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The Importance of Microstructure in Redox Flow Batteries

Tuesday, 1 June 2021 19:00 (1 hour)

Producing energy from intermittent renewable energy sources has been developed over the past decades. One of the goals at the grid-scale is to provide sustainable energy output to the end-users [1]. To this end, efforts must be done to store a huge amount of energy in robust batteries to provide stable and flexible electricity to the customers during peak hours. Redox flow batteries (RFBs) have been attracted attention to be one of the best candidates amongst electrochemical technologies [2]. RFBs are a highly efficient energy storage technology that uses reduced/oxidized states of species for charge/discharge purposes. The performance of RFBs is evaluated using a polarization curve which describes the relationship between the cell voltage and the current density [3]. At higher current densities, the cell voltage drops drastically as a result of mass transport loss, meaning that the mass transport controls the performance and power range of RFBs [4]. The poor design of electrode microstructure is one of the main causes of this occurrence. Hypothetically, it can be overcome by tailoring or engineering the microstructure of the electrode. Therefore, the reactive transport of ionic solution in RFBs has been simulated in pore-scale using Pore Network Modelling (PNM) to investigate the effect of the electrode microstructure on the performance of RFBs. This work focused on Hydrobromic Acid (HBr) RFBs that hydrogen gas is oxidized in the anode and the produced protons are transferred to the cathode to reduce bromine in the cathode. By use of two unstructured and structured pore networks and two interdigitated and flow-through flow patterns, the performance of RFBs were investigated. This work aims to optimize the electrode microstructure to broaden the power output of RFBs. Initial results show that species are mostly consumed in the outlet and the proximity of the membrane, mainly as a result of lower advective force in these areas. Consequently, bigger overpotentials were observed in these regions due to the lack of species supply. Also, concentration distribution in the flow-through pattern was more uniform than the interdigitated one. This can be explained by the electrolyte flow direction in the electrode and greater advection force in the flow-through pattern.

Time Block Preference

Time Block B (14:00-17:00 CET)

References

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- [2] A. Z. Weber, M. M. Mench, J. P. Meyers, P. N. Ross, J. T. Gostick, and Q. Liu, "Redox flow batteries: a review," *J. Appl. Electrochem.*, vol. 41, no. 10, p. 1137, 2011.
- [3] M. Skyllas-Kazacos, M. H. Chakrabarti, S. A. Hajimolana, F. S. Mjalli, and M. Saleem, "Progress in flow battery research and development," *J. Electrochem. Soc.*, vol. 158, no. 8, p. R55, 2011.
- [4] M. D. R. Kok, A. Khalifa, and J. T. Gostick, "Multiphysics simulation of the flow battery cathode: cell architecture and electrode optimization," *J. Electrochem. Soc.*, vol. 163, no. 7, p. A1408, 2016.

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