Alternative applications for sustainable Blue Energy generation and storage

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Motivation

Salinity gradients can be applied for storage of electricity and conversion of thermal differences (e.g. solar heat, industrial waste heat) into sustainable electricity, all by means of harmless environmentally safe technology. These closed systems are scalable, universally applicable and constructed from abundant materials. The main materials are NaCl solutions. Additionally, the content of the system can be controlled and fouling reduced to an absolute minimum. Salinity gradient systems constitute a promising alternative to fossil fuels and might turn out to be a versatile tool in transforming our energy supply and storage.

Concept

One alternative application of RED is a battery. In Electro Dialysis (ED) mode of operation, energy is spent to separate a brackish solution into a concentrated and diluted solution. In RED mode, the two solution mix and energy is recovered.

A typical Reverse Electro Dialysis (RED) system consists of a set of alternating cation and anion exchange membranes in between two electrodes. Water of different salinity flows along the membranes. Because of a difference in chemical potential of the two solutions, an electrical potential develops over each membrane. Ions move from the more concentrated solution to the more dilute solution. As a result of different selectivity of the two membrane types, anions can only move towards one electrode, whereas cations can only move towards the opposite electrode. This process results in a current over the two electrodes and an external load can be connected to harvest energy.

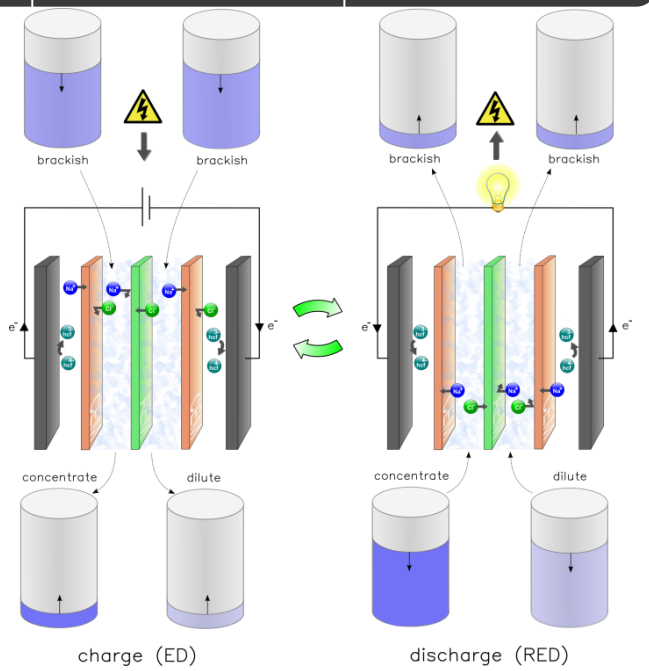

Figure 1. A salinity gradient battery. Red squares depict cation exchange membranes (CEM), green square depicts anion exchange membrane (AEM). Additional membranes may be added.

Technological challenge

Properties of a good battery generally include high round trip efficiency (%), high power density and high energy density (kWh/m^3). Current RED designs cope with several hydraulic and electrical resistances. These resistances lower the efficiency and power density of the salinity battery. Additionally, the type of salt, temperature of solution and concentration differences are important factors determining the energy density of the salinity gradient battery. The goal is to reduce losses, to have a high power density and to increase energy density of the system.

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