

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

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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 Propulsion | Automotive Range extender | Stationary APU | Stationary residential CHP | Stationary Backup power | Portable Generators |
| 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

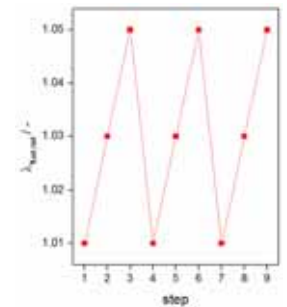
The Test Programs (TP) are prepared specific to different applications. They represent topics of interest demanded by end-users concerning the function and the performance of industrial fuel cell stacks.

| # | TP name | Comprised Test Modules | Applications | | | | | |
|------|---------------------------------|--|-----------------------|---------------------------|----------------|----------------------------|-------------------------|---------------------|
| | | | Automotive Propulsion | Automotive Range extender | Stationary APU | Stationary residential CHP | Stationary Backup power | Portable Generators |
| 2.01 | Performance Assessment | 2.14, 2.15, 2.18 | x | x | x | x | x | x |
| 2.02 | Performance Mapping | 2.03, 2.04, 2.05, 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, 2.04, 2.05, 2.06, 2.15, 2.18, 2.19 | x | x | x | - | x | x |

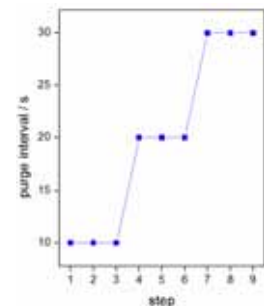
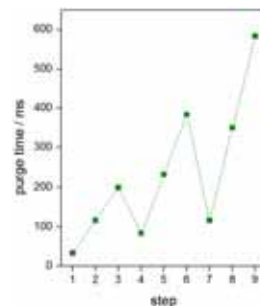
Exemplary Functional / Performance Test Module TM2.19 Dead End Operating Conditions

This TM is a testing procedure concerning the fuel cell stack behavior operating in dead end mode on the anode side.

This behavior is mainly influenced by the purged fuel volume on the anode outlet, presented by the net fuel stoichiometry (physical relevant test input parameter).



This parameter can not be controlled directly. Therefore, the purge time and the purge interval are varied during the test.



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