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Experimental Simulation of a Large Electrolysis Stack with a Differential Laboratory Scale Test Cell

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Abstract

The application of large-scale electrolysis stacks for energy storage of surplus renewable energy is an important step towards limiting the climate crisis. While research takes place in the laboratory on a small scale, the findings shall be applied to large industrial-scale electrolyzers. This raises the question of whether and how the behaviour of a large stack can be predicted from the performance of small test cells in the laboratory.
Therefore, a novel test cell ("differential cell") was developed to simulate and test the conditions in different sections of a large-scale electrolyzer in a laboratory cell (Figure 1). For this work, the differential cell is configured as a classic alkaline cell with a separator, but the concept can be transferred to other electrochemical cells. To map a section of a stack in the test cell, it must be possible to set all local conditions. These include operating conditions like temperature, pressure, KOH concentration, and flow rate. Other parameters are the gas content in the electrolyte and the mechanical contact pressure or gaps between electrodes and separator. The parameters depend on the position in the stack and change due to flow conditions and pressure loss in the flow field, heat generation, consumption of water, and production of gas. Even the electrode gap or contact pressure in the active cell area is not necessarily the same at every location. All these parameters can be adjusted in the differential cell and thus different locations in a large stack can be simulated.
The experiments with the differential cell indicate which performance can be expected at which position in the stack. The sensitivity of the parameters can be investigated to identify optimisation potential. By simulating different points in a large electrolyzer, the overall performance of the stack can be predicted from experiments in the laboratory.
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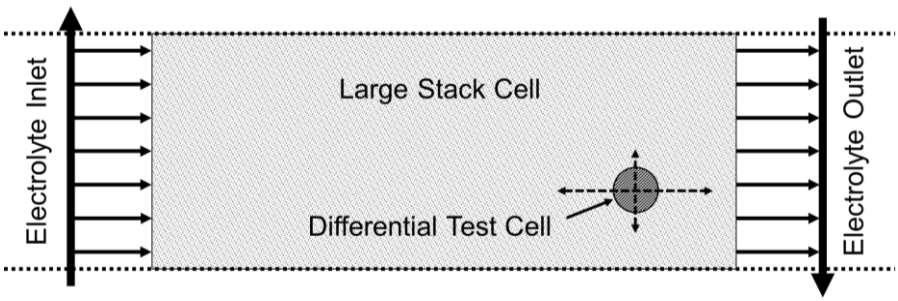

Figure 1: Schematic illustration of the differential test cell as a section of a large-scale electrolyzer