United Arab Emirates University, College of Engineering and KU Leuven, Faculty of Engineering Science invite you to a

PhD Dissertation Defense (Dual Degree)

entitled

ELECTRODIALYSIS PROCESS FOR THE SIMULTANEOUS TREATMENT OF REJECT BRINE AND CAPTURE OF CARBON DIOXIDE

by

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Date & Venue

15 May 2023, 4:00 – 6:00 pm

F1 Building, Room 0046

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Abstract

Desalination plants are highly efficient in producing desalinated water for potable applications. However, the process also generates reject brine, which is highly concentrated saline water. In order to produce 1 liter of potable water using desalination, approximately 1.5 liters of reject brine is generated. The disposal of reject brine presents a significant challenge for the desalination industry. Typically, this waste product is discharged into the sea, causing environmental damage, and polluting marine life. Moreover, certain countries heavily rely on desalination to meet their potable water needs, which results in the emission of greenhouse gases. As desalination plants consume a significant amount of energy, they are often located near power stations, which leads to the release of large quantities of carbon dioxide (CO_2) into the atmosphere.

This PhD study proposes a multi-chambered electrodialysis process for desalination industries to manage the two pollutants (i.e., CO_2 and saline waste). This can efficiently manage these pollutants in a single set of reactions to produce value-added products such as hydrochloric acid, carbonates/bicarbonate salt mixture, and irrigation standard water. To achieve the simultaneous treatment of the pollutants mentioned, two different schematic electrodialysis configurations were designed, namely the batch circulation configuration and the bipolar membrane configuration. Membranes and equipment can be fouled by multivalent ions such as calcium, magnesium, and sulfate, and thus, they must be separated from reject brine streams. To accomplish this, the reject brine underwent pretreatment using a selective electrodialysis process. To comprehend the hydrodynamics and electrochemistry involved in the process, a 2D stationary and isothermal computational fluid dynamics (CFD) model was developed to analyze the transfer of ions in a multichambered rectangular electrodialysis process. The model was constructed by coupling Nernst-Planck equations with Navier-Stokes equations and was numerically solved using the finite element method. The model can predict local concentration, ionic flux, electrolyte potential, velocity distribution, and limiting current density. The batch circulation electrodialysis, bipolar membrane electrodialysis, and selective electrodialysis were separately analyzed using various parameters and optimized for maximum performance.

Keywords: Bipolar membrane electrodialysis, Desalination, Selective electrodialysis, Reject brine, Carbon dioxide capture, CFD modeling.