Scaling AWE from Lab to Stack:
Relevant parameters and stack design

Felix Lohmann-Richters, Lukas Ritz, Anna Mechler, Martin Müller
Forschungszentrum Jülich GmbH, Electrochemical Process Engineering (IET-4)
52425 Jülich, Germany
f.lohmann-richters@fz-juelich.de

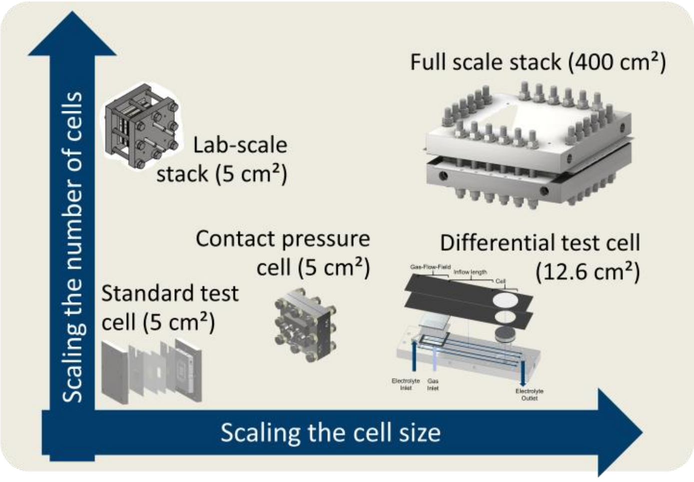
Alkaline Water Electrolysis (AWE) holds great promise for large-scale green hydrogen production as it does not rely on scarce noble metal catalysts. Significant improvements have been reported by tuning electrodes, separators and cell design. However, the transition from laboratory scale to application can be challenging. The two key issues for rapid transfer of improvements to application are reliable measurements at laboratory scale as well as scale-up of cell size and number of cells without loss of performance.

Efforts are undertaken to improve the comparability of single cell measurements by an international round-robin test. First results indicate that already on this cell level temperature variation and iron traces have a strong effect on performance.[1] Beyond this, the effects of scaling from laboratory size to industrial size, i.e., from cm² to m², are still less understood. It is claimed that a well-engineered stack will have the same performance as a single cell,[2] but it remains unclear what 'well-engineered' really means. Several parameters can vary across a cell or stack, such as temperature, gas content and contact pressure. Neither their variability nor their influence on the performance are well understood.

We have developed a set of tools to understand and enable the translation from cell to stack (see scheme). This toolbox allows studying several relevant parameters individually, thereby improving the understanding of scaling effects in AEL. As expected, the current densities improve with temperature. However, the influence of other parameters depends a lot on the cell design and operation parameters.

Based on our findings, we designed and characterized a 400 cm² short stack. This is an increase of the active area from the lab cell by a factor of 80 and stacking several cells. Despite this significant scale up, we successfully translated the electrochemical performance from the lab cell.

Overall, we will show the most important parameters and an innovative stack design for successful scale-up from single cells to stack.



The presented research was funded by the German Federal Ministry of Economic Affairs and Climate Action and the project "NextH2 - Next generation of powerful and efficient alkaline electrolyzers for regenerative H2 generation" 03EI3011A-C.

[1] S. Appelhaus, *et al.*, *Int. J. Hydrogen Energy 95*, (**2024**), 1004-1010.
[2] N. Danilovic, *et al.*, *ECS Trans. 75*, (**2016**), 395-402.