

CFD Analysis of Ageing-Relevant PEM Fuel Cell Flow Field Designs

Andreas Diemath*, Markus Reiter and Reinhard Tatschl

AVL List GmbH
 Advanced Simulation Technologies
 Hans-List-Platz 1, 8020 Graz, Austria
 e-mail: andreas.diemath@avl.com, web page: <https://www.avl.com/>

ABSTRACT

Multiphysics 3D CFD simulations are performed to analyze and quantify the impact of flow-field design on the performance relevant cell internal humidity, temperature and current distributions in a single-cell configuration. For this purpose, the water concentration, temperature and reaction current density distribution patterns obtained in a zero-gradient configuration with straight anode/cathode flow-channels are compared to the simulated results obtained for a bipolar plate with meander-shaped channels. 3D-CFD simulations are performed for the original JRC clamping device [1] to provide reference data for the underlying zero-gradient configuration. The simulated performance of the zero-gradient cell is validated by comparison of the U-I curves with their measured counterparts. To create the cathode flow conditions aimed at resulting in pronounced cell internal temperature and humidity gradients, a dedicated bipolar plate with a meander-shaped channel [2] is developed and again analyzed using 3D-CFD simulation. The simulation results clearly illustrate the spatial variations in current, concentration, and temperature distribution for the high-gradient flow conditions, which in turn promote accelerated material degradation (see Figure 1).

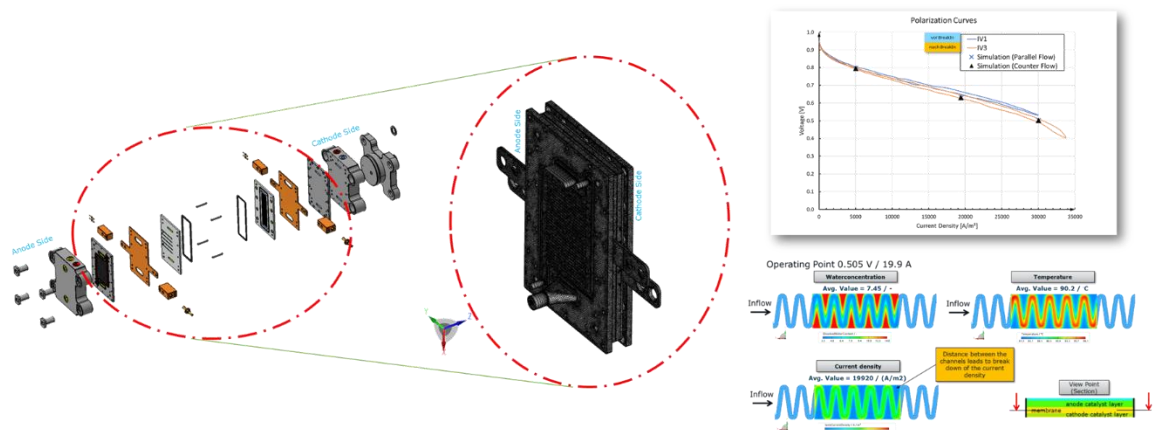


Figure 1: left: simulation domain derived from the original JRC clamping device; right: polarization curve of zero-gradient approach (top right), high gradient cathode flow conditions and exemplary results (bottom right)

REFERENCES

- [1] T. Bednarek, G. Tsotridis, *Development of reference hardware for harmonised testing of PEM single cell fuel cells*, JRC Technical Report, doi:10.2760/83818 (2021)
- [2] M. Reiter et al, *Embedded Fiber-Optical Sensor for Enhanced In-situ Monitoring via Additive Manufactured PEM Fuel Cell Diagnostic*, JSSS Journal (2026).