Investigation of inorganic ionic impurities in AEM electrolysis and their impact on durability and long-term efficiency

Description:

In order to produce renewable hydrogen efficiently and cost-effectively, the anion exchange membrane water electrolysis (AEMWE) technology is emerging as a promising alternative to conventional PEM and alkaline electrolysis systems. AEM electrolysis combines the advantages of both technologies, such as high current density operation, low-cost materials, and the potential use of PFAS-free and PGM-free components. However, for the large-scale implementation of AEM electrolysis, long-term stability and durability of cell components remain critical challenges. One major factor influencing the degradation and performance loss in AEM electrolysers is the presence of inorganic ionic impurities in the feed water or electrolyte. Impurities such as calcium (Ca^{2+}), magnesium (Mg^{2+}), iron (Fe^{3+}), zinc (Zn^{2+}), chloride (Cl^{-}), sulphate (SO_4^{2-}), and carbonate species (CO_3^{2-}/HCO_3^{-}) can lead to membrane fouling, precipitation, catalyst poisoning, and a reduction in ionic conductivity. These effects result in increased cell resistance, efficiency losses, and reduced lifetime of AEM components.

In this thesis, within the framework of the project *ELYSIUM – AEM-Electrolysis: Scaling, Integration, Utilization, and Manufacturing*, the impact of inorganic ionic impurities on the electrochemical performance and durability of AEM single-cell components will be investigated. The work involves the controlled exposure of AEM cells to defined impurity levels, followed by electrochemical characterization (I–V characteristic curves, impedance spectroscopy, and durability tests). Post-test material analysis (e.g., SEM/EDX, IC, GC-MS) will be carried out to identify and quantify impurity-induced degradation effects. The thesis aims to gather essential information on the mechanisms of impurity-induced degradation, contributing to the evaluation of system sustainability and assessment of the long-term technical development of AEM electrolysis towards robust, PFAS-free and PGM-free technology.

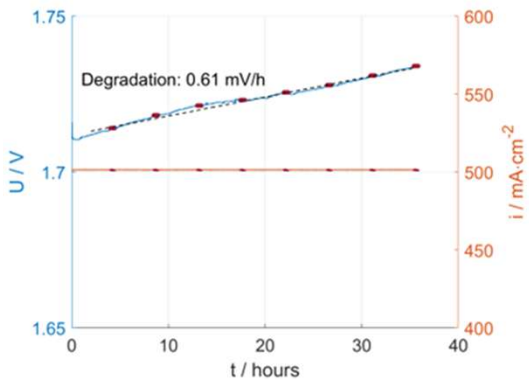

Figure 1: Voltage increase over time at constant current load indicating degradation in the cell setup (Source: HyCentA)

Content:

- Literature research on AEM water electrolysis and degradation caused by ionic impurities (1 month)
- Planning and execution of single cell tests in the lab setup including data evaluation and interpretation (3 months)
- Thesis writing (1 month)

Start: Any time
Duration: approx. 6 months
Paid Master Thesis
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