NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE | Nanyang Environment and Water Research Institute

Low-Energy Desalination
Pilot-Scale Investigation of Semi-Closed Reverse Osmosis (SCRO) for Low-Energy, Low-Fouling, and Highly Adaptive Seawater Desalination

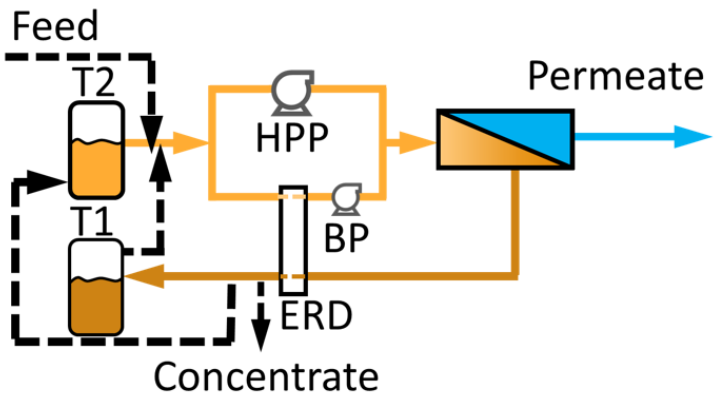
Abstract:
Seawater desalination is one of the major sources of freshwater supply for Singapore. However, it is the most energy-intensive process among all the water taps. According to PUB, the current energy consumption during seawater desalination is 3.5 kWh per m^3 freshwater production, among which desalination stage via the prevailing single-stage reverse osmosis (SSRO) design consumes 2.5 kWh/m^3. In this project, we aim to validate a novel semi-closed reverse osmosis (SCRO) process, which was patented in our previous research, for lowering energy consumption of seawater desalination via pilot-scale testing and investigation. The proposed project is an extension of our prior and on-going studies on modelling and laboratory testing of our invented SCRO. The preliminary results show that SCRO can potentially reduce more than 25% energy consumption and membranes undergo much lower fouling when compared with conventional SSRO.

The proposed pilot testing will explore two major scenarios for SCRO applications: (1) retrofitting existing SSRO-based desalination plants, and (2) implementing optimized SCRO in new SWRO desalination plants. We will first validate the system stability and robustness during SCRO operation.

Then we will establish optimized system design and operating parameters for SCRO via systematical investigation of various performance-limiting factors. We will also explore the benefits of the unique feature of SCRO that allows the treatment of intermediate brine for mitigating fouling/scaling, improving boron removal, and reducing chemical consumption. According to modelling, it is expected that the optimal SCRO operation could not only save energy consumption but also be more adaptive to varying feed conditions.

The success of this project can help place Singapore in the forefront of developing innovative low-energy seawater desalination technology in the world and significantly reduce carbon emissions in Singapore's desalination industry.

Proposed technology



Semi-Closed Reverse Osmosis (SCRO)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- **Overall objective:** Following our on-going lab-scale studies of SCRO, this project aims to further demonstrate various advantages of SCRO, such as low energy consumption, low fouling and high adaptiveness to varying feed quality, via systematic **pilot-scale** investigations.

- **Scope:**
  - Testing the scenario for retrofitting existing SWRO plants
  - Test and optimization of the scenario for constructing new SWRO plants based on SCRO process
  - Explore all the advantages of SCRO.