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Ion exchange membranes for the selective separation of monovalent cation

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Electrodialysis (ED) is a widely used electromembrane process that allows the selective separation of mixtures of ions from water. In this process, charged membranes are used to remove ionic species from an aqueous solution. Ion-exchange membranes can be employed with an applied electric field in order to force ions to pass from feed side to receiving side. Ion exchange membranes can be classified into two categories: cation exchange membranes and anion exchange membranes. Cation exchange membranes contain negatively charged groups and only allow the transport of cations, while anion exchange membranes transport only the anions.

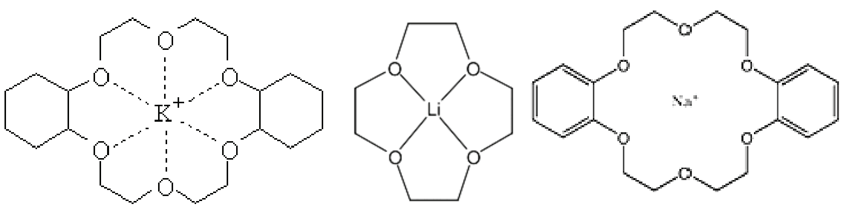

Figure 1 : A number of crown ethers with the ligand they selectively bind.

So far, separation of monovalent and multivalent cations from each other is possible. However, separation of ions of the same valence from aqueous environments with high separation efficiency has not been achieved yet. Our aim is to develop a membrane that can distinguish between two ion species of the same charge and, in addition, can transport an ionic species against its electrochemical gradient with an externally applied electrical potential as driving force. The incorporation of crown ethers (Figure 1) into the polymer matrix can offer an promising alternative to overcome the lack of membrane selectivity for one specific ion species. Depending on its selectivity, the presence of crown ether into the polymer matrix allows selective binding of a specific type of ion species, which, in turn, changes the transport number of that particular ion species. In our approach, we focus on the selective separation of Li^+ from Na^+. Brine water and seawater contain considerable amounts of lithium. Lithium is an essential element for energy storage (Li+ batteries) at present and in the future. This explains that the selective recovery of Li^+, e.g., from seawater, gains great attention. In this study, we studied the effect of the presence of Li^+ selective crown ethers on the transport properties of Li^+ over the membrane. Several different polymers are used as cation exchange membranes and as matrix for the crown ethers. These polymers are blended with 12 crown-4, a well known Li^+ ionophore. The transport properties of the membranes are characterized in terms of permselectivity, ion exchange capacity, and membrane resistance.

Swelling properties are also investigated by water uptake with LiCl, NaCl and HCl solutions. It is found that the polymer type and the blending ratio affect the transport properties of Li^+.

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