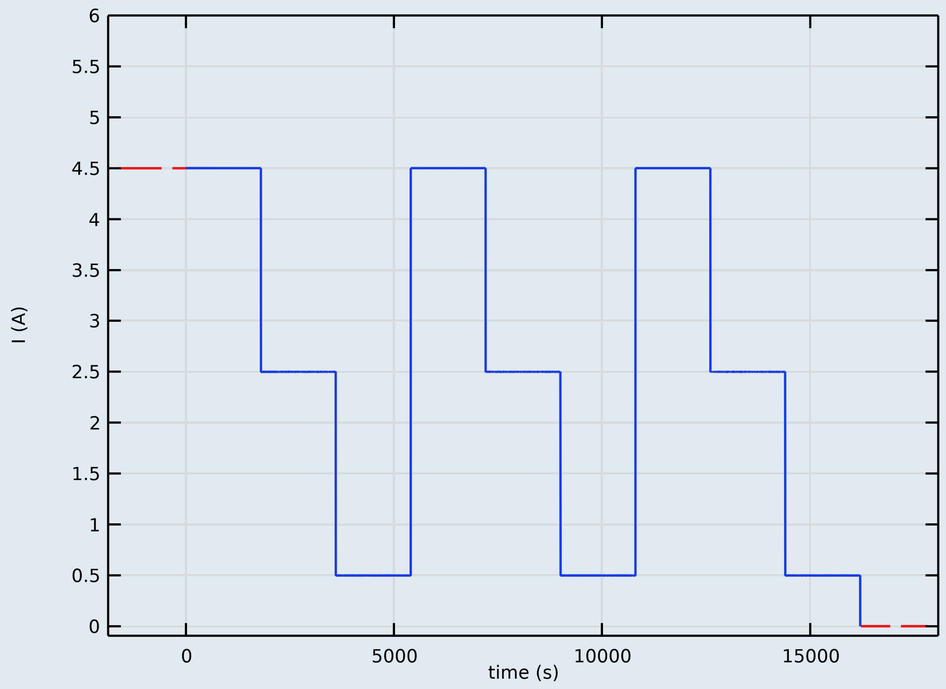

Model Building and Parameter Estimation for Electrodialysis Systems

We study model building and parameter estimation in electrodialysis systems fed by time-varying electric currents and equipped with water and salt online sensors.

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Abstract

Electrodialysis (ED) is a unit operation for the separation of electrolytes. Its modeling requires estimating several parameters and performing many batch desalination experiments [1]. However, parametric estimation can be simplified by focusing on the most important engineering parameters [2] and using a model-based optimization approach [3]. Recently, it has been shown how the simultaneous measurement of solute and water transport in a miniaturized ED system together with the use of ordinary differential equations (ODEs) for modeling the system allow the estimation of model parameters from experimental data obtained from a single experiment [4]. Here we follow a similar approach by using several time-varying electric current patterns as inputs to the ED stack and assess parameter estimation.

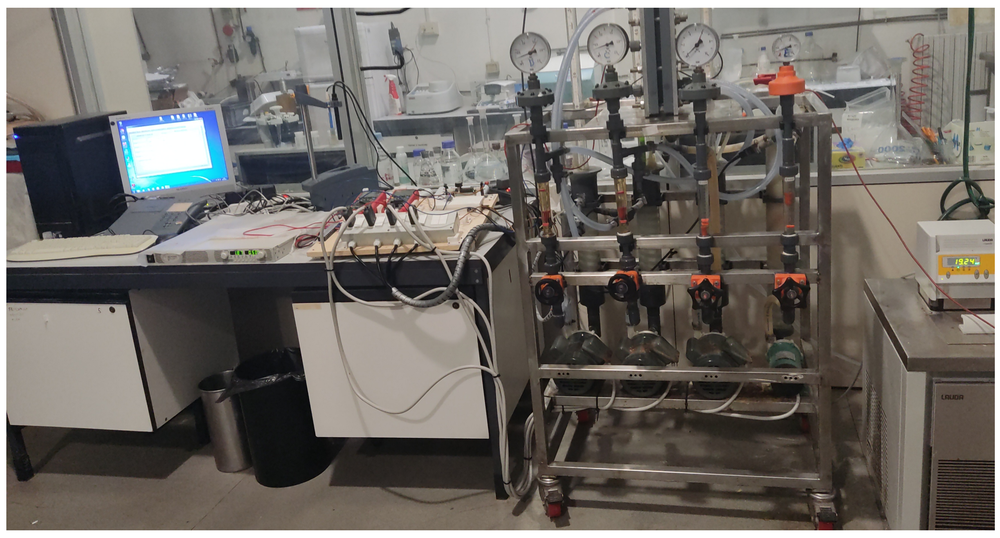

FIGURE 1. ED pilot plant equipped with online level and conductivity sensors, DC generator and data logging.

Methodology

Experimental set up
ED stack model EUR2 (Eurodia industrie SA) equipped with CMX and AMX (Tokuyama Soda Co) membranes, Pt anode, Ti cathode, conductivity and level online sensors, DC generator controlled by PC.

Simulations and parameter estimation
- 4 ODEs for concentrations (C) and volumes (V) of the solutions in the concentrating (C) and in the diluting (D) tanks
- 4 parameters for water (L_W, t_W) and salt (L_B, t_B) transport properties

COMSOL® implementation
0D dimension, mathematics, global ODEs and DAEs, parameter estimation

Results

Figure 2 shows an example of the high sampling rate data collected along with the simulation results obtained by using the estimated parameters set. A good agreement can be observed. Table 1 reports the estimates of the parameters for two electric current patterns.

Current pattern	t_B (-)	L_B (m/s)	t_W (-)	L_W (s mol / kg m)
Step	0.95	$1.43\ 10^{-8}$	8.8	$1.20\ 10^{-9}$
sinusoidal	0.99	$1.1\ 10^{-8}$	8.9	$1.28\ 10^{-9}$

L_B seems to be the most difficult parameter to estimate. This is because it represents diffusion that exerts a small contribution to salt flux compared to electromigration. The approach appears adequate but further work is necessary to confirm the results.

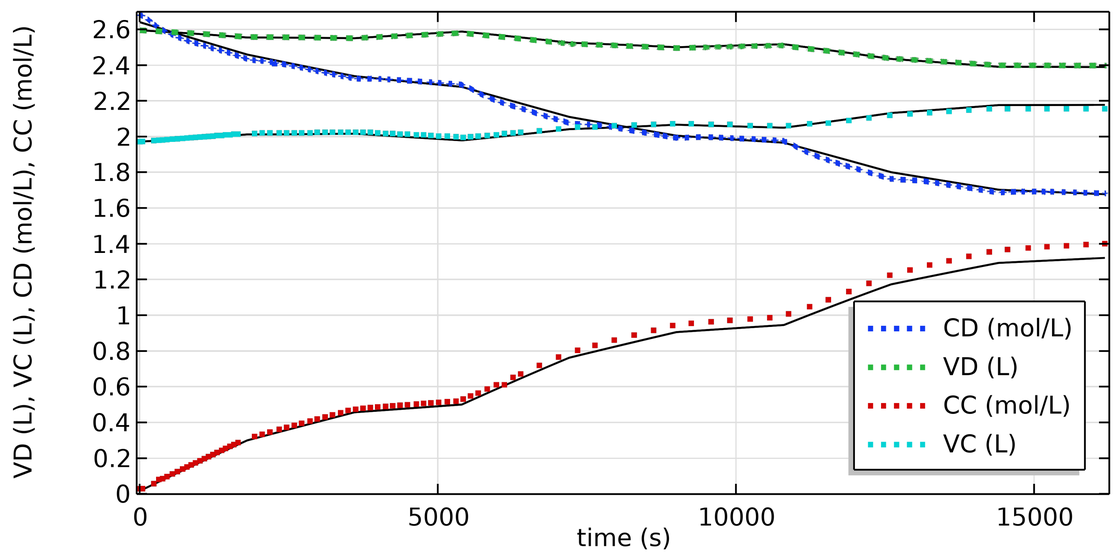

FIGURE 2. Results of data fitting: simulation (continuous line) and experimental values (dots) for CD, CC, VD and VC vs. t.

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