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Subject Area	Wasseraufbereitung
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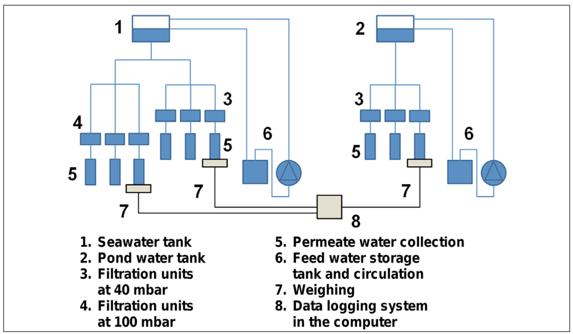
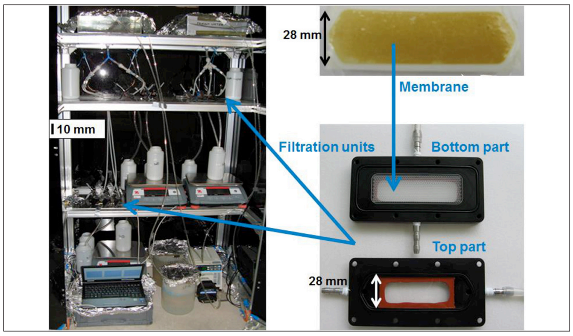
Ultralow-energy membrane pre-treatment for seawater reverse osmosis (SWRO)

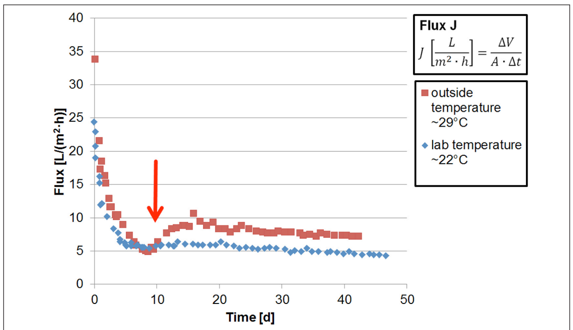
Student exchange project HSR-NTU



Overview of the experimental set-up running at a temperature of +22 °C and +29 °C



Set-up (left) and constructed membrane filtration units (right). Membranes are placed at the bottom part which is sealed with the top part.



Flux J of seawater at 100 mbar and 22 °C and 29 °C. After 10 days of operation, the system at 29 °C was relocated (red arrow).

Introduction: Gravity-driven membrane (GDM) filtration, which allows the feed water to pass through the membrane by its gravitational force, is increasingly used for the production of drinking water in developing and emerging countries. This study proposed the application of this technique as a pre-treatment method for SWRO. Previous studies indicated that at these low pressures, the biological community within the filtration units played an important role in fouling layer control. The goals are to evaluate if flux stabilization takes place during dead-end, low-pressure ultrafiltration of seawater, and the influence of temperature and pressure on the filtration performance.

Proceeding: Seawater and pond water were used as water feed and compared. The filtration performances and biofilm morphologies were compared at two different temperatures (22 °C and 29 °C) and two different pressures (40 mbar and 100 mbar). The GDM system consisted of a feed water tank, dead-end filtration units and permeate bottles. Flat sheet polyethersulfone (PES) membranes with a pore size of 100 kDa were used. Permeability (P), flux (J) and temperature corrected flux values (J_{20}) were calculated. The thickness of the fouling layer was monitored with optical coherence tomography (OCT) and the morphology via confocal microscopy. The biotic community structure of the fouling layer was observed in order to determine higher organisms feeding on bacteria.

Result: After one week of filtration, the permeate flux stabilized. The measured flux of GDM fed with either seawater or pond water was always higher at ~29 °C than at ~22 °C: The flux of GDM fed with seawater and a transmembrane pressure of 100 mbar at ~29 °C was 7.4 $Lm^{-2}h^{-1}$ and 4.7 $Lm^{-2}h^{-1}$ at ~22 °C. Using 40 mbar and seawater the flux was 5.4 $Lm^{-2}h^{-1}$ at ~29 °C and 3.6 $Lm^{-2}h^{-1}$ at ~22 °C. Similar results were obtained using 40 mbar and pond water. The results show that higher temperature and higher pressure cause higher flux in GDM. The morphology of the fouling layer became more heterogeneous during operation time. A diverse and active community of bacteria, heterotrophic and autotrophic protists as well as metazoans could be observed within the filtration chambers. It is suitable to use GDM filtration as a pre-treatment method for reverse osmosis, but the application still needs to be optimized.