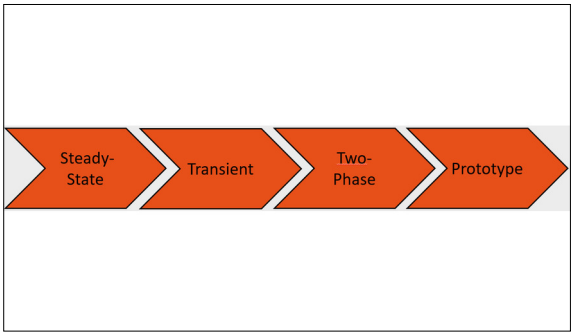
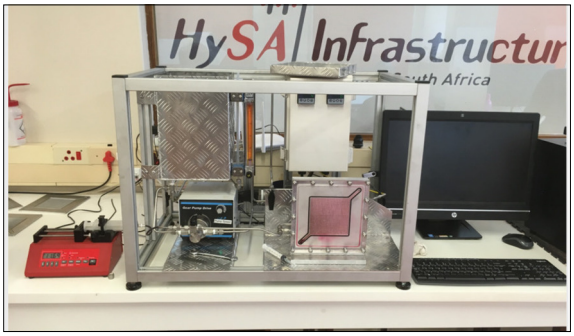
Olivier
Paul

Graduate Candidate	Olivier Paul
Examiner	Boris Meier
Co-Examiner	Dr. Dmitri Bessarabov, North West University, Faculty of Engineering, Potchefstroom
Subject Area	Numerical flow simulations

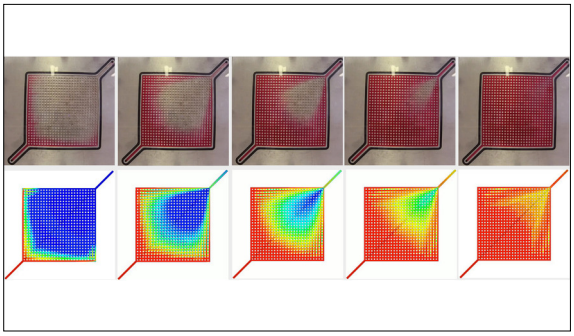
CFD modeling and flow visualisation in the flow-field channels of a water electrolyser



Approach
Own presentment



Experimental setup to record pressure drop and ink colouring.
Own presentment



Visual comparison of experiments and simualtion (timeperiod 0.3-3s, flowdirection from bottom left to top right)
Own presentment

Definition of Task:

It is the goal of this project, to generate a model of the water flow in a typical electrolytic flow-field using CFD. The objective includes the visualization of water flow by introducing a colorant agent and compare it with the modelling results. Therefore, a test-rack is available at the HySA laboratory.
It is expected that the CFD-model will be validated by the experimental work. Once the CFD-model is confirmed, the optimization of the cell can be done in the CFD software.
As optimization criterion a uniform water flow is aimed at. Which ideally results in constant flow speeds over the cell. Furthermore, a lower pressure drop across the cell is desirable with regard to the efficiency of the electrolyser.

Approach / Technology:

Experimental work:
The experiments will be conducted at the HySA Infrastructure institute. If necessary, the experimental setup can be modified marginally (i.e pressure gauges). The setup contains a test-rig with two pumps, one each for water and ink. The flowrates can be adjusted with a integrated flow meter (from 0.5l/min up to 2l/min). Additionally, the water can be heated if necessary.
Furthermore, there is a PC which is running a LabView-script to process in- and output data. Two different cell geometries can be tested in the test-rig, they differ in their pin geometry. One model is equipped with square pins the other with round pins. The dimensions of the flowfield are the same for both cell geometries (106x106mm). The pressure drop over the cell is according to first experiments between 0.1-1bar.

Simulation:
An accurate solution has been approached stepwise. In a first attempt a steady-state solution in a single-phase simulation has been calculated. With a converging solution of the steady-state a time-dependent transient simulation has been initialized and calculated.
As soon as those two work steps have been completed a two-phase simulation could be set up.

Result:

After the simulation was set up and a converging solution for a steady-state was achieved, the transient (time-dependent) simulation could be performed. The most valuable outcome of the transient simulation is the ink colouring of the cell, which can be compared directly with experiments. As viewable in the images below, the colouring of the simulation matches the experiments. The border area of the cell is flooded first, due to less flow resistance in the border area. Improvement of the cell can now be performed digitally in the simulation.