Electrodialysis and electrodialysis reversal (ED/EDR) are membrane-based desalination technologies which are widely used to desalinate brackish water. This research presents the effects of operational parameters – such as temperature, velocity, applied voltage, and feedwater composition – on the removal of monovalent and divalent ions through the ED / EDR process. Additionally, the theoretical/empirical model was developed using dominant dimensionless numbers in the ED/EDR process and showing the Stanton number as a function of Peclet number and the dimensionless applied voltage. This dimensionless form of the model extends the model’s applicability to large scales. Additionally, a new model was developed for the selective removal of ions in ED/EDR based on the presented dimensionless ion removal correlations, showing how operating factors affect the removal of divalent counter ions against monovalent counter ions. Moreover, the parameters that affect the current efficiency of individual ions were investigated, showing that operating factors have different effects on the current efficiencies of two different counter ions with different electrical charges. Preliminary pilot-scale experiments were conducted at the Brackish Groundwater National Desalination Research Facility on a General Electric pilot-scale EDR system. Next, a laboratory scale ED setup with a complete data acquisition system was designed and built. Using this system, experiments were conducted at the laboratory scale so that operating conditions could be controlled well and the effects of noise factors could be removed or reduced, allowing the effects of operating conditions to be more precisely verified.

"THEORETICAL, EXPERIMENTAL, AND PREDICTIVE MODELS FOR ION REMOVAL IN ELECTRODIALYSIS AND ELECTRODIALYSIS REVERSAL"

Fischer-Tropsch synthesis (FTS) is the reaction of carbon monoxide (CO) and hydrogen (H2) at high pressures and temperatures in the presence of Fe, Co, or Ru to produce mainly straight-chain aliphatic hydrocarbons, water and carbon dioxide. Commercially FTS is carried out by two alternative types of processes: high-temperature processes, where the products are in the gas phase, and low-temperature processes, where some products are also in the liquid phase and three phases are present at reaction conditions (Gas-liquid-solid). Current multiphase reactors technologies show important advantages, namely, good heat transfer, high catalyst efficiency, convenience for catalyst reloading/regeneration, and low costs, and they are also considered promising for further development of FTS technologies. Thus, it is of practical interest to investigate the properties of the liquid reaction media that enhance the activity and selectivity of FTS to further improve reactor performance. Liquid phase reactions at the water/oil interface of Pickering emulsions have shown great advantages in heterogeneous catalysis. For example, solubility differences can drive the migration of desirable products to a different phase, thus facilitating the separation/removal of products and avoiding undesired reactions. In recent work, we have used metal-doped nanohybrids (carbon nanotubes – metal oxide) to stabilize emulsions during Fischer-Tropsch synthesis catalysis. We observed that the emulsion system extends the life of the catalyst and improves the C1/C5+ product balance. Also, Aliphatic hydrocarbons migrate preferentially to the oil phase while short alcohols remain in the water phase, which facilitates the separation of products. In this work, we systematically study the effects of support hydrophobicity on the activity and selectivity of Fischer-Tropsch synthesis. Two types of supports with varying hydrophilicity (silica and carbon nanotubes) are decorated with Ru metal and tested for liquid-phase Fischer-Tropsch synthesis using a batch reactor (H2:CO = 4:1, 220 °C, 55 Bar). Different ratios of water/oil are also used and the activity and selectivity is determined. Interestingly, reactions with the more hydrophobic supports in biphasic systems show higher CO consumption rates than those observed with the less hydrophobic supports at similar conditions. The results of catalytic activity and selectivity are discussed in terms of the interaction of the catalyst particles with the water and oil phases at the interface during reaction.

"ENHANCED ACTIVITY OF FISCHER-TROPSCH SYNTHESIS USING HYDROPHOBIC CATALYST IN OIL/WATER REACTION SYSTEMS"