Enhancement of counter-ion transport through ion-exchange membranes in electrodialytic processes

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ABSTRACT

Ion-exchange membranes (IEMs) are ionic conducting materials. They have various applications such as: fuel cell (PEMFC), electrochemical synthesis (Cl₂/NaOH), desalination, purification, separation, and environment. Despite these applications, several aspects are still unknown, such as: the membrane structure, the conduction mechanisms, and concentration polarization. The main obstacle in electro-membrane processes such as electrodialysis is the concentration polarization phenomenon, which remains one of the incomprehensible phenomena in IEM transport. This phenomenon is common to all systems operating a selective ionic transfer through an interface; it arises from the difference in ions mobility in the solution and in the membrane. A better understanding of concentration polarization can help to improve the membrane performance, the process efficiency, and in the reduction the process operation cost. In this research, we studied the effect of the ammonia buffer (NH₃/NH₄⁺) on the counter-ion transfer through the anion- and the cation-exchange membranes AMX and CMX, respectively. The results show that the ammonia addition facilitates the counter-ion transfer in both cases and gives a total elimination of the system polarization, but with different behaviors of CMX and AMX membranes. The classical concentration polarization theory remains insufficient to explain the obtained results.

Keywords: Ion-exchange membrane; Limiting current density; Over-limiting current; Electrodialysis; Concentration polarization; Water dissociation

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