Karlsruhe Institute of Technology

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bachelor thesis – numerical

Validation of a Mixture Model for Liquid Water Transport in OpenFOAM

Background

Gas liquid flow phenomena are relevant in many technical applications. One example is the flow inside the channels of a proton exchange membrane fuel cell (PEMFC). Here, water, which is the product of the fuel cell reaction, can exist in its liquid state due to the PEMFC's low operating temperature, impairing the fuel cell's power in certain flow states. Large-scale simulations of fuel cell systems require computationally affordable modelling approaches for liquid water transport that work on relatively coarse grids. One promising approach is the mixture model, where the mixture of liquid and gas is considered to be a single fluid and one set of equations is solved with the mixture's properties.
A version of this model is implemented in an OpenFOAM solver aiming to account for all relevant physical phenomena in the fuel cell, including condensation and liquid water transport.

Content of the Thesis

The goal of this thesis is validating the liquid water model implemented in the OpenFOAM fuel cell solver using data from already validated OpenFOAM two-phase solvers.
After choosing a suitable solver, a suitable test case is set up, first for testing liquid water transport without phase change. The test case is solved using both the already validated solver as well as the newly implemented solver. Here, the newly implemented solver only acts as a multi-phase solver, i.e. fuel cell reactions and species transport are not considered. The solutions of both solvers are compared for the validation process.
In the next step, another test case is set up, now also considering phase change and the process shown above is repeated.

Requirements

basic knowledge in fluid mechanics and programming
OpenFOAM basics

Beneficial Skills

basic knowledge in C++ programming

Start: May 2023

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