 and 700mA/cm^2.



Temperature trend during temperature sensitivity

SOCTESQA:
Solid Oxide Cell and Stack Testing, Safety and Quality Assurance
Project website: www.soctesqa.eu

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