Reverse Electrodialysis with seawater and concentrated brine: a comprehensive process modelling

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Abstract

Among the great variety of renewable energy sources investigated during last decades, Salinity Gradient Power (SGP) is gaining more and more interest in the scientific community. Reverse Electrodialysis (SGP-RE) represents, in turn, a promising technology to convert this energy source directly into electric current by means of a suitable process involving the use of ion exchange membranes.

The efficiency of this conversion is strongly related to process streams characteristics, membranes properties and the stack design: in particular, as in the conventional electrodialysis process, a number of non-ideal effects can affect significantly the system performance such as “parasitic currents”, i.e. the ion transport not through membranes but inside stack manifolds, water transport through the membranes, etc.

In the present work, realized within the EU-FP7 funded REAPower project, a mathematical model has been developed for the Reverse Electrodialysis process aiming at the development of a comprehensive modelling tool, able to take into account also the effect of “non-ideal” behaviour of the system.

The model has been implemented in a solver software (gPROMS®) and validated experimentally for different operating conditions and using different stack design. Finally, the model has been used to carry out a performance analysis, highlighting the effects process parameters and system’s non-ideality on the overall performance of the SGP-RE unit, in order to collect further information for stack design optimisation from lab-scale up to pilot-scale.

Keywords

Salinity gradient power; reverse electrodialysis; modelling; seawater; brine; performance analysis