Reverse Electrodedialysis Power Production

*Progress in the development of an innovative system*

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Main facts

- Project name: *Reverse Electrodialysis for Alternative Power production - REAPower*
- Collaborative project - FP7 (FET)
- **Starting date:** 1 October 2010
- **Closing date:** 30 September 2014
The Reverse Electrodialysis technology
The concept

To produce energy from salinity gradients generated by ultra-concentrated brines and sea- or brackish-water

Technological benefits for the SGP-RE process

New potentials for the exploitation of brines
The vision

SGP-RE Unit

- 450 kW_{el}
- 0.014€/kWh

**brine**
- Salt concentration: 263 kg/m³
- Flow: 130 m³/h

 seawater
- Salt concentration: 35 kg/m³
- Flow ≥ 130 m³/h

“diluted” brine recycling

- 12.5 MJ per m³ of brine
- Size about 2 x 2 x 2.5 meters
- 42,000 m² of membranes

waste
The objectives

i) Define and optimise materials and components tailored to the requirements of the technology;

ii) Optimise the design of the SGP-RE cell pairs and stack using computer modelling tools;

iii) Validate the model and assess the developed materials, components and design by laboratory stack tests;

iv) Evaluate and improve the system performance through tests on a prototype fed with real brine;

v) Analyse the “economics” and assess the perspectives

vi) Define the next R&D steps
Achievements and perspectives

IEMs performance enhancements

**Increased permselectivity**

Membrane materials have been improved to achieve permselectivity of 84% for the CEM and 65% for the AEM (Na⁺ is smaller than Cl⁻ and can go through the AEM easier) (measured between 0.5M and 4M NaCl)

**Reduced membrane resistance**

Membrane specific resistance is below 1.5 Ω.cm² @ 100 μm. Further reductions will come from thinner membranes
Membrane Integrated Spacer and fluid dynamic optimisation

Tests are being performed for the preparation of **Membrane Integrated Spacers**, aiming at membrane thickness in the range **10-20 μm**.

**CFD simulations** have been adopted along with experimental characterisation of different spacer thicknesses and geometries.
Redox couples and stack design

Redox couples selection

Several redox couples have been tested under different conditions, finding the most promising for the SGP-RE prototype: FeCl₃/FeCl₂; Water/Na₂SO₄; [Fe(CN)₆]³⁻/[Fe(CN)₆]⁴⁻.

2 stack generations already designed and tested

Two different stack geometries have been already designed, constructed and tested and are now available for the consortium.
Multi-scale model implementation

Computational Fluid Dynamic of SGP-RE stack

Experimental tests on SGP-RE stacks

Process model implementation

Lower scale info

Multi scale model implementation

validation

Multi scale model validation

Model’s predictions on process performances & optimisation

www.reapower.eu
Power density output: effect of IEMs properties

Simulation of a 1000 cells stack assuming a linear decreasing of IEMs resistance with IEMs thickness. \( \alpha_{\text{AEM}} = 0.65, \alpha_{\text{CEM}} = 0.90 \). Spacer thickness of seawater/brine compartments \( \delta = 200 \, \mu m \).
Prototype installation site: Ettore-Infersa saltworks

Direct access to both saturated brine and seawater from open channels

Installation place within an old, restructured WINDMILL
Which brines for the SGP-RE process?

Environmental issues related to brine discharge have become more and more crucial in a number of different situations such as:

- Desalination plants
- Mining activities
- Salt industry

- REAPower can offer a solution as a non-conventional source of minerals and energy, while diluting the brine before disposal
Thanks for your attention

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