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Master Thesis – Numerical

# Validation of a Hybrid Multiphase Model for Electrolysis

**Background**

Hydrogen is considered one of the technologies for climate-neutral energy supply in the future. Efficiency and durability are important for the commercial success of PEM fuel cells and electrolysers. Current research projects are focusing in particular on how to deal with multiphase effects. In fuel cells, gaseous hydrogen and oxygen react to form liquid water, while in electrolysis, gaseous hydrogen and oxygen are produced from liquid water. The new phase that is created must be effectively removed via the microchannels of the electrochemical converter. Inadequate removal can reduce efficiency and accelerate degradation.

An optimized design of the distribution fields is crucial for the efficient removal of the resulting phase, as they distribute the mass flow to the microchannels and bundle it again. There is currently no optimization strategy for the design of these distribution fields that takes the influence of two-phase effects into account.

Since it is not practical to simulate high-resolution two-phase models on an entire cell, the multiphase behavior within the active area should be represented by a simple algebraic model. Reference data is required for this model. To generate this data, the *multiMorph* solver should be used on a representative geometry section. This solver first requires validation for the intended application.

**Content of the Thesis**

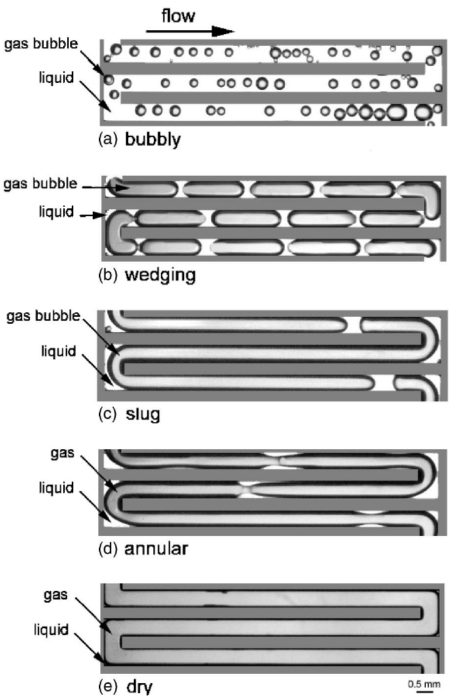
This thesis aims to validate the hybrid CFD solver multiMorph for electrolysis applications. Then, the algebraic model will be compared with multiMorph for a simple distributor field.

First, a literature review on typical and hybrid multiphase models must be conducted. A special focus will be placed on the *multiMorph* approach of the HZDR. In addition, a suitable reference for validating the model will be selected from the literature. For example, a flow regime map with associated pressure loss measurements (e.g., Cubaud, 2004) could be used for this purpose.

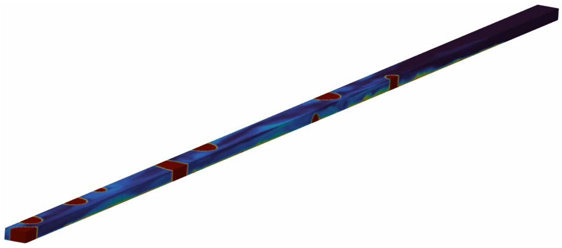
To validate the model, a CFD workflow must then be developed for comparison with the experimental results. This setup can then be used to perform a parameter study of different gas and liquid velocities. The study will then be evaluated and compared with the experiment.

Now the behavior can be analyzed in a simple distribution field. The multiphase behavior is to be analyzed once with *multiMorph* and once with the algebraic model. To do this, the algebraic model must first be fitted to the previously generated data. For both approaches, variables such as pressure loss and distribution between the channels can be compared.

Finally, the results should be critically discussed and evaluated.




Cubaud, 2004



multiMorph

**Requirements**
Basics of fluid mechanics,
OpenFOAM, Programming
**Beneficial Skills**
Multiphase flow, Python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