# Investigation of Ion Facilitation Using Corrugated Membrane in Electrodialysis

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## Abstract

Electrodialysis(ED) is an electrochemical separation process in which charged membranes are used to separate ionic species in presence of electrical potential. The efficiency of ED depends on polar membranes, flow hydrodynamics of electrolytes, concentration polarization arising due to difference in transport number of ion in bulk and the membrane matrix. This creates concentration depletion at the solution-membrane interface compared to the bulk and imparts resistance to ion transport. Minimization of this concentration polarization will facilitate ion transport and increase the ED process efficiency. Introduction of promoters inside this gap will cause turbulence and inter mixing of layers. This will increase pressure drop and minimize resistance to ion transport by reducing concentration polarization. Application of non-conducting spacers causes pressure drop besides creating shadow effect of the electric field exposed to the ions in bulk. With flat surface of membrane having no corrugation, the fluid flow remains practically undistributed throughout its length. To avoid this shadow effect corrugation membranes are promoted. Fluid flows over corrugated polar membrane surfaces create turbulence. It affects diffusion boundary layer and influences ion transport in ED by reducing concentration polarization thickness.

Corrugated membrane having different geometry shape would facilitate better mixing of fluid layers and reduces diffusion boundary layer thickness. Performance of each geometry was simulated using COMSOL® to find their influence on ion separation. In present investigation, mathematical model based on Nernst-Planck equations, Navier stokes, continuity, mass balance equations were framed and solved using COMSOL Multiphysics® to understand the flow and concentration profile within ED cell. The model equations were effectively applied to flow channels containing corrugated membrane surface. The shape, dimension, size (semicircle, rectangular, square) and spacing between corrugations were systematically investigated and compare with netted spacer which is commonly used to find best corrugation for charged ions removal. Mess size, shape and its configuration was selected from predefined options in COMSOL®. Simulations of all geometries were carried out with different mess configuration.