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Interaction of bubble dynamics and manufactured porous electrodes in flow through membraneless water electrolysis

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Low cost hydrogen production is essential to meet global hydrogen production targets by 2050. Therefore research into alternative water electrolysis device design may lead to reduction in capital costs. One emerging alternative to the capital cost is the use of membraneless electrolysers. In particular we focus on diverging flow through membraneless devices which utilise cell and porous electrode geometry to separate hydrogen and oxygen without a separator or membrane. They can also utilise alkaline conditions allowing for lower cost catalyst and construction materials.

However, the technology is not commercial and the influence of the design of the device and the manufactured porous electrode properties are unknown. Computational fluid dynamic simulations (OpenFOAM) using the volume of fluid method is used to model the two-phase flow of hydrogen and oxygen bubbles coupled to electrochemistry. Different device geometry, porous electrodes, flow and current density are varied to investigate their impact on the cell potential.

Electrolyte flow distribution and scaling of the devices are investigated, which are highly dependant on the sizes of the pores, electrode gaps and higher Reynolds number flows. The initial results show that there is an interplay between the pore size and the electrode length in order to maintain uniform flow across the electrode, which is important to reduce bubble blockage of the electrode surfaces. The effect of the electrode microstructure on the current density distribution are evaluated and strategies to avoid bubble accumulation are discussed. Changes to the porous electrode morphology through advanced manufacturing techniques, along with the wettability and device flow geometry could lead to higher efficiency, low capital cost water electrolysis.

Participation

In-Person

References

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