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Motivation

Along the last decade, renewable energy sources have been revolutionary growing with more than 12% growth rate per annum. However, renewable energy sources despite being abundant and cheap they are intermittent sources where their supply does not necessarily match the consumers demand. Energy storage systems provide an alternative solution to store the excess energy and then recover it when needed, such systems ensure reliability and efficiency of renewable energy supplies.

Recently, there have been advancements in energy storage systems capable of storing GWh-scale energy capacity, such systems despite being promising they still possess several environmental and safety issues. In this project, Acid-base flow battery ABFB is employed as a storage system with water and salt as active materials. Figure 1 is an illustration of the system concept where water is dissociated into acid and base at the junction of the bipolar membrane during the stage of charging. Then acid and base are stored in tanks till the discharge state where they recombine to produce water and salt.

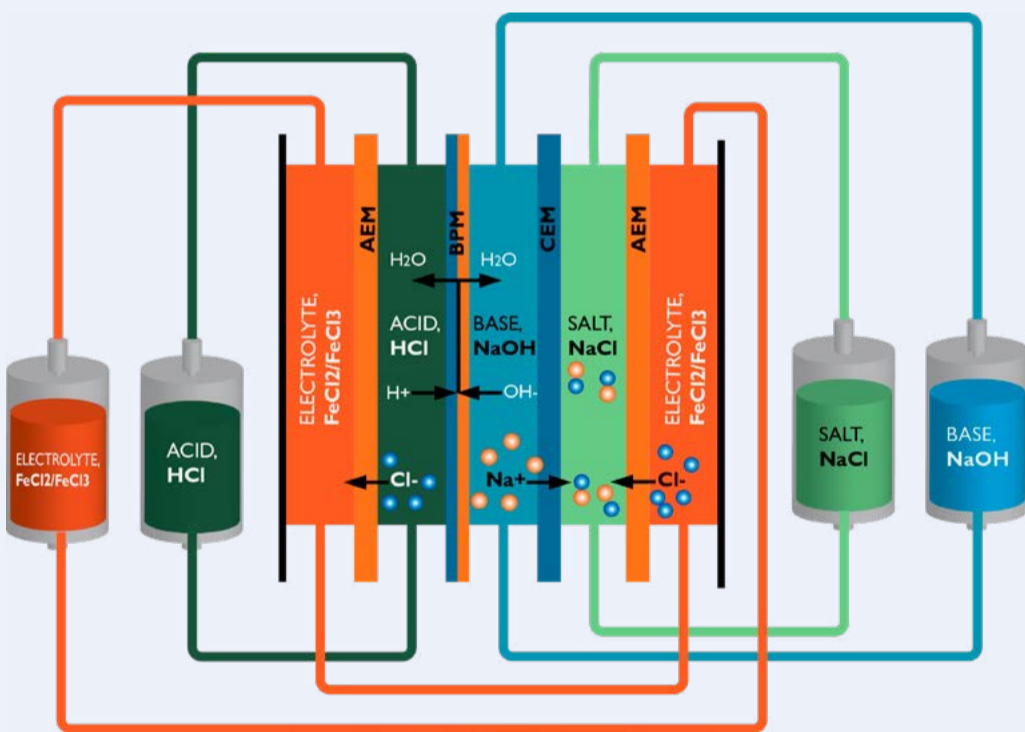


Figure 1. A Schematic illustration of ABFB

Technological challenge

In this system, the bipolar membrane is the most crucial and limiting part, during charging water molecules diffuses into the BPM junction and dissociates into a proton and hydroxyl ions while during discharging proton and a hydroxyl ions form water.

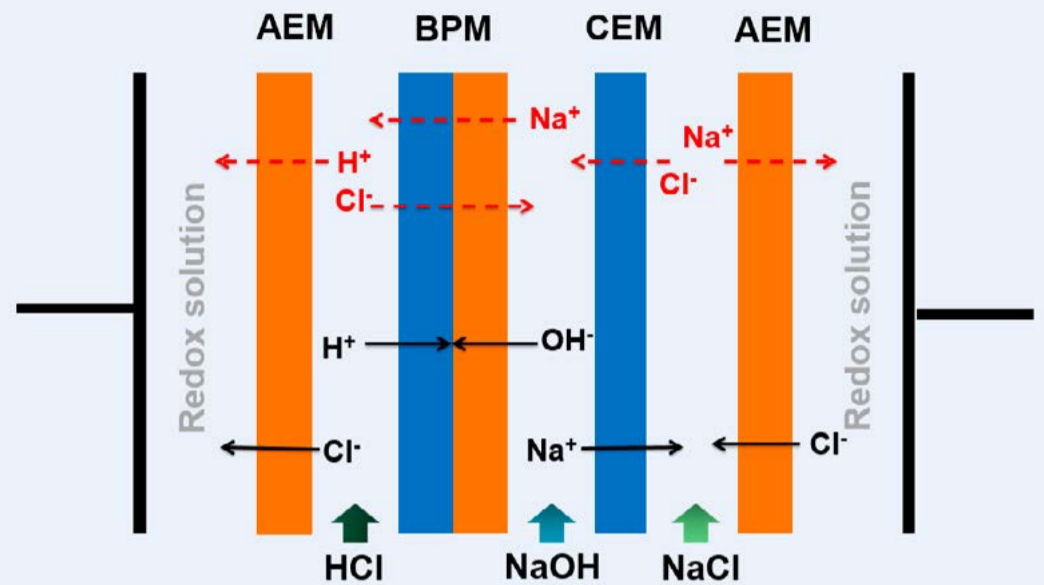


Fig 2. Possible routes of co-ion transfer through ion exchange membranes and bipolar membrane in ABFB (in red).

The ABFB exhibits several drawbacks mainly due to the bipolar membrane performance :

1. BPM delaminates when discharging at higher current densities due to the high rate of water formation at the junction of AEM and CEM which surpasses the level of water diffusion.
2. Low round trip efficiency (27%) as a result of unwanted co-ion transfer as shown in Figure 2 (the transfer of ions/protons through membranes with the same charge)^[1].
3. Internal resistance of the system needs to be lowered.

Research goals

The aim of this project is to develop bipolar membranes and ion exchange membranes which could overcome the drawbacks of the state of art membranes. This includes developing bipolar membranes capable of discharging at higher current densities without delamination. In addition, development of anion and cation ion exchange membranes that mitigate undesired co-ion transfer.

[1] Van Egmond WJ, Saakes M, Noor I, Porada S, Buisman CJN, Hamelers HVM. Performance of an environmentally benign acid base flow battery at high energy density. Int J Energy Res. 2018;42:1524–1535



Acknowledgment:

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