FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

STACK-TEST

"Start-Stop Phenomena and Strategies for PEM Fuel Cells", 11.12.2014, Freiburg, Germany

Start-Stop Test Procedures on the PEMFC Stack Level

Different Approaches from the EU-funded Project Stack-Test

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General approach

- Degradation phenomena should be restricted to Start-Stop effects.
- Stack temperature is maintained to the nominal temperature in order to avoid effect of a thermal cycling

Data Post Processing:
Start-Stop degradation rate can be calculated based on:

- ➢ Voltage during nominal load phase
- ➢ Polarization curves BoT and EoT

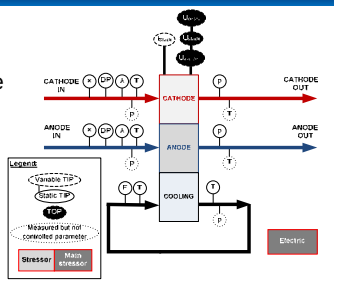

Fig. 1: General setup for Start-Stop testing

Procedure 1: Simulation of automotive Start-Stop

Test Procedure:

1. Run the stack in reference conditions at nominal current during 10 minutes.
2. Decrease load from nominal current to 0 A.
3. Decreases the pressure from nominal pressure to ambient for anodic and cathodic compartment.
4. Stop H_2 flow and maintain min. air flow until average cell voltage is lower than 100 mV. During this time, resistive load should be applied in order to decrease time to OCV.
5. Fix hydrogen flow to the start flow until average cell voltage tends to OCV (U_{OCV} > 0.9 V).
6. Increase the pressure from ambient to reference pressure at anode and cathode side.
7. Repeat step 1

Approach:

- Procedure near to automotive application.
- Anodic compartment filled with air during stop phase without nitrogen flush.
  - ➢ Main stressor hydrogen/air boundary included in the test.
  - ➢ Safety problem due to the formation of explosive hydrogen/air mixture.
- Resistive load decreases time of high, corrosive cathode potential
  → Can be removed for AST tests

Option:

2 shut-off valves at stack inlet and outlet.
→ Eliminate the influence of the test bench volume for H_2.

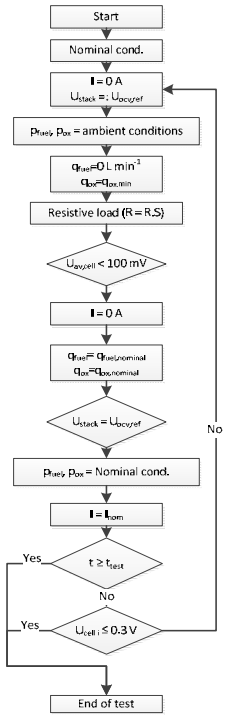

Fig. 2: Flow chart for automotive Start-Stop

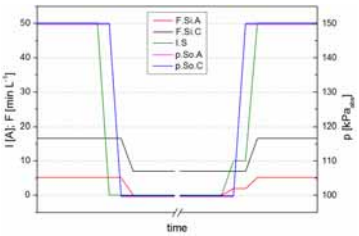

Fig. 3: Test profile for automotive Start-Stop

Procedure 2: Laboratory Start-Stop

Test Procedure:

1. Run the stack in reference conditions at nominal current during 10 minutes.
2. Decrease load from nominal current to 0 A.
3. Decreases the pressure from nominal pressure to ambient for anodic and cathodic compartment and stop reactant media flows.
4. Nitrogen flush at anode- and cathode compartment to reduce the minimum cell voltage to < 100 mV / load toggling during this time (e.g. 1A -> 0A -> 1A ....) or applying of resistive load in order to decrease time to OCV.
5. Set air flow to equivalent 40% of max. stack load and increase pressure at cathode-side to about 1.1-1.15 kPa_{abs} (faster air diffusion to anode side, cell voltages tend to come near 0V).
6. Set also hydrogen flow to equivalent 40% of max. stack load (cell voltages tends to OCV).
7. Increase the pressure from ambient to reference pressure at anode and cathode side.
8. Repeat step 1.

Approach:

- Procedure adapted to safety regulations in typical laboratories.
- Nitrogen flush minimizes air content on anode side.
  - ➢ Main stressor hydrogen/air boundary excluded in the test.
  - ➢ No safety problem.
- Resistive load decreases time of high, corrosive cathode potential
  → Can be removed for AST tests

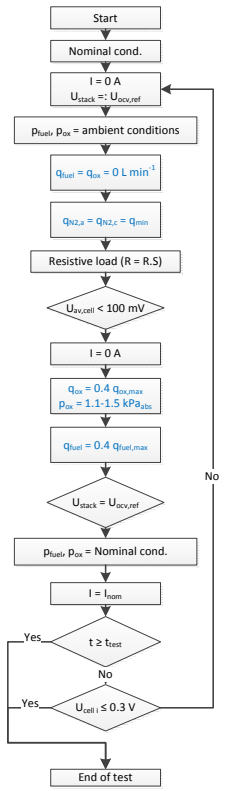

Fig. 4: Flow chart for laboratory Start-Stop

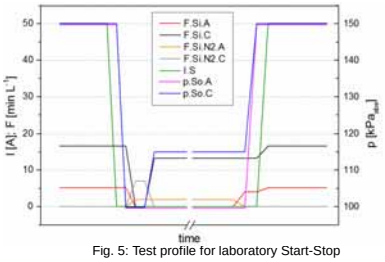

Fig. 5: Test profile for laboratory Start-Stop

Get involved

All test module and program documents are available and feedback is most welcome:
http://stacktest.zsw-bw.de/

Acknowledgement

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