Modelling Gas Evolution in Aqueous Nickel-Zinc Battery Cells

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Rechargeable nickel-zinc batteries (RNZB) are a promising alternative to existing batteries for next-generation energy storage. They are based on low-cost, abundant and easily recyclable raw materials and have the advantage of high stability, safety and robustness. The drawback of RNZBs is their moderate lifetime resulting from the interplay of undesirable side reactions such as gas evolution during cycling.

In this contribution, we model a rechargeable nickel-zinc cell with focus on gas evolution during cycling. Our 1D+1D model describes the transport and the reactions at the electrodes including Zinc dissolution[2,3] in one dimension and diffusion within the cathode particles along another radial dimension. Emphasis is on describing gas evolution leading to pressure increase and electrolyte loss in the cell. For the $NiOOH/Ni(OH)_2$ proton intercalation cathode, it is important to describe the evolution of oxygen (OER) at the end of charge. Modelling of the side reactions at the cathode relies on similar nickel-based batteries such as NiMH batteries[1]. At the zinc anode, the evolution of hydrogen (HER) and the recombination of oxygen are modelled. The cell has a catalyst in the headspace that partially compensates the pressure increase due to gas formation by recombining H_2 and O_2 to form water. Further pressure differences can be balanced with a valve. Within the macroscopic perspective, microscopic phenomena such as electrochemical reactions and precipitation are also considered.

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Key word: nickel zinc battery, alkaline aqueous electrolyte, zinc anode, nickel cathode, oxygen evolution reaction, hydrogen evolution reaction, side reaction, pressure development

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