Stability Investigations of Alkaline Water Electrolysis – Impact of Fe-Impurities and Dynamic Operation

Niklas Thissen,[1] Sharon V. Pape,[2] Felix Lohmann-Richters,[2] M. Müller,[2] A. K. Mechler[1,2,3]
1 Electrochemical Reaction Engineering (AVT.ERT), RWTH Aachen University, Germany
2 Institute of Energy Technologies, Electrochemical Process Engineering (IET-4), Forschungszentrum Jülich, Germany
3 JARA Energy, Aachen/Jülich, Germany

A.Mechler@fz-juelich.de

Alkaline water electrolysis (AWE) remains a highly promising technology for green hydrogen production. Herein, good performances can be achieved with Ni-based electrodes offering a low-cost alternative to noble metal catalysts. In this context, the performance of the Ni electrodes has been shown to be highly affected by Fe in the electrolyte,[1,2] which is originating from impurities and steel periphery. Even though the exact mechanisms of the Fe-Ni interplay have not yet been fully understood, a significant activity increase for OER was observed with increasing Fe-concentrations under laboratory conditions.[3] On the other hand, AWE is suspected to be unable to respond to fluctuating loads. Overall, the impact of Fe on the stability, especially under fluctuating load, has not yet been studied intensively.

In this study, we investigated the role of Fe and dynamic wind profiles on the stability of AWE systems. Beaker and flow cell experiments were conducted with Ni mesh electrodes in 30 wt.% KOH at 80 °C, with current densities up to 1 A cm^{-2}.[4] We track the path of the Fe over the course of the experiments and find that both anode and cathode are affected depending on the initial Fe-concentration in the electrolyte as well as the duration of the experiment. Results show that during constant current operation, most Fe from the electrolyte deposited on the cathode, causing deactivation of the anode over time due to changes in the dynamic Ni-Fe system under operation (Figure 1a). On the cathode, degradation of up to 400 mV was observed in Fe-lean solutions, which could be avoided in systems with higher Fe-concentrations. The effects can be mitigated by dynamic operation, as the Fe-concentration in the electrolyte can be stabilized. However, under highly fluctuating loads, like currents directly originating from wind turbines, the behavior of the electrolyzer is even more complicated and difficult to predict. Here, we will show an approach to extract performance data from highly dynamic load profiles and compare them to interrupted operation.

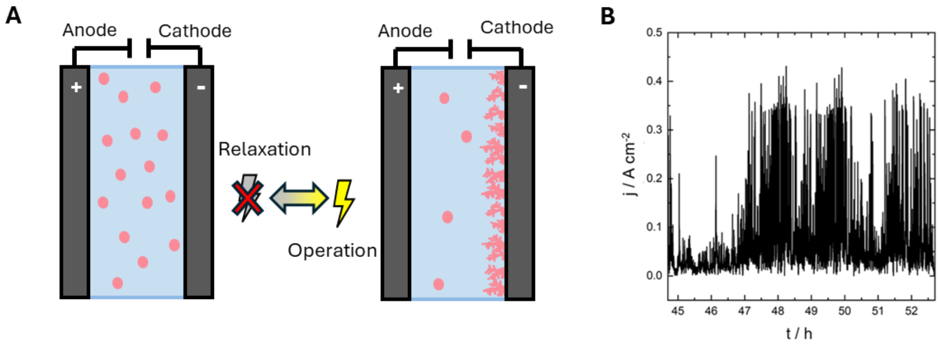

Figure 1: (a) Schematic illustration of the proposed Fe movement during operation and relaxation of the electrolyzer. (b) Electrolyzer response to a dynamic wind profile operation.

References

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