GIANTLEAP

DELIVERABLE D4.2

PUBLIC

Full-size stacks delivered for integration into fuel-cell systems

Stefan Hemmer (ElringKlinger)

Quality Assurance: Federico Zenith (SINTEF)

Project acronym: GIANTLEAP

Project title: Giantleap Improves Automation of Non-polluting Transportation with Lifetime Extension of Automotive PEM fuel cells

Project number: 700101

Document date: December 20, 2017

Due date: October 31, 2017

Keywords: Full-size stack modules

Abstract: ElringKlinger as the responsible partner for stack development designed and manufactured three full-size stacks for testing purposes and system integration

Revision History

Date	Description	Author
19.12.2017	Deliverable report	Stefan Hemmer
19.12.2017	Quality Assurance	Federico Zenith

Table of Contents

1 Full-size stacks delivered for integration into fuel-cell systems

Within the second phase (Task 4.2) of the Giantleap project, ElringKlinger as the responsible partner for stack development designed and manufactured three prototype full-size stack modules for laboratory experiments and integration into the fuel-cell range-extender bus system. The required gross power of the two fuel-cell stacks based on first system simulations made by BEG, based on VDL driving profiles, was set to 80 kW. As a major result, the required gross power at 0.6 V average cell voltage as the nominal load point could be reached on short-stack level using a suitable cell configuration. After discussions within the project consortium, the operating pressure level was defined. The full-size stack modules were dimensioned based on this pressure level, and the compressor (one of the major BoP components of the fuel cell system) was selected.

For an optimal technical and economical design of the fuel cell system, it was important to determine fundamental characteristics of the chosen cell configuration during several tests, and provide them as an input for further system development to BEG. Also optimal interfaces between the full-size stack modules and the surrounding fuel cell system were defined. The interfaces and the resulting scope of delivery is shown in figure 1.

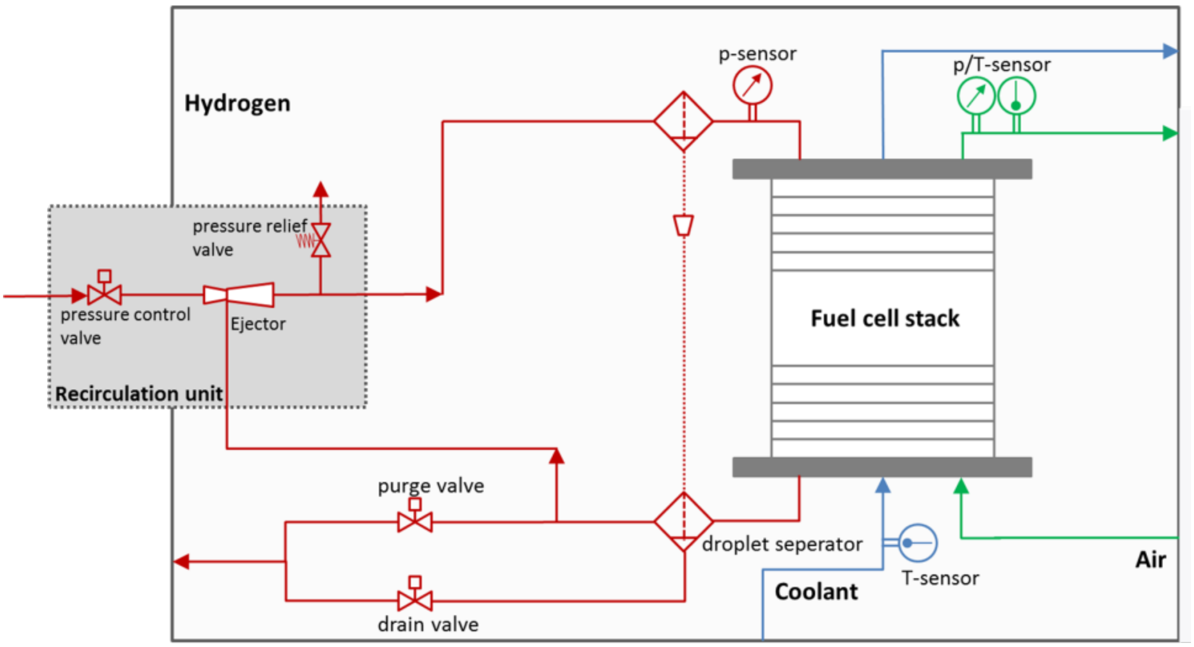

Figure 1: Interfaces of the fuel-cell stack module, including passive hydrogen recirculation unit.

The P&ID shows that a major part of the anode sub-system is already integrated in the full-size stack module by the hydrogen recirculation unit. Anode gas circulation is in general necessary to maintain sufficient gas distribution and for effective liquid product water discharge from the cells. Therefore, the main part of the experiments is dedicated to testing suitable configurations that supply the fuel-cell stack with a high gas circulation rate over a wide load range.

As a first step, the stack modules were operated under ambient pressure at the nominal load point to evaluate operational stability and performance. As an example, the cell voltage distribution of the first stack is shown in figure 2. The graph shows that the cell voltage distribution is very homogeneous, having a difference between the mean cell voltage of 0.598 V and the minimum cell voltage of 0.586 V (red bar) of only 2% in total. This is a strong indication for well-balanced component selection (bipolar plates, MEA, sealing, etc.) and a robust stack concept. The average cell voltage of 0.6 V at 250 A load leads to a cell performance of 150 W per cell under ambient pressure. With regard to the nominal pressure level of the fuel-cell system, tests with pressurized media were made. The results regarding operational stability and cell voltage distribution are equivalent to the ambient operation mode. Figure 3 shows the cell voltage distribution of the stack module for pressurized operation at 1.8 bar_a. Also in this case, the cell voltage distribution is very homogeneous. The minimum cell voltage of 0.590 V (red bar) deviates less than 3% from the average cell voltage of 0.603 V. Another key message of the first tests with the full-size stack modules was that the performance level reached earlier in short-stack testing could be confirmed on full-size scale. After successfully testing the full-size stacks at ElringKlinger's testing facility, they were sent to BEG for system integration.

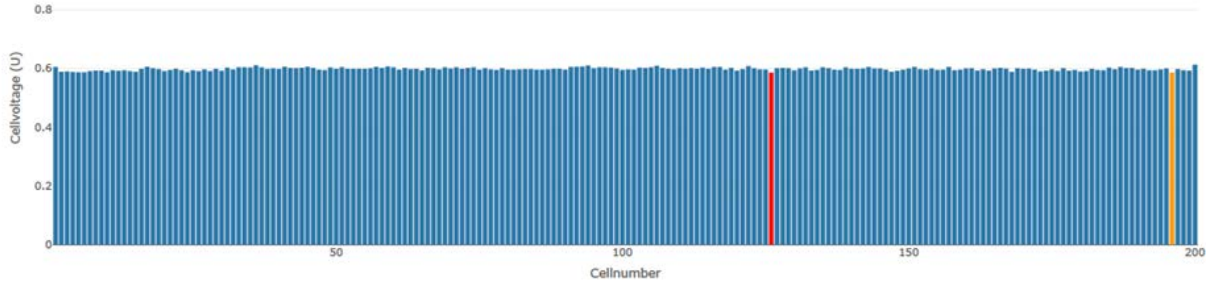

Figure 2: Cell voltage distribution at atmospheric operation (250 A) / Deviation mean cell voltage to minimum cell voltage (red bar) approximately 2%.

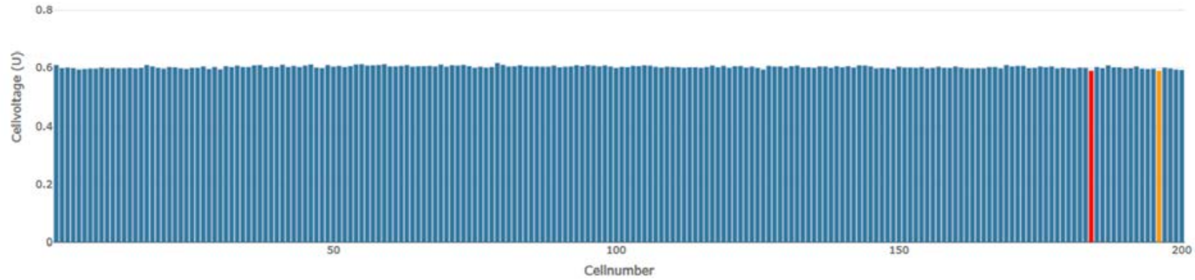

Figure 3: Cell voltage distribution at pressurized operation (330 A) / Deviation mean cell voltage to minimum cell voltage (red bar) approximately 2%.

In parallel, development of a passive hydrogen circulation unit was one of the key objectives for the first half of this project. After the identification of a suitable configuration of ejector and pressure-regulation valve via ex-situ testing, multiple tests on full-size stack level were done. These experiments, using high-performance ejectors, demonstrated that the hydrogen pump's substitution by an ejector does not affect the stack's voltage-current characteristic and cell voltage stability in a wide operational range in atmospheric as well as pressurised conditions.

Full-size stacks delivered for integration into fuel-cell systems