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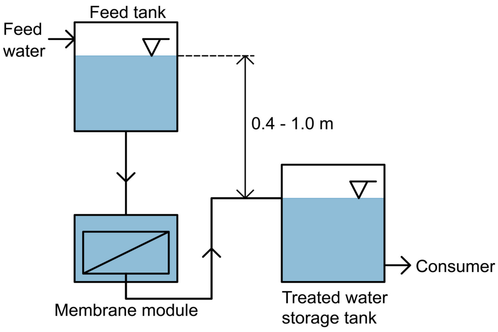
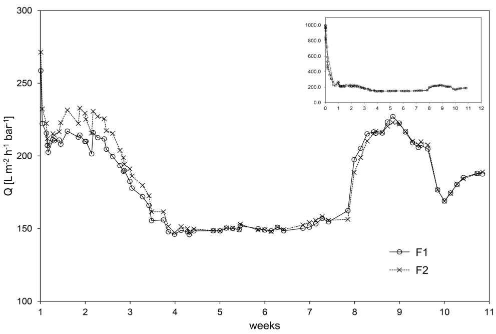
Subject Area	Water treatment
Project Partner	NTU, SMTC, Singapur

Ultra low energy membrane pre-treatment for seawater reverse osmosis (SWRO)

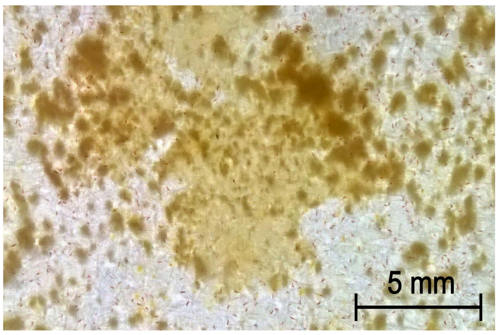
Enhancing permeate quality and establishing a novel method for AOC measurement in seawater



Working principle of gravity-driven membrane filtration. A hydrostatic pressure creates the necessary driving force for membrane filtration.



Permeability of the two membrane modules F1 and F2 tested. Flux decrease is followed by stable flux and flux recovery.



Bacterial colonies on the membrane surface. Eukaryotes are visible as oblong dark spots.

Introduction: Reverse osmosis for seawater desalination (SWRO) plays an increasingly important role for the provision of drinking water to a growing world population. The technology has been perfected over the past decades and is close to the theoretical minimum in terms of energy demand. However, SWRO still consumes large amounts of energy. The high operational costs have so far excluded energy-scarce developing countries from employing SWRO. Besides, the technology is being criticised for its ecological impact which stems from the intake of large amounts of seawater and the release of chemicals, sometimes in sensitive marine habitats. Potential for lessening both the resource and the environmental impact lies in pre- and post-treatment processes. Gravity-driven membrane filtration (GDM), an operating mode of ultrafiltration requiring no energy and no chemicals, is seen as a promising alternative for existing pre-treatment processes. GDM relies on the microbial community living in the membrane's biofouling layer which fosters conditions leading to a stable flux over long periods of time.

Approach/Technologies: The main purpose of pre-treatment in SWRO is the elimination of foulants, e.g. assimilable organic carbon (AOC) and transparent exopolymer particles (TEP), which lead to permanent fouling and scaling of RO membranes. Previous experiments with GDM as a pre-treatment method for SWRO have demonstrated AOC removal using submerged flat-sheet membranes. This thesis builds on previous research combining submerged flat-sheet membranes with an additional tank containing a submerged biofilm carrier. The increased biofilm volume in the tank is expected to further improve AOC removal. To measure AOC concentrations throughout the experimental setup, a novel method employing flow cytometry for bacterial counting is established further and assessed for reproducibility.

Result: The current experiment has shown a comparatively high stable flux and an unexpected flux recovery after two months of operation. These effects can be linked to a diverse eukaryotic community in the system. The concentration of TEP in the feed water has been lowered to levels comparable with alternative pre-treatment methods. AOC removal could not be confirmed. Nevertheless, trends for AOC and dissolved organic carbon (DOC) as a whole towards the end of the experiment looked promising. Long-term observation, allowing full development of the biofilm on the carrier, is necessary for a final statement on AOC removal.