FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING

STACK-TEST

Stack-Test – Development of EU-wide uniform performance test schemes for PEM fuel cell stacks
Work package 2: Special view on functional and performance testing

J. Mitzel, **E. Gülzow** , **A. K. Friedrich**
German Aerospace Center, Pfaffenwaldring 38-40, 70569 Stuttgart, Germany
E-Mail: Jens.Mitzel@dlr.de; Phone: +49 711/6862-8063
L. Jörissen
Centre for Solar Energy and Hydrogen Research Baden-Württemberg (ZSW), Helmholtzstrasse 8, 89081 Ulm, Germany
E-Mail: ludwig.joerissen@zsw-bw.de; Phone: +49 731/9530-605

Key project activities:

- Functional / Performance Testing
- Durability Output Testing
- Environmental / Safety Output Testing
- Liaison to Standard Developing Organizations and Industry

11 participating institutions based in 6 European countries
Total cost 5.64 Mio € / FCH-JU contribution 2.91 Mio €

Project Objectives

- Industry wide harmonized test procedures for PEMFC stacks shall be developed and validated.
- The work is based on the experiences of the FCTESTNET, FCTES^{QA} series.
- Performance / functional, durability and safety outputs for vehicle propulsion, stationary and portable applications shall be addressed. Generic test modules shall be defined and experimentally validated.
- Additionally application oriented test programs shall be derived and validated.
- A two phase approach is pursued starting with an initial selection and definition phase followed by experimental validation.
- The test modules and test programs are expected to be methodologically sound and independent.
- Contact to industrial practice will be established by the implementation of an industrial advisory group consisting of selected key stakeholders along the value chain of the fuel cell industry.
- The consortium will liaise with international standardization activities and contribute to the improvement of existing standards by pre-normative research and – if deemed necessary – initiate new work item proposals.

Development of Generic Test Modules

Different Test Modules (TM) are defined for the functional and performance characterization of a PEMFC stack (see table below). The master document TM2.00 defines requirements and methodology for parameter variation, stability and data acquisition. The other TMs are focused on the variation of one physical relevant input parameter.

#	TM name	Applications					
		Automotive			Stationary		Portable Generators
		Propulsion	Range extender	APU	residential CHP	Backup power	
2.00	Master document	x	x	x	x	x	x
2.03	Humidity Sensitivity	x	x	x	x	x	x
2.04	Temperature Sensitivity	x	x/-	x	x/-	x/-	x
2.05	Pressure Sensitivity	x	x	x	x	x	x
2.06	Lambda Sensitivity	x	x	x	x	x	x
2.07	Fuel/Oxidant Composition	x	x	x	x	x	x
2.11	Freeze Start	x	x	x	-	x	x
2.14	Continuous operation at constant load	x	x	x	x	x	x
2.15	Polarization Curve	x	x	x	x	x	x
2.17	Ambient conditions	x	x	x	-	-	x
2.18	Electrochem. Methods	x	x	x	x	x	x
2.19	Dead end operating conditions	x	x	x	-	-	x

Prepared Test Programs

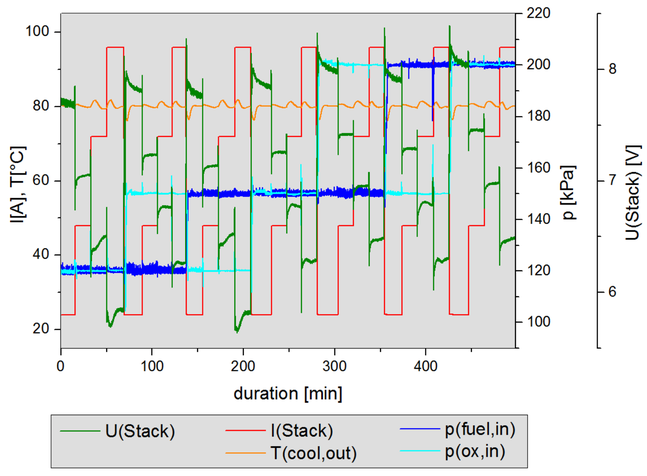
The Test Programs (TP) are prepared specific to different applications. They represent topics of interest demanded by end-users concerning the function and the performance of industrial fuel cell stacks.

#	TP name	Comprised Test Modules	Applications					
			Automotive			Stationary		Portable Generators
			Propulsion	Range extender	APU	Residential CHP	Backup power	
2.01	Performance Assessment	2.14, 2.15, 2.18	x	x	x	x	x	x
2.02	Performance Mapping	2.03-2.06, 2.15, 2.18	x	x	x	x	x	x
2.03	Tolerance to ambient conditions	2.07, 2.11, 2.17, 2.18	x	x	x	-	x	x
2.04	Dead end performance	2.03-2.06, 2.15, 2.18, 2.19	x	x	x	-	x	x
2.05	Stack performance optimization	2.14, 2.18	x	x	x	x	x	x

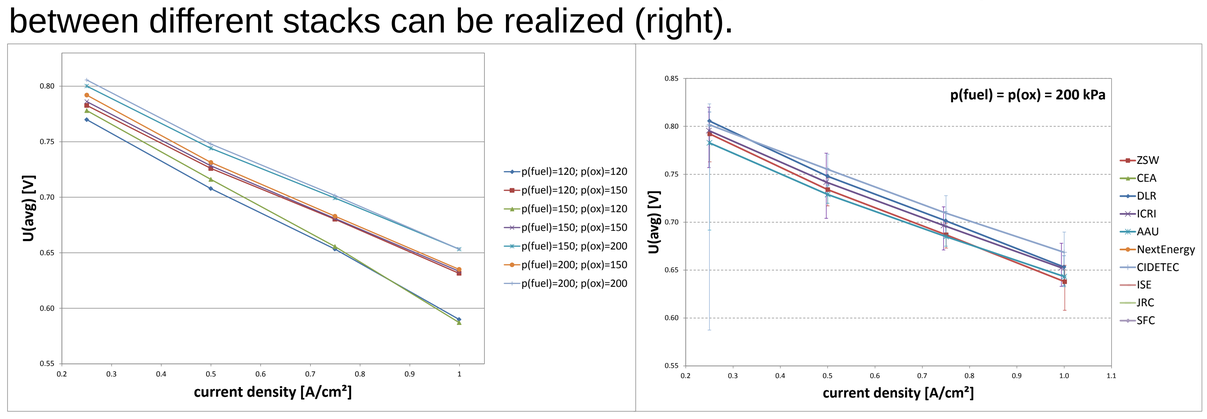
Exemplary Functional / Performance Test Module TM2.05 pressure sensitivity

Methodology:
This TM defines the testing procedure for the study of reactant pressure sensitivity of a test object by simultaneous or successive variation of the pressure in the anodic and/or cathodic compartment.

Exemplary Validation:
The test operating conditions are based on automotive conditions and the reactant pressures (3 steps) as well as the load level (4 steps) are varied.



The use of this procedure allows the reproducible assessment of the pressure impact on the performance of a given stack (left).
Furthermore, measurements at different testing facilities or comparisons between different stacks can be realized (right).



Acknowledgement:
The research leading to these results has received funding from the **European Union Seventh Framework Programme** (FP7/2007-2013) for the Fuel Cells and Hydrogen Joint Technology Initiative under grant n° 303445.
Test procedures acquirable: **stacktest.zsw-bw.de**