Group: Advanced Materials for Chemical Sensitivity (AMCS)
Project: **Functionalized Ion-exchange Membrane for Na+ Selectivity**
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Introduction and aim

Dutch crops are mainly grown on substrates, detached from soil, which allows for recirculation of the irrigation water. High concentrations of Na^+ in water affect the permeability of soil and causes infiltration problems. Most importantly, at certain levels it is toxic for crops. Reuse of irrigation water is therefore often limited by the accumulation of Na^+. Nowadays, this irrigation water, containing valuable nutrients, has often to be discharged to the environment as a brine stream. Therefore, reuse of water and nutrients would be enhanced if Na^+ could be selectively removed from irrigation water. However, up to now there is still no cost-effective industrial technology that can selectively remove Na^+. This project aims to develop a membrane-based material that can separate Na+ from the irrigation water meanwhile preserving other nutrients present, notably K^+.

Approach

This project focusses on the one-side surface modification of a commercially available cation-exchange membrane (CEM) with K^+-selective crown ethers. The idea behind this approach is that the K^+-selective crown ether will hinder/block the passage of K^+, but not that of Na^+, thereby enabling selective Na^+-transport. The modification of CEM involves the covalent attachment of the crown ether to specific functional groups (*i.e.* $-SO_3H$, $-COOH$, $-NH_2$) at high density at one side of the surface of the CEM. Figure 1 summarizes several possible reaction schemes for this CEM modification. The resulting asymmetric cation exchange membrane will be implemented in an electrodialysis system to study ion transport.

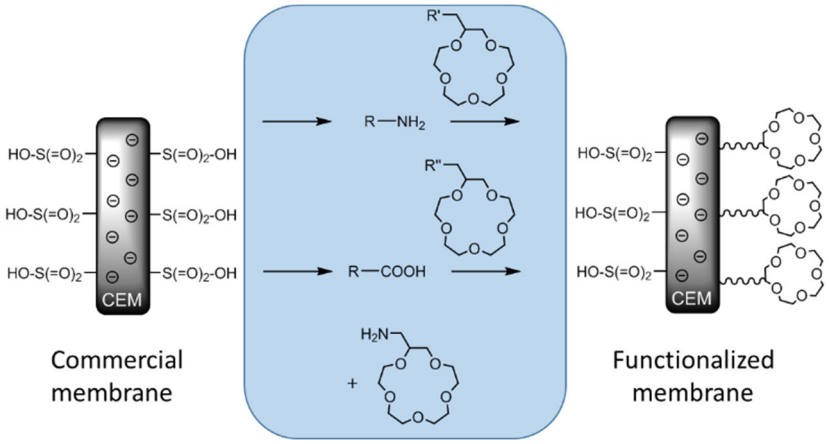

Figure 3. Possible membrane modification schemes to obtain a one-side, crown-ether-functionalized membrane. R' = OH/COOH, R'' = OH/NH_2.

Opportunities for BSc, MSc and internship students

Thesis work may include, i) the chemical modification and characterization of the CEM and, ii), the functional characterization of the modified membrane using electrodialysis. Depending on the nature of research activities, the research will be conducted at Wageningen University and/or Wetsus in Leeuwarden. The PhD research of Zexin Qian is performed in close collaboration with FujiFilm and WaterFuture, two companies linked to the Wetsus research program and desalination theme.

Technique to be used

Organic synthesis and the characterization of molecules (NMR, IR, possibly MS) and modified surfaces (XPS, IR, AFM) and the characterization/performance of membranes in electrical resistance, permselectivity and electrodialysis studies.

Contact

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