MODEL-BASED DESIGN OF ELECTRODIALYSIS SYSTEMS TO REDUCE FOULING

Introduction

Biochemicals and biofuels are rapidly gaining importance as building blocks for a sustainable economy. A major challenge in the production of biochemicals is the extraction of the product from the reaction medium. Electrodialysis (ED), a separation process that employs an electric field and ion-exchange membranes, is able to separate charged components efficiently and selectively from a solution and is well-suited for this task. In practice, however, these ED installations are very susceptible to fouling which reduces their performance drastically. Mitigating fouling in ED is therefore of high interest to the bio-based industry and the main objective of this master thesis. To achieve this, mathematical models will be used to describe the electrochemical and physical processes occurring in an ED unit. Such a model can then be used to optimise the operation and test innovative designs.

Methodology

Electrodialysis can be modelled with the Nernst-Planck equation for the transport of charged molecules and the Navier-Stokes equations for the fluid flow. These equations are implemented in the open-source CFD tool OpenFOAM. Here, the domain is discretised into a three-dimensional grid over which the equations are solved to simulate a flow field and obtain concentration profiles.

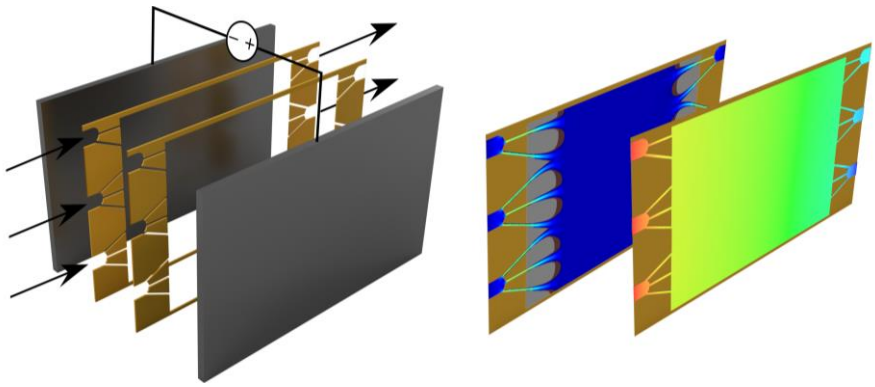

Figure 1 – Representation of a simple ED stack with the expected flow field (middle) and solute concentration (right) within a spacer channel.

Objectives of the thesis

The aim of this thesis is to further extend the electrodialysis model. Several investigative paths are available and depending on personal interest the focus can shift towards one or more of the following topics:

- simulation of complex geometries (spacer channels),
- implementation of fouling models,
- model-based design (whether or not automated).

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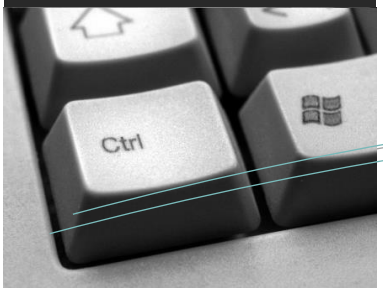

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