TECHNISCHE UNIVERSITÄT DRESDEN

innovatION
Selektive Entfernung monovalenter Ionen aus salzhaltigen Wässern

Monovalent Selective Desalination by Membrane Capacitive Deionisation

Rosentreter H.[1], Schödel D. [1], Oddoy T.[2], Jeske M.[3], Danz K.[3], Meier-Haack J.[2], Bauer B.[3] & Lerch A.[1]

[1] Technische Universität Dresden; [2] Leibniz Institute of Polymer Research Dresden e. V.; [3] FUMATECH BWT GmbH

Monovalent Selective Membranes

In regions with freshwater scarcity, saline waters are often desalinated by reverse osmosis or distillation to be used as drinking water and for irrigation purposes. Due to the complete demineralisation, remineralisation of the permeate is usually needed[1]. Within the joint project innovatION, we develop selective ion exchange membranes which will be integrated into a capacitive deionization to remove monovalent ions such as sodium, chloride and nitrate, while polyvalent ions like magnesium and calcium can remain in the water.[2]

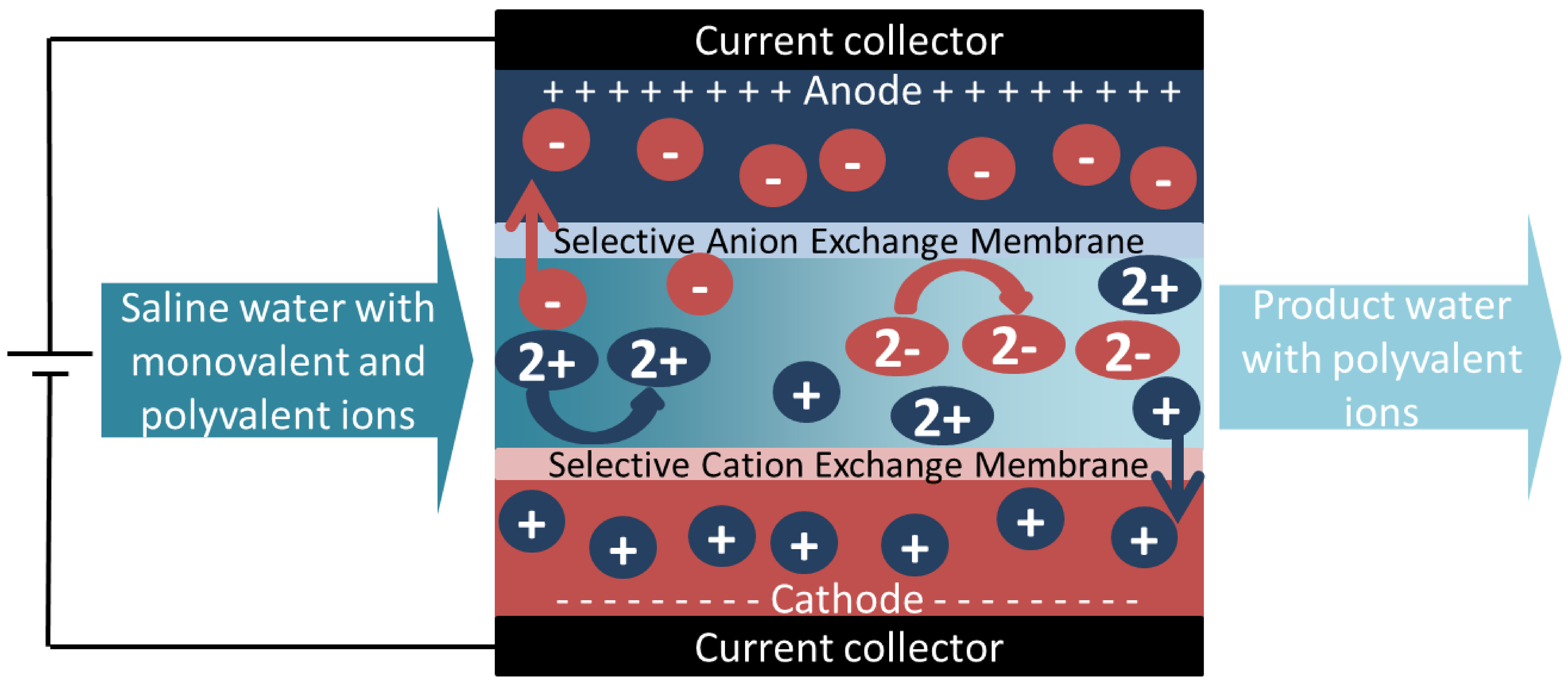

Figure 1. Principle of the selective membrane capacitive deionisation with high retention of monovalent ions (mMCDI).

Material & Methods

Production of Selective Ion exchange membranes

Selective ion exchange membranes are produced by FUMATECH BWT GmbH and Leibniz Institute of Polymer Research Dresden e.V. Hereby, the following approaches for the development of monovalent ion selective anion- as well as cation exchange membranes (AEMs and CEMs) will be investigated:

i. coating of a NF-membrane (feed side) with ion-exchange material

ii. coating/filling the permeate side of a NF-membrane with ion exchange material

iii. preparation of ion-exchange membranes using MF-membranes or non-wovens as support for pore-filling

iv. preparation of ion exchange membranes based on interpenetrating networks (IPN) consisting of an inert matrix (modified polyethersulfone (PES)) and a crosslinked ion-exchange material dispersed in the matrix

v. Coating of ion exchange membranes with neutral or opposite charge.

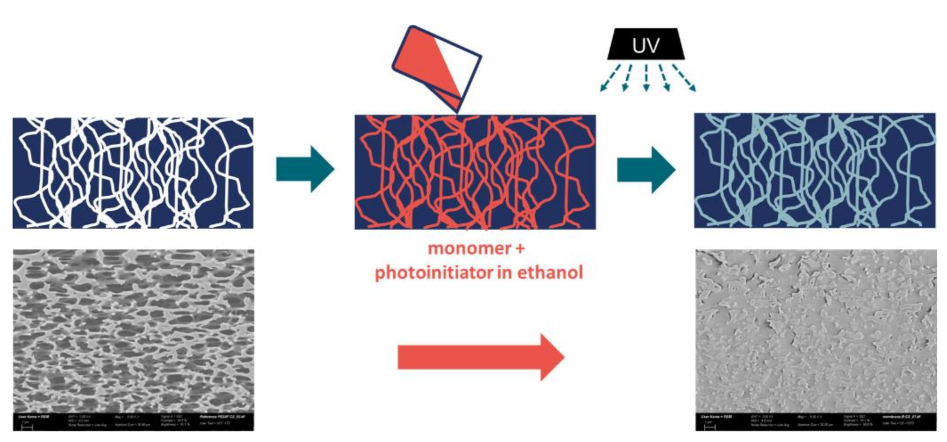

Figure 2. Preparation scheme of pore-filled membranes and SEM of support membrane (left) and pore-filled membranes (right).

Evaluation of Membranes

The novel membranes are evaluated by measuring thickness, resistance, permselectivity, swelling, ion exchange capacity, microscopy, stress-strain behaviour, FTIR-Spectroscopy, thermogravimetric analysis, monovalent ion selectivity within MCDI.

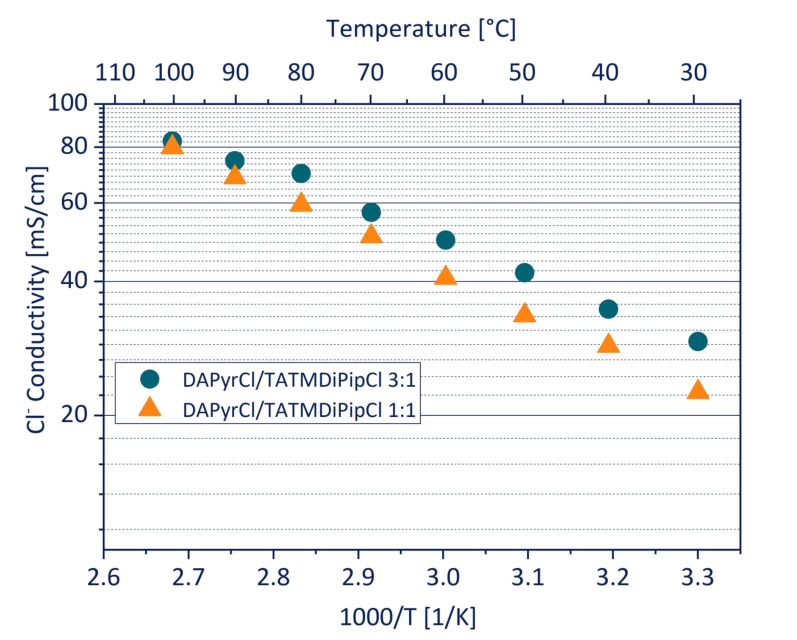

Figure 3. Cl^- Conductivity of pore-filled AEMs measured in humid air (95% relative humidity).

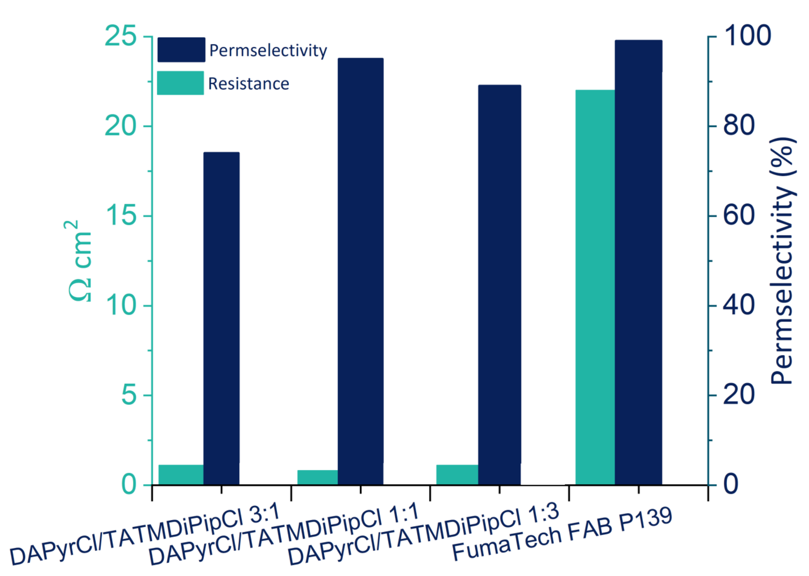

Figure 4. Resistance and permselectivity of pore-filled AEMs.

Modelling & Application of mMCDI

The desalination performance is investigated for varying feedwater salinities and adapted process parameter using the newly designed membranes. Further, we will use mass transport and flow modelling to describe the desalination performance and energy efficiency. The efficiency of the mMCDI is thereby evaluated by a holistic economic-ecological sustainability assessment.

The monovalent membrane capacitive deionisation (mMCDI) is tested in laboratory-scale and pilot-scale on the East Frisian island Langeoog and in Nienburg in Germany. In addition, the further use of the diluate as drinking water and for managed aquifer recharge will be analysed. The results of this project will be used to compare the mMCDI, as a new and innovative selective desalination technology, with conventional desalination technologies.

Figure 5. Laboratory plant designed by DEUKUM GmbH and elkoplan staiger GmbH.

Literature:

1 Rosentreter H., Walther M. & Lerch A. Partial Desalination of Saline Groundwater: Comparison of Nanofiltration, Reverse Osmosis and Membrane Capacitive Deionisation. Membranes 2021, 11, 126.

2 Rosentreter H., Schödel D. & Lerch A. https://innovat-ion.de/en-US

fumatech Funktionelle Membranen und Anlagentechnologie BWT GROUP

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