Navigating the Dynamics of Alkaline Water Electrolysis: Methodological Approaches to Aging Characterization

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The utilization of alkaline water electrolysis (AWE) presents a promising path for cost effective large-scale production of hydrogen using renewable energy [1]. Originally, AWEs have been designed for stationary operation. Given the dynamic and fluctuating nature of renewable energies, understanding the impact of dynamic operation and various potentials on the durability of alkaline electrolysers is crucial.
Even though AWE is considered a mature technology, there is a lack of long-term data and a comprehensive understanding of aging [2]. In this study, the start-up and aging behavior of AWE systems are explored. A cell with 5 cm^2 active cell area and Nickel electrodes was operated stationary and dynamically at potentials ranging from 1.6 V to 2.4 V for a total duration of 9000 h. Polarization curves, impedance measurements, and gas purity measurements were recorded in between for a consistent operational comparison.
The start-up behavior and aging of the electrolyser system, as exemplarily depicted in Fig. 1, were thoroughly analyzed, and methods for defining these characteristics were compared. The study revealed that start-up and aging are dependent on the applied potential and operation mode. Furthermore, it indicates the need for standardized evaluation criteria.
The research presented in this study contributes to the understanding of AWE responses during prolonged operation. It proposes methods for determining the start-up time and the degradation rate, establishing evaluation criteria for alkaline electrolysis systems. Defined evaluation criteria are applicable to stationarily and dynamically operated alkaline electrolyser systems, advancing the understanding of how operation modes impact alkaline electrolysis and the utilization of green hydrogen from renewable energies. The findings are moreover crucial metrics for modeling the durability of alkaline power systems and for identifying operation strategies for longevity.

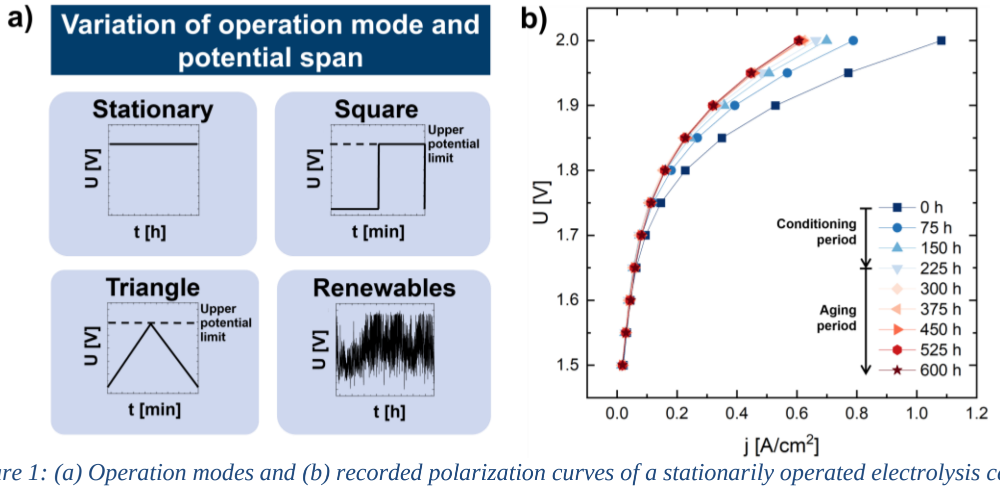

Figure 1: (a) Operation modes and (b) recorded polarization curves of a stationarily operated electrolysis cell during 2 V operation.

[1] Brauns, J.; Turek, T. (2020): Alkaline Water Electrolysis Powered by Renewable Energy: A Review. In: Processes 8 (2), p. 248.
[2] Ehlers, Johan C.; Feidenhans'l, Anders A.; Therkildsen, Kasper T.; Larrazábal, Gastón O. (2023): Affordable Green Hydrogen from Alkaline Water Electrolysis: Key Research Needs from an Industrial Perspective. In: ACS Energy Lett. 8 (3), p. 1502–1509.

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