

Towards seawater electrolysis in alkaline media: assessing the impact of hypochlorite

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The growing trend towards developing off-shore wind projects farther from shore and in deeper waters is driven by the vast energy potential and the abundance of suitable off-shore sites [1]. Nevertheless, power transmission costs increase significantly with both power and distance. Water electrolysis offers a potential solution by converting off-shore wind electricity into a valuable product directly on site, thereby reducing the power transmission cost. However, conventional water electrolyzers require pure water and integrated off-shore desalination plants add costs, complexity and environmental concerns [2]. As a result, seawater electrolysis has emerged as a promising solution to address the challenges posed by offshore wind projects. In the current work, we highlight the critical role of operating conditions, in particular cell voltage, in mitigating the impact of chlorine during electrolysis. Firstly, we demonstrated the operation of an alkaline electrolyser under industrially relevant conditions (30wt% KOH, 80°C) without any deterioration in the presence of 0.5M KCl as long as the cell voltage remains below 2 V (Figure 1.a). In that case, as can be expected from the Pourbaix diagram, no hypochlorite (ClO^-) is being formed.

We then also further investigated the relationship between hypochlorite concentration and performance degradation. A dedicated spectrophotometric method was employed to determine the concentration of hypochlorite during galvanostatic experiments at 0.5 A/cm². Hypochlorite reacts with o-tolidine inducing changes in the solution's absorbance. By using a calibration curve, the hypochlorite concentration is determined. Figure 1.b shows the interplay between hypochlorite concentration and electrolyser performance. When the performance is constant (30wt.% KOH), the change in absorbance is minimal. Conversely, under conditions leading to performance degradation (1M KOH), resulting from a cell voltage exceeding 2 V, a clear correspondence between the cell voltage evolution and ClO^- concentration in the anolyte can be observed. This correlation highlights the role of hypochlorite in being the root main cause of performance losses during seawater electrolysis in alkaline media.

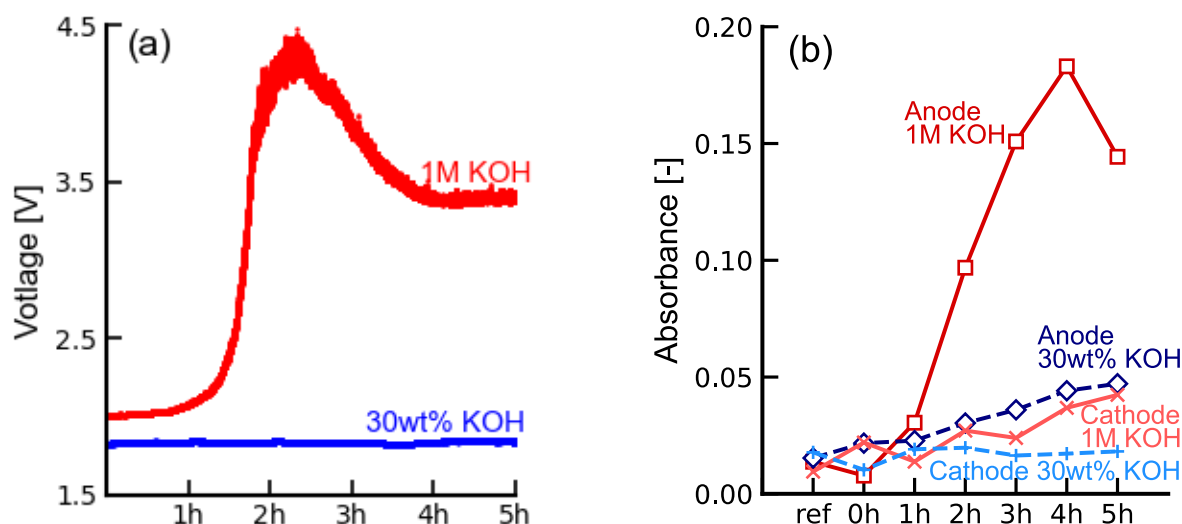


Figure 1: Evolution of (a) cell voltage at 0.5A/cm² at 80°C and (b) ex-situ room temperature measured hypochlorite concentration over time in the presence of 0.5M KCl for two electrolyte concentrations (1M and 30wt.% KOH).

[1] IRENA (2024), *Floating offshore wind outlook*, International Renewable Energy Agency, Abu Dhabi.

[2] O. S. Ibrahim, A. Singlitico, R. Proskovics, S. McDonagh, C. Desmond, J. D. Murphy, "Dedicated Large-Scale Floating Offshore Wind to Hydrogen: Assessing Design Variables in Proposed Typologies," *Renew. Sustain. Energy Rev.*, vol. 160, 112310, Mar. 2022.