Membrane design for fouling control in reverse electrodialysis

Renewable energy sources are crucial to meet the growing world energy demand in a sustainable way. In recent years, salinity gradient energy has shown an increased potential as a viable source of renewable energy. This energy is based on the generation of electricity from the mixing of aqueous solutions with different salinity, such as river and seawater. Reverse electrodialysis (RED) is used to harvest the salinity gradient energy by using ion exchange membranes (Figure 1).

RED has been extensively investigated on laboratory scale and since a few years on pilot plant scale at the Afsluitdijk between the Waddenzee and Lake IJssel (NL). The pilot tests revealed that performance and operation of RED under real, natural conditions is much more challenging than in a laboratory environment. Natural feedwater streams contain several foulant species like e.g. multivalent ions, micro-organisms, silicates and humic acids. These species interact with the membrane surface in the RED stack, reducing the power output up to 60% in the first few days of operation. To run the RED stack at a stable and high performance level, fouling control needs to be developed based upon modification of the chemistry of the membranes. The combination of sophisticated lab scale equipment and the opportunity to work with real feedwaters opens up new opportunities to study and to overcome issues related to membrane fouling.

The aim of this PhD project is to investigate the influence of the chemistry of RED membrane materials on fouling in natural conditions. In particular, it involves the study of the interactions taking place at the membrane-feed interface and the development of suitable membranes to control these interactions. Newly designed membrane materials and surface modifications will be implemented in the RED system for optimal RED performance with natural feedwaters.

Figure 1: Schematic illustration of the working principle of RED. River water and seawater flow alternately in channels separated by anion and cation exchange membranes (AEMs and CEMs, respectively), which enable selective transport of anions and cations. The ionic current flowing inside the stack is converted in an electrical current by a redox couple at the electrodes.

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