



Science for a
moving society

FINAL REPORT

1336 | 2023 – Frankfurt am Main

Brennstoffzellen-Kaltstart

PEM-FC-Kaltstartsimulation

FC Cold Start

PEM-FC cold start simulation

FC Cold Start

Project no. 1411

PEM-FC cold start simulation

Final report

Abstract:

The objective of this research project is the development of a modular, real-time capable simulation model of PEM fuel cell systems for cold start investigations. The model will be based on the pre-existing model, which has been developed within the preceding FVV project Fuel cell system simulation - Membrane humidification management (FVV project number 6012982 / 01.2018 - 31.01.2020) and will be enhanced for cold start investigations.

Special focus is placed on the model of the fuel cell stack, which will be designed with a 2D-1D spatial resolution and enhanced for a better consideration of liquid water in the channel and landing structure of the flow field. To ensure real-time capability a prediction method of the initial values for the numerical solver will be developed, which will be complemented by a machine learning approach.

The system-level simulation model of the fuel cell stack will be supplemented by highly detailed multidimensional CFD simulations. The CFD model is essential for the investigation of the water distribution within the cell layers, which is of particular interest for cold start, as well as phase change phenomena such as condensation and evaporation. For further validation of the simulation results, electrical measurements on a segmented experimental cell will be performed in a test rig.

The most critical balance of plant component - with regard to cold start - is the membrane humidifier. Therefore, the model of the membrane humidifier will be enhanced with particular attention. Due to the lack in available data, the relationship between the performance of a membrane humidifier and the operating conditions will be derived from CFD modelling.

By the combination of simulative and experimental approaches as well as the complementing expertise of the project partners (tme and ZBT), a highly validated fuel cell system model will be developed, able to simulate the transient behaviour of fuel cell systems during cold start up. This model will enable a fast and cost-effective development of energy-efficient, fast and non-damaging start up processes for fuel cell vehicles at cold ambient temperatures.

The objective of the research project was achieved.

Duration:	01.09.2020 – 30.11.2022
Funding organisation(s):	FVV eV // Science for a moving society (FVV)
Funding number(s):	FVV 601411
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Related reports:	R604 (2023)

Acknowledgement

This report is the scientific result of a research project undertaken by the FVV eV and performed by the Hydrogen and Fuel Cell Center GmbH (ZBT) under the direction of Dr.-Ing. Peter Beckhaus and by the Chair of Thermodynamics of Mobile Energy Conversion Systems (tme) at RWTH Aachen University under the direction of Univ.-Prof. Dr.-Ing. (USA) Stefan Pischinger.

The FVV would like to thank the directors Beckhaus and Pischinger and their scientific research assistants – Matthias Bahr, M.Sc. (ZBT), Dr.-Ing. Sönke Gößling and Maximilian Schmitz, M. Sc. (tme) – for the implementation of the project. The project was conducted by a working group led by Dr.-Ing. Stefan Kaimer (Ford-Werke GmbH). We gratefully acknowledge the support received from the project coordination and from all members of the project user committee.

The research project was self-financed (funding no. 601411) by the FVV eV.