AVL Fuel Cell Diagnostic Toolchain

Unleashing the Potential of Fuel Cells

THE CHALLENGE

The degradation of fuel cells cannot be avoided, but it can be slowed down to meet lifetime requirements. To achieve this, the operating and control strategy of the fuel cell system must be calibrated to be sensitive to states that accelerate degradation to avoid unnecessary stressors. Since fuel cell degradation is strongly interconnected and non-linear, exploring its cause-and-effect relations is not straight forward but AVL has developed AVL Fuel Cell Diagnostic to help.

This provides invaluable insights for fuel cell system developers.

THE SOLUTION

AVL developed an expert layer within our automation system –also available as standalone version – which automatically extracts stressors and hazardous states of fuel cells during operation on the testbed using multiple available data sources. AVL Fuel Cell Diagnostic enables engineers to quantify and relate multiple stressor and degradation-inducing states during operation.

Quantifying stressors allows for conscious calibration of the operating strategy of the fuel cell systems, i.e., where efficiency, performance, and lifetime can be considered and deliberately balanced.

THE ADDED VALUE

- Fuel Cell Diagnostics Toolchain with powerful diagnostic applications using unique AVL expertise
- Available either as an add-on to the testbed automation or as a stand-alone device
- Runs on dedicated hardware that can be easily connected to a testbed using well-known interfaces like UDP or CAN
- Online diagnostic feedback
- Recording and tracking degradation-inducing effects on the UUT
- In the background, state-of-the-art expertise in fuel cell degradation is deployed as an algorithm
- In addition to the software, diagnostic information can be augmented either by using additional hardware equipment and sensors (CO2 sensor to detect carbon corrosion, fluoride emissions to detect membrane thinning, electrochemical impedance spectroscopy to detect dry-out and flooding) or additional simulation solutions and virtual sensors

Simply provide the relevant input signals to the diagnostics software and use the extensive options for degradation analysis. A diagnostic toolchain with embedded expert knowledge from our PUMA 2 Fuel Cell testbed automation.

FEATURES:

Cell voltage monitoring:

- Compact visualization of average stack voltage, showing actual highest / lowest voltage values and parameterized stack limits (yellow / red)
- Detailed visualization of individual cell voltages, average stack voltage, calculated average of 5 cells, indicator of cells exceeding standard deviation, and history cell voltages

POL (polarization) curve loss split to estimate the the stack's individual losses

- Baseline for calculation: measured polarization curve (voltage / current curve)
- New feature provides calculation of losses represented in an online view (activation losses, ohmic losses, mass transport losses, polarization curve fit)

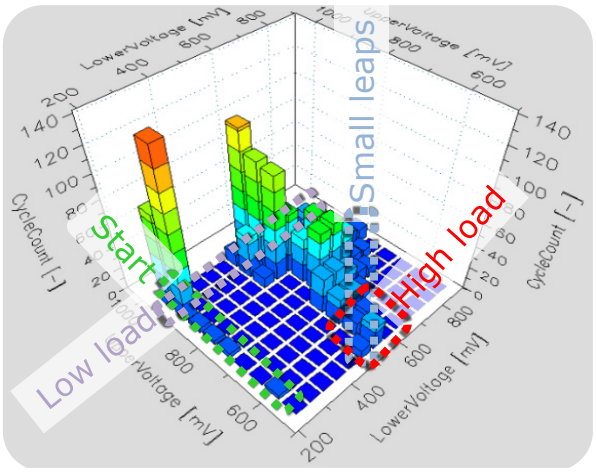
OCV (open-circuit voltage) application monitoring stress factor

- The current stress factor (1-10) as well as a lifetime stress factor is calculated considering high temperature and low humidity using a look-up table.

Startup/shutdown counter – Count harmful starts or stops to derive stress on the fuel cell

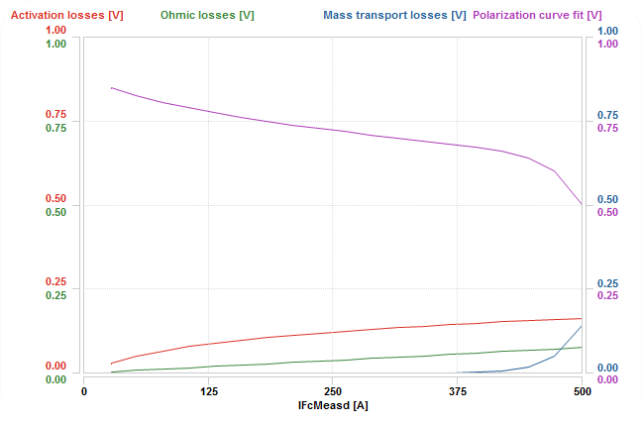
Cell bleed-down indication – Indicate membrane gas crossover with bleed-down application

Dynamic operation detection – Detect and visualize complex operating cycles in a histogram



POL (polarization) curve measurement to follow the evolution of the stacks' performance

- Measure the polarization curve following either an official or a customer-specific procedure
- Identify and visualize the polarization curve measured
- Plot actual POL curve with a beginning of life curve (BoL) or any previously measured curve directly during online execution



EIS Measurement- state of the art electrochemical measurement

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