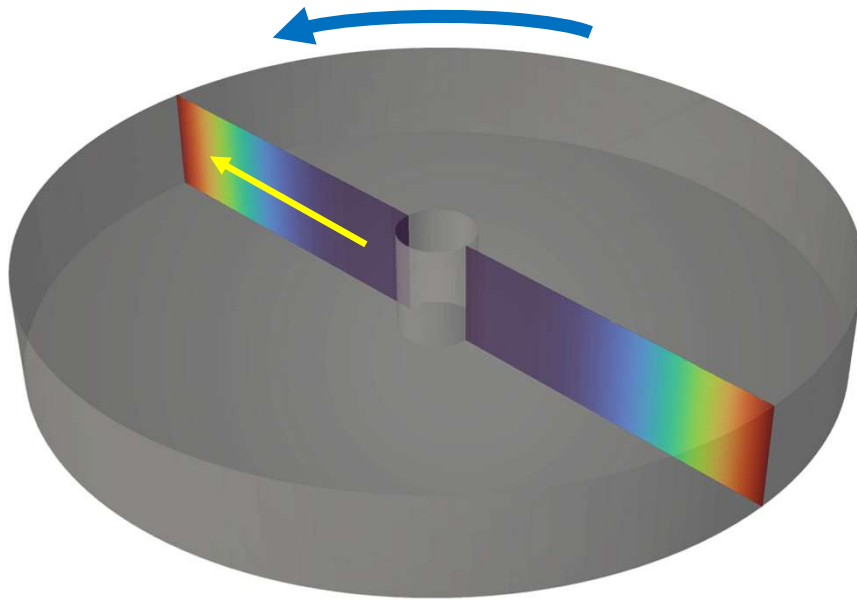


Integrated Tidal Desalination: Harvesting Ocean Energy with Zero Electrical Conversion

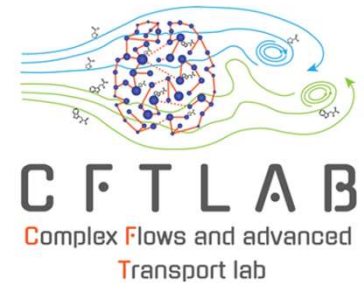


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Alperen Turkyilmaz

Cosan Daskiran, Ph.D.

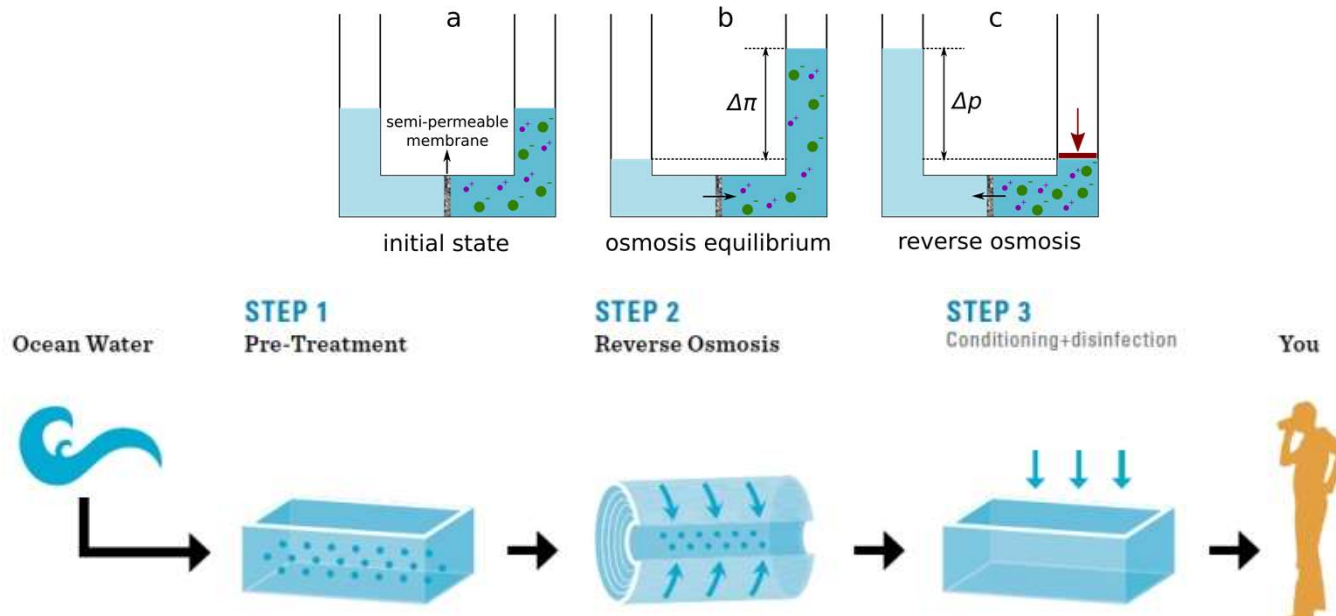
Mustafa Usta, Ph.D.



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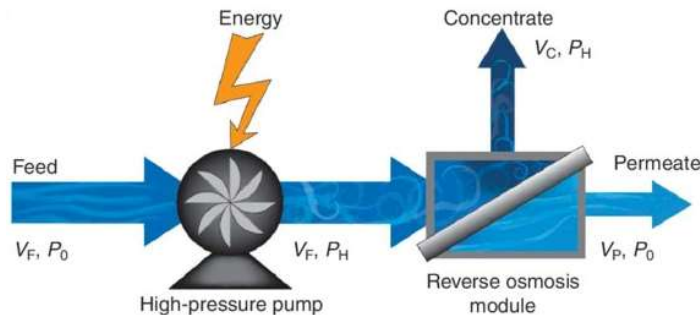


Reverse Osmosis Desalination

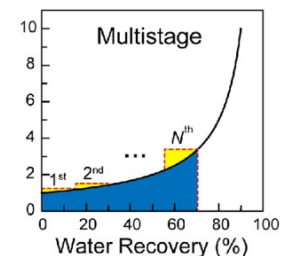
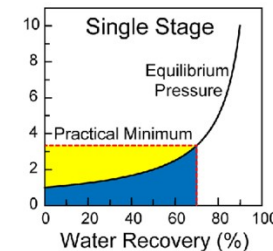
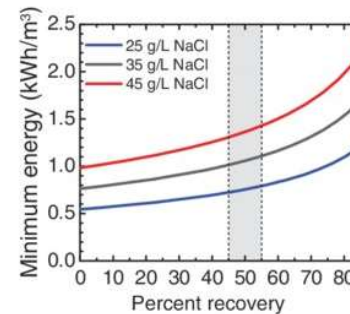
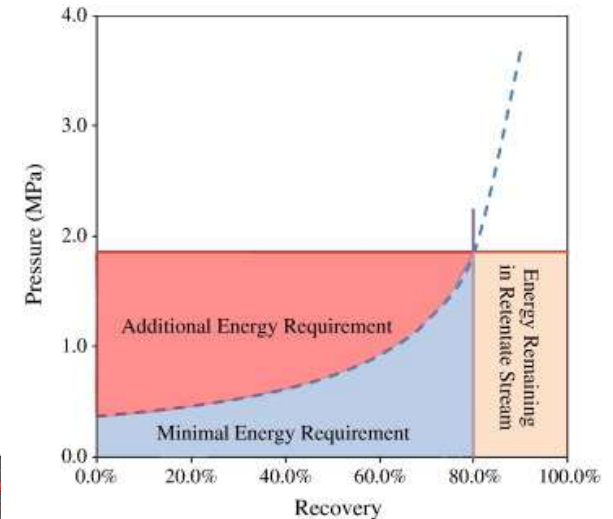
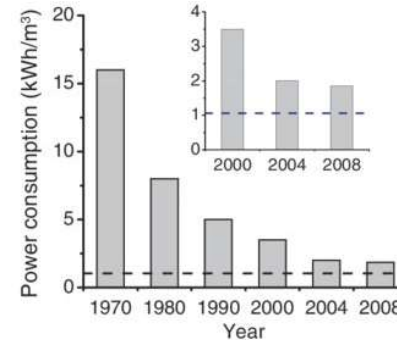


- Among many other methods Reverse Osmosis (RO) sidesteps the hurdle of solution heating and becomes one of the prominent and leading process.
- Relies on applying pressure to separate clean water from feed water that may include brackish, seawater, and wastewater.
- The pressure requirements up to 200 bars makes this process energy intensive.

Reverse Osmosis Desalination



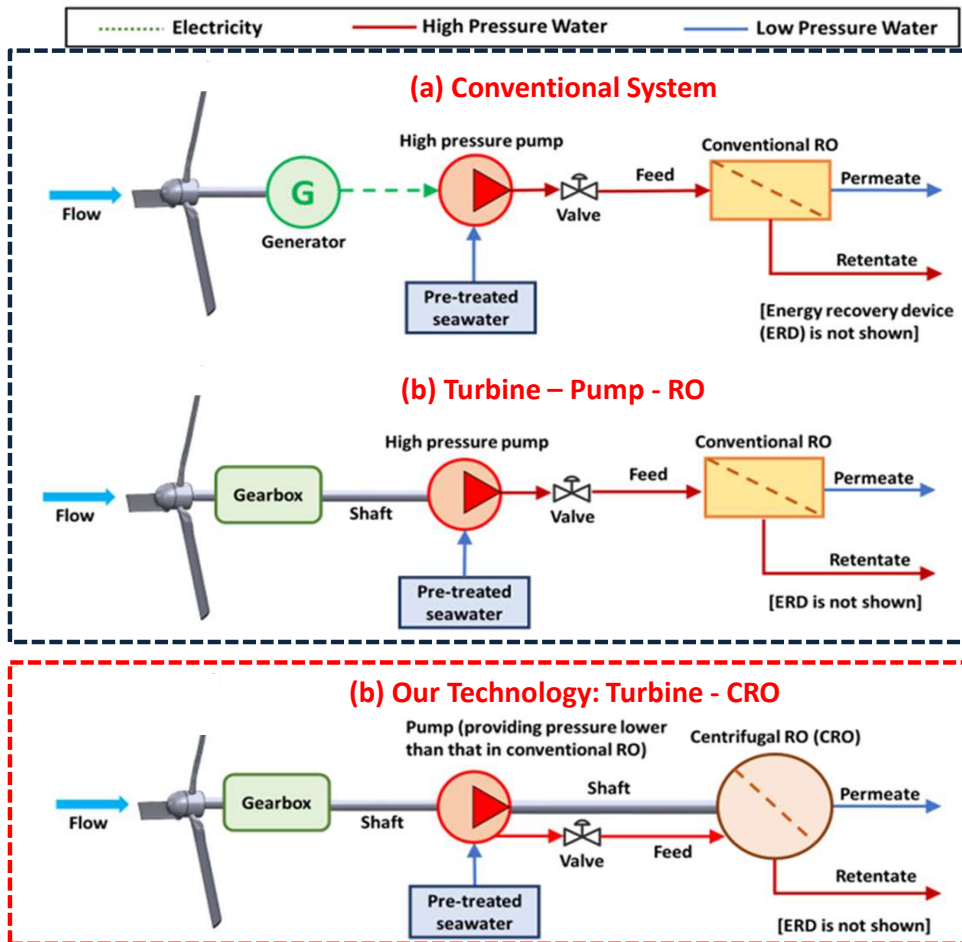
- RO systems operate under a uniform transmembrane pressure to achieve target water recovery.
- Literature identifies this uniform pressure application as a key source of thermodynamic and mechanical energy inefficiency.
- Multi-stage RO configurations mitigate pressure mismatch but introduce additional complexity, capital cost, maintenance cost, and inter-stage energy losses.
- Current research primarily focuses on optimizing membrane selectivity and incorporating energy recovery devices.
- Despite advances, pressure generation still dominates energy consumption and leads to energy waste.



M. Elimelech, W.A. Phillip, The Future of Seawater Desalination: Energy, Technology, and the Environment. Science 333,712-717(2011). DOI:10.1126/science.1200488

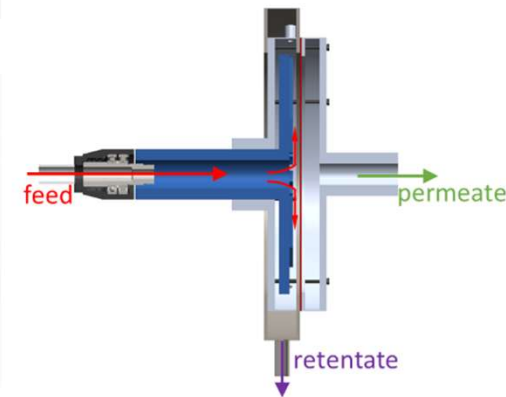
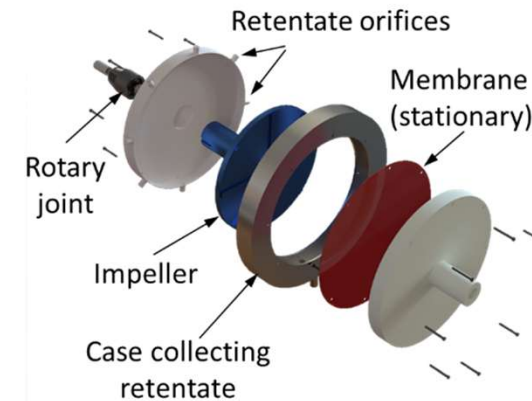
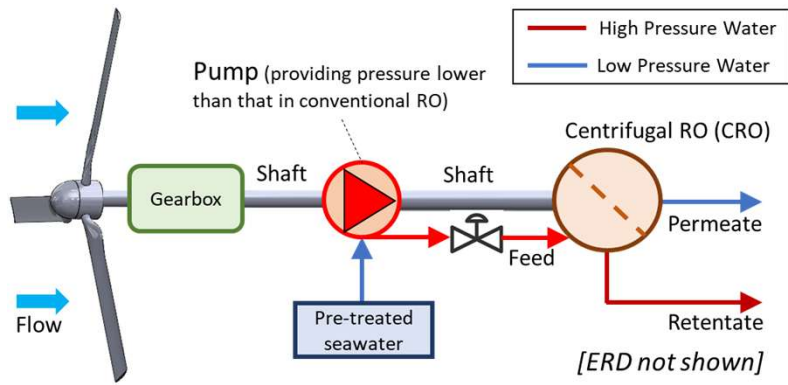
C. Liu, K. Rainwater, L. Song, Energy analysis and efficiency assessment of reverse osmosis desalination process, Desalination, 276, 352-358 (2011). DOI10.1016/j.desal.2011.03.074.

Desalination Systems – RO/CRO



- Conventional systems harness tidal energy and convert it into electricity to drive high-pressure pumps for RO.
- Integrated systems aim to forward tidal energy directly to high-pressure pumps without electrical conversion.
- Centrifugal RO system utilize tidal energy to directly rotate the centrifugal module, assisted by a pump operating at significantly lower pressure compared to conventional or integrated systems.

Desalination Systems – RO/CRO



- CRO module functions as a rotating pressure exchanger, leveraging angular momentum to pressure feedwater across a radial path.
- This architecture eliminates the need for electricity generation, avoiding conversion inefficiencies entirely.
- Rotation of the module establishes a continuous pressure gradient, closely following thermodynamic efficiency and thereby minimizing energy losses.