Solid Oxide Cell and Stack Testing, Safety and Quality Assurance

Collaborative Project - *FCH JU GRANT AGREEMENT N° 621245*
THEME [SP1-JTI-FCH.2013.5.4]
***Start date**: 01.05.2014 – **Duration**: 36 months*
***Project Coordinator**: M. Lang – DLR*

DELIVERABLE REPORT (REVISED VERSION)

D.2.1 – LIST OF SOC SPECIFICATIONS (REVISED VERSION)	
Due Date	31 August 2014
Main Author	G. de Marco (JRC)
Co-Author(s)	N. Kotsionopoulos (JRC), T. Malkow (JRC), G. Tsotridis (JRC) M. Lang (DLR), C. Auer (DLR), K. Couturier (CEA)
Work package	WP2
Work package leader	JRC
Date released by WP leader	11.04.2016 (revised version)
Date released by Coordinator	11.04.2016 (revised version)

DISSEMINATION LEVEL		
PU	*Public*	***X***
PP	*Restricted to other programme participants (including the Commission Services)*	
RE	*Restricted to a group specified by the consortium (including the Commission Services)*	
CO	*Confidential, only for members of the consortium (including the Commission Services)*	

NATURE OF THE DELIVERABLE		
R	*Report*	***X***
P	*Prototype*	
D	*Demonstrator*	
O	*Other*	

SUMMARY	
Keywords	*SOFC, SOEC, short stack, technical specifications*
Abstract	The objective of this deliverable is to define the most important generic technical specifications of solid oxide cell/stack assembly unit (SOC) for procurement.

D.2.1 – LIST OF SOC SPECIFICATIONS (REVISED VERSION)

1 Introduction

For the validation of the test modules and programs the solid oxide fuel/electrolysis cell short stack assembly unit has to be specified and defined among the partners of the SOCTESQA project. Due to the higher impact of the hydrogen and fuel cell technology to the market penetration, system relevant testing samples are preferred in this project. If possible, it is aimed to use one uniform test sample for all work packages, e.g. a 3- or 5-cell short stack in the planar design. In order to decide which test specimen will be used in this project a list of generic SOC specifications is very useful. Therefore, this deliverable contains an overview with the most important generic SOC stack specifications. This list will be sent to the stack suppliers, in order to fill in the specifications of their SOC stack. By comparing the filled in lists of the stack suppliers with the test station capabilities of the project partners, the most suitable stack supplier for the procurement of the test assembly units will be selected. Due to confidential reasons with the stack suppliers, this public deliverable does not contain the detailed technical specifications of the SOC stack manufacturers but only the generic ones.

The relevant SOC active cell size should be in the range of 100 cm^2. The cells are anode supported (ASC) or electrolyte supported (ESC). The specification of the short stack comprises compulsory data like flow design, active area, cell design, electrical power, fuel utilization, mechanical load, heating rate, cooling procedure, maximum temperature, maximum current density and minimum (SOFC) / maximum (SOEC) voltage. Where possible, also the properties of the used components, e.g. bipolar plates, protective layers, contact materials and cell components are specified. Another important issue is the definition of the interfaces between test sample and test station. The stack interface (connectors, terminals, etc.) will depend on the manufacturer's choice. Although WP2 will specify the interface between the test device used to perform stack tests using stacks made available to the testing partner in this project, the project scope does not extend to harmonise any technical interface between stack and test equipment.

2 List of SOC specifications

2. 1 General Shortstack Specifications

Description	Unit	Note/comments	Relevant for test station
Number of cells / repeat units (RU)	n	min 3, max 5 (from the same batch)	X
Cell active area	cm^2	min 80 cm^2, max 150 cm^2	/
Electrical voltage test pin for each repeat unit		Welded high temperature wire (length approx. 100 cm), isolated with ceramic cloth (if possible)	X
Electrical current connection at bottom and top plate		Ideally bore holes for connection of rods / wires with a screw	X
Number of temperature sensors (thermocouples)	n	Min. 6 thermocouples (see below)	X
Stack temperature sensor positions		2 bore holes in short stack bottom and top plate, diameter tbd	X
Gas temperature sensor positions		4 high temperature fittings in fuel gas inlet and outlet of fuel gas and oxide gas	X
Stack footprint area	cm^2	Tbd by stack supplier	X
Stack height	cm	Tbd by stack supplier	X
Gas flow design		Counterflow or Coflow	X
Kind of gas in/out connection size		Screw or clamp	X
Gas in/out connection size	mm	Ø 6-12 mm (outlets should not create backpressure inside the stack)	X
Length of the tubes for the gas in/out tubes	mm	Ideally adjusted to the corresponding test station conditions	X
Cell design		Electrolyte supported (ESC) or anode substrate supported (ASC)	/
Interconnect design		Machined plate / stamped sheet with Cr-evaporation protection layer on air side	/
Interconnect material		High temperature ferritic steel (e.g. similar to Crofer APU22)	/
Fuel electrode		Ni+YSZ	/
Electrolyte		YSZ	/
Barrier layer		GDC (only for LSCF cathodes)	/
Air electrode		LSM or LSCF	/
Stack price	€	Stack price has to fit to the project budget	/
Others			

2. 2 Operating Parameter Specifications

Description	Unit	Note/comments	Relevant for test station
Operation mode		SOFC and SOEC	X
Operating temperature	°C	min 700°C, max 900°C	X
Max. operating temperature	°C	Tbd by stack supplier	X
Max. heating rate	°C/min	Tbd by stack supplier	X
Fuel gas inlet temperature	°C	As operating temperature	X
Oxide gas inlet temperature	°C	As operating temperature	X
Max. acceptable ΔT in/out under stationary conditions at 750°C	°C	Tbd by stack supplier (stack should be manufactured without insulating materials)	/
Max. acceptable temperature gradient over stack height	°C	Tbd by stack supplier	/
Max. acceptable temperature gradient over cell area	°C	Tbd by stack supplier	/
Max. electrical current	A	Tbd by stack supplier	X
Min. voltage of repeat unit (RU)	V	Tbd by stack supplier	X
Fuel gas volume flow rate per RU (range)	slpm	Tbd by stack supplier	X
Oxide gas volume flow rate per RU (range)	slpm	Tbd by stack supplier	X
Max. pressure (air side)	bar	Tbd by stack supplier	(X)
Max. pressure (fuel side)	bar	Tbd by stack supplier	(X)
Max. pressure drop (Fuel gas inlet – outlet)	mbar	200 mbar (Tbd by stack supplier)	/
Max. pressure drop (Oxide gas inlet – outlet)	mbar	200 mbar (Tbd by stack supplier)	/
Mechanical load	kg	Max 200 kg	X
Temperature for applying the mechanical load	°C	Tbd by stack supplier	X
Stack post diagnostic		Tbd	/
Others			

2. 3 Performance Shortstack Specifications

Description	Unit	Note/comments	Relevant for test station
Leakage rate fuel gas compartment to outside	ml/min	Max. 50 ml/min (air, 30 mbar) (Tbc by stack supplier)	/
Leakage rate oxide gas compartment to outside	ml/min	Max. 100 ml/min (air, 30 mbar) (Tbc by stack supplier)	/
Leakage rate fuel gas compartment to –oxide gas compartment	ml/min	Max. 50 ml/min (air, 30 mbar) (Tbc by stack supplier)	/
Performance for SOFC operation (Power density and fuel utilization))	mW/cm²	Min 400 mW/cm² @ 0.7 V; H_2 fuel utilization rate 40 %; 750ºC	/
Performance for SOEC operation (SOEC Power density and steam conversion rate)	mW/cm²	Max. 500 mW/cm² @ 1.3 V; H_2+90%H_2O; steam conversion rate 40 %, 750ºC	/
Degradation rate	%	After stack conditioning max 5 %/1000 h under galv. SOFC/SOEC @ 0.3 A/cm^2	/
Reproducibility		Acceptance criteria Tbd	/
Others			