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MATHEMATICAL MODELING OF AN ION TRANSFER IN A DONNAN DIALYSIS PROCESS VIA NERNST-PLANCK EQUATION

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The rising demand, combined with depleting sources of raw materials is forcing the industries to look for an alternative sources of these critical raw materials. One of these alternative sources are concentrated brines, produced in a seawater desalination process, as well as industrial wastewaters containing metal ions. These brines contain substantial amounts of minerals such as lithium and magnesium, which are considered a critical raw resource by the EU. The major problem with this source is the complexity of this mixture, containing a wide variety of ions, and requiring a specialized approach for recovery of the compounds of interest. One of relatively new approaches capable of achieving this is a membrane crystallization utilizing ion exchange membranes. In this process an ion of interest is transported across the ion exchange membrane via a Donnan dialysis process after which it is reacted with a suitable precipitant resulting in the formation of crystalline phase. In this process the mass transfer across the membrane via a Donnan dialysis is a key step determining the rate of the process.

One of the key tools required for an effective development of a new process is a suitable mathematical model capable of describing the systems and phenomena taking place in these systems. The objective of this study is to compare and verify some of the approaches for description of the Donnan dialysis process found in literature. These tested approaches are based on various simplifications of a Nernst-Planck equation. After determining of the required parameters, the four different models were verified against an experimental data of ion transport across an anion exchange membrane under different conditions. The results highlight the importance of selection of a suitable model for description of these systems.

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