# *CFD analysis of concentration polarization phenomena in spacer-filled channels for Reverse Electro-Dialysis*

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**Abstract**

Performances of Reverse Electro-Dialysis (RED) process depend on many factors acting in a complex way: components properties (i.e. membranes, spacers, electrodes), stack geometry, operating conditions and feeds features. Polarization phenomena may significantly affect the actual membrane potential, thus reducing the gross power produced. On the other hand, C-polarization phenomena may significantly be reduced by suitably choosing the hydrodynamic regime within the stack. Such a choice may in turn significantly require higher pumping power, thus reducing the net power output.

Computational Fluid Dynamics methods may well represent a powerful tool to study the fluid flow and mass transfer in spacer-filled channels for RED processes. Up to present only few works have so far dealt with the analysis of fluid flow as confirmed by the very few papers present in literature and no works, to authors' knowledge, addressed the mass transfer phenomena in these systems.

In this work, carried out within the EU-FP7 funded REAPower project, CFD simulations were carried out in order to study the fluid flow behaviour and mass transport phenomena within spacer-filled channels. A *unit cell approach* was adopted to investigate the effect of spacer morphology, followed also by simulations of a larger domain consisting of a five unit cells, to investigate the influence of the computational domain choice on model predictions.

The case of RED process with seawater and brine has been investigated. Results show that C-polarization is negligible if a 5M NaCl brine flows in the channel, while a slightly more important effect is observed for a 0.5M solution (seawater). In all cases, minimisation of C- polarisation is counteracted by an increase in channel pressure drops, which in turns may lead to a reduction in the system net power output. Thus, a compete analysis of CFD prediction can suggest useful directions for the choice of a suitable spacer for process performance optimisation.

**Keywords:** CFD, modeling, concentration polarization, spacer filled channel