Power from salt: effect of temperature on hydrogen generation from reverse electrodialysis

Youwei Jia [a], Sandra E. Kentish [a], George Q. Chen [b]

[a] Future Fuels, Co-operative Research Centre, Department of Chemical Engineering,

[b] Department of Chemical Engineering, University of Melbourne, Victoria 3010

*youj4@student.unimelb.edu.au, (+61) 435964077

Abstract:

Salinity gradient power (SGP), the osmotic energy from controlled mixing of streams with different salt concentration, is an emerging renewable energy that has gained popularity. SGP can be harvested and stored in the form of hydrogen with membrane-based technology such as reverse electrodialysis (H_2-RED).

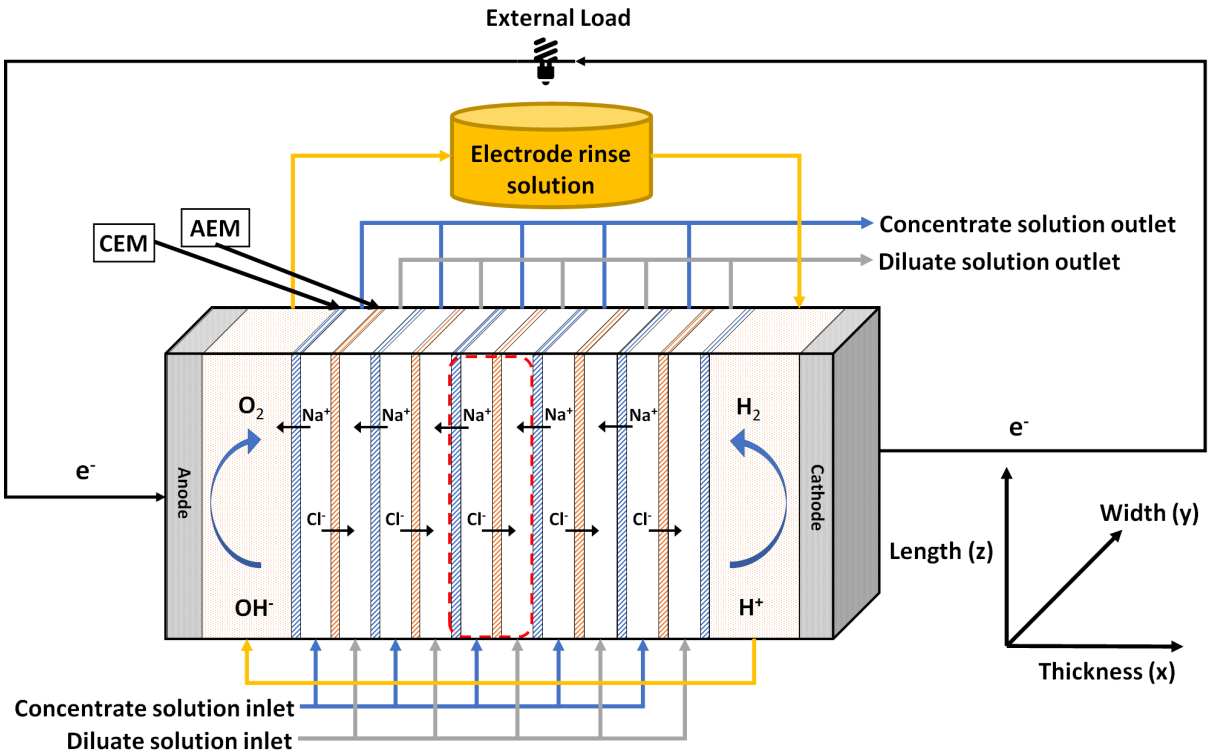

Figure 1: Schematic of a H2-RED stack.

A H_2-RED system consists of internal and external components (Fig 1). The internal component (aka stack) consists of repeating units of anion exchange membrane (AEM) and cation exchange membrane (CEM) placed in between the solutions of different salt concentration. The ion exchange membranes control the movement of ions and allow the cations and anions to move in opposite directions, which generates an ionic current. The external component consists of electrodes and electrode rinse solution which make use of the ionic current to electrolyse water.

Although H_2-RED system has been proposed, the optimisation of the system is not well documented, especially the effect of temperature. A large amount of heat energy is required to elevate the temperature of each stream, so it is of interest to consider the effect of the temperature on each stream separately. An increase in temperature of the electrode rinse solution can reduce the potential required for water electrolysis while an increase in the feed solution temperature can reduce the stack resistance. Based on our simulations, an increase in temperature of the 20-cell pair stack from 20 to 60 ^{0}C results in an over twofold increase in hydrogen generation. Conversely, a similar increase in temperature of the electrode solution results in a 20 % increase in hydrogen generation. However, 7 times more heat energy is required to heat up the feed solution as compared to the electrode solution. This study will be useful in situations where limited waste heat can be provided to a H_2-RED system. The model results will be confirmed by experimental data in a later stage.

Keywords: salinity gradient power, reverse electrodialysis, temperature, hydrogen