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ALKALINE ELECTROLYSIS AT 1 A·CM^{-2} BELOW 2V: INVESTIGATING AND ISOLATING OVERPOTENTIALS

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The storage of renewable energy requires a cheap, scalable and efficient technology, able to store electricity both on short-term and inter-seasonal time scales. Energy storage as hydrogen, produced by the electrolysis of water, has been shown to be a promising technology capable of fulfilling these requirements. A key issue hampering the commercial scale rollout of alkaline electrolysers is the low current densities (<0.25 1 A•cm^{-2}) currently associated with the technology – often up to a factor of ten below the competing PEM technology. With the application of zero gap cell design, as well as state of the art catalyst coatings, an alkaline electrolysis cell is demonstrated with 1 1 A•cm^{-2} at under 2 V. Targeting an increase in current density requires a full understanding of the losses in the cell, which has been limited to *ex-situ* measurements of the three main overpotentials: activation, ohmic and mass transport. In this research, the three overpotentials are isolated *in-situ* using electrochemical impedance spectroscopy and Tafel plots to give key information about the main contributions to cell voltage. The use of a Raney-nickel cathode, and Ni-Fe$(OH)_2$ anode, both prepared by facile electro-deposition methods onto porous substrates, coupled with a state of the art membranes and zero-gap cell design allows the cell to reach 1 A•cm^{-2} below 2V – with stable performance demonstrated for over 100 h. The setup is carefully characterized using both *ex-situ* microscopy and *in-situ* electrochemical methods, showing that the ohmic resistance of the currently used Zirfon is the limiting overpotential in the initial cell – the use of emerging membranes such as Sustainion could reduce this figure by an order of magnitude.

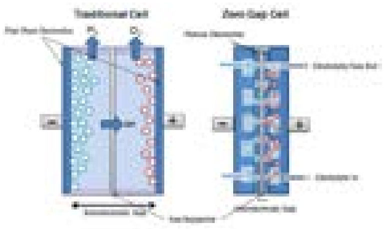

Figure 1: The use of zero gap cell design is crucial in permitting the operation of alkaline electrolysers at high current densities.

Recent Publications

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Biography

Robert Phillips is a PhD student at the Energy Safety Research Institute at Swansea University. His research interests include energy storage as hydrogen, produced by alkaline electrolysis. His current research is focused on increasing the power density and efficiency of alkaline electrolysis cells, with a key interest in utilizing zero gap cell design.

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