

Water Desalination Energy & Environmental Challenges



Methods of desalination

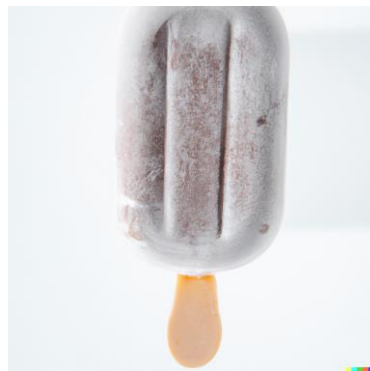
Thermal methods:

- MED/MSF

Feed > Heat > Vapor > Fresh water

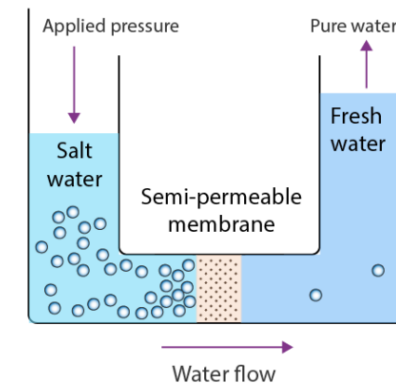
- Vacuum freezing (VFVC)

Feed > Freezing > Vacuum > Fresh water

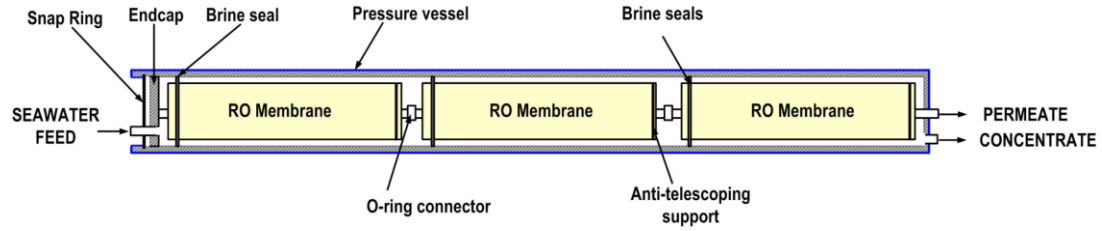
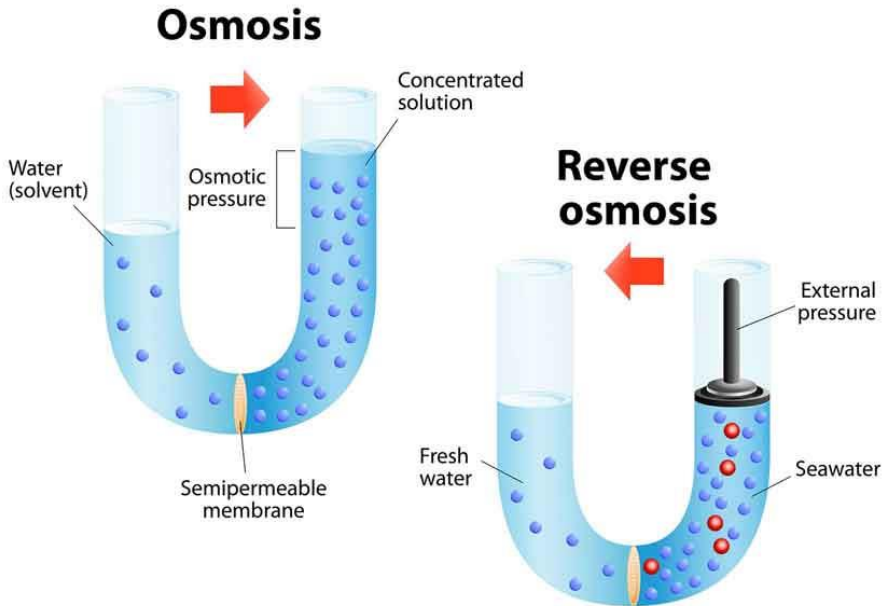


- Reverse Osmosis method:

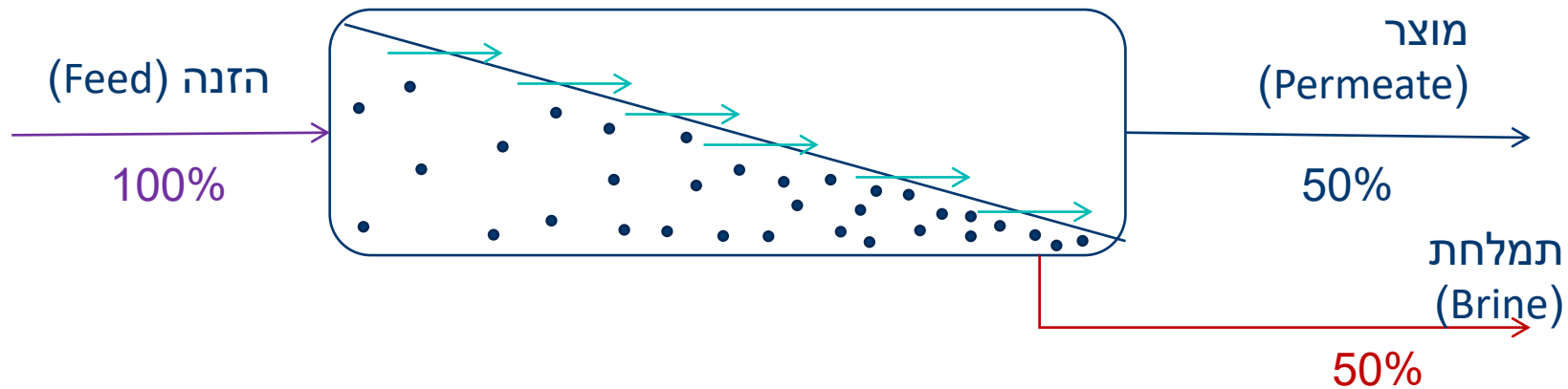
Feed > Pressure > Fresh water



How does reverse osmosis work?



Recovery Rate



$$\%Recovery = \frac{Q_{Permeate}}{Q_{Feed}} = \frac{Q_{Permeate}}{Q_{Permeate} + Q_{Brine}}$$

Energy Challenges

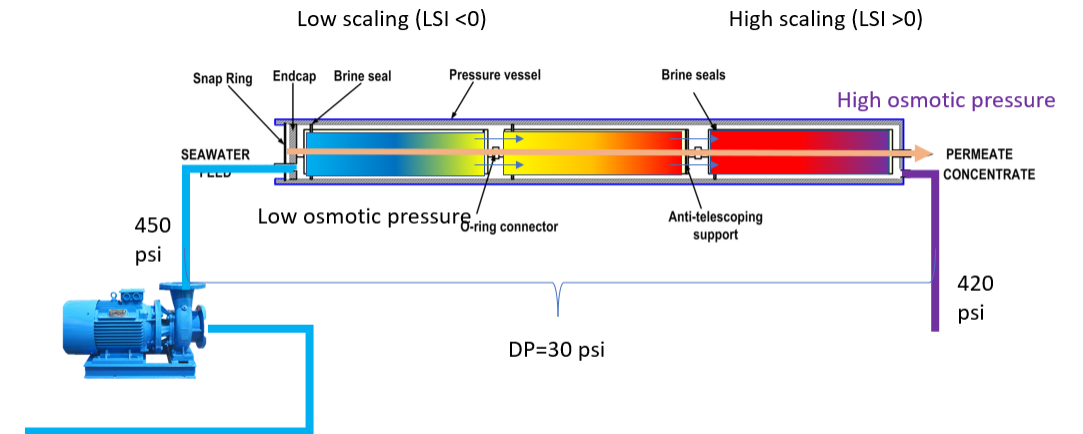
- Fact:
- Large desalination facilities desalinate $\sim 50,000 \text{ m}^3/\text{h}$
- \pm Olympic pool every 2 minutes...
- Problems:
- How much energy it takes to evaporate that much water? ($\sim 1.15 \text{ US\$ per m}^3$)
- How much energy it takes to pressurize that much water? ($\sim 0.63 \text{ US\$ per m}^3$)
- Specific energy = $\sim 3.2 \text{ kWh/m}^3$

Environmental Challenges

- Fact:
 - Large desalination facilities desalinate $\sim 50,000 \text{ m}^3/\text{h}$
 - \pm Olympic pool every 2 minutes...
 - 50% of the water will go back as brine
- Problems:
 - Chemicals as antiscaling agents (Phosphates), flocculants (Fe_2SO_4) and acids must be added.

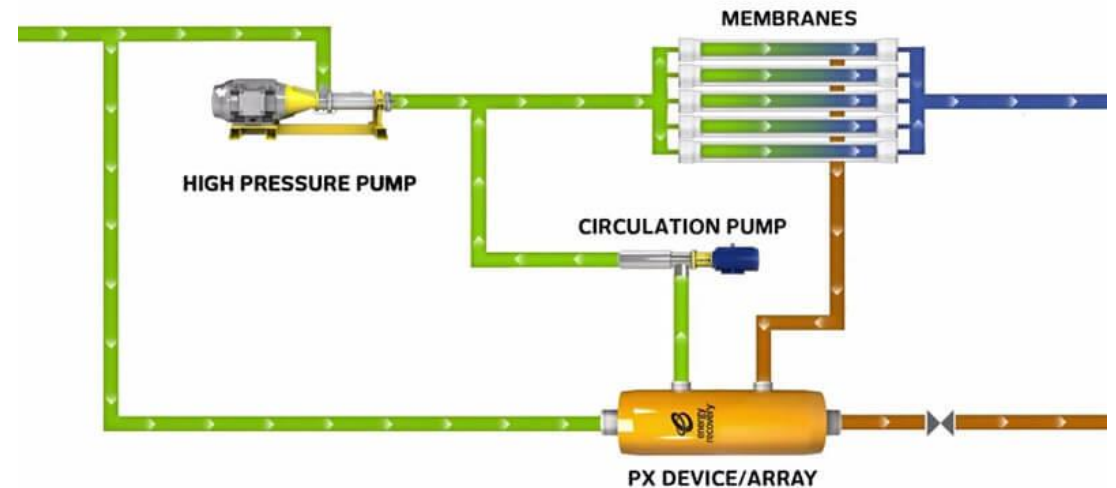
Why won't we work in higher recovery?

- Membrane scaling
- Higher concentration of brine stream
- Higher energy consumption

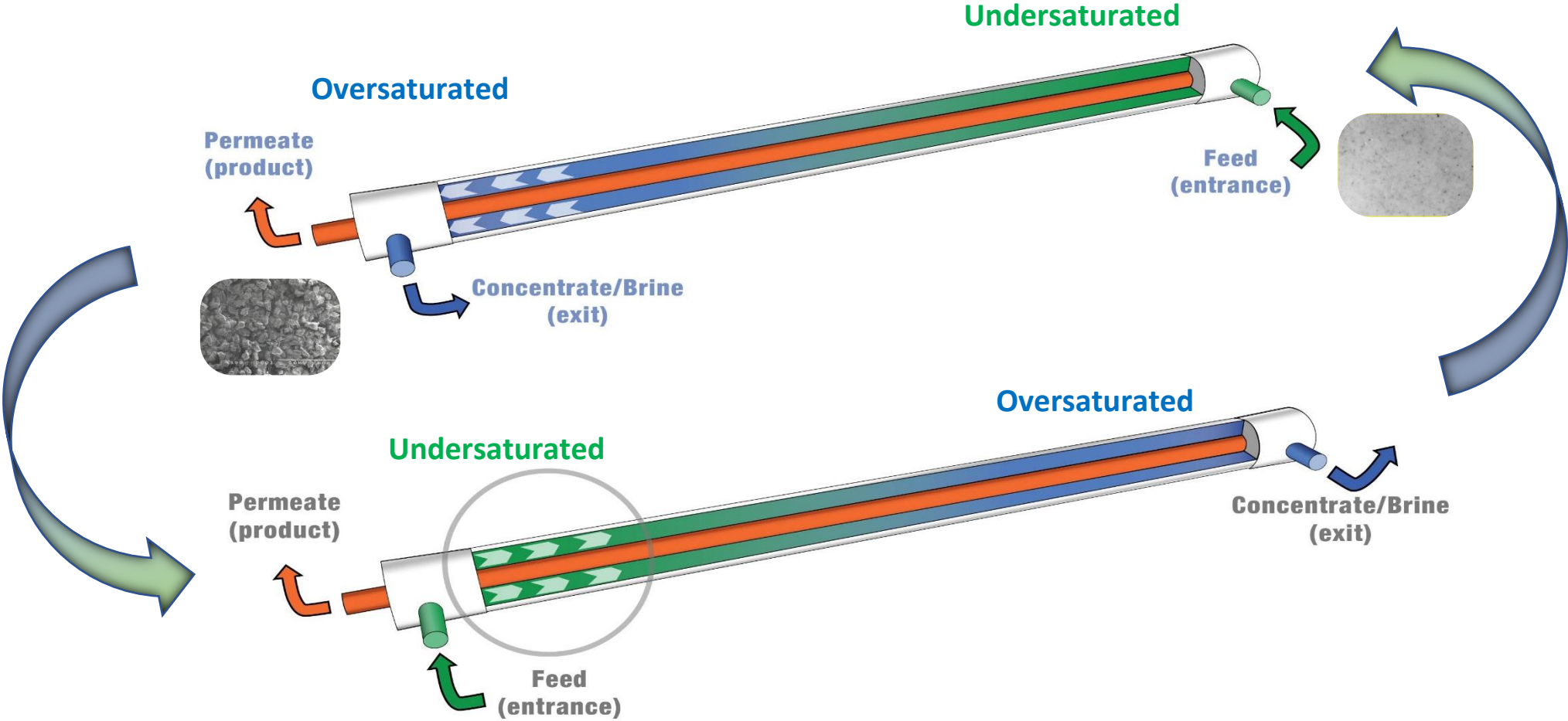


Energy Recovery

- Using the pressure from brine side to help pressurize inlet stream.
- 1) High pressure brine IN
- 2) Low pressure feed IN
- 3) High pressure feed OUT
- 4) Low pressure brine OUT

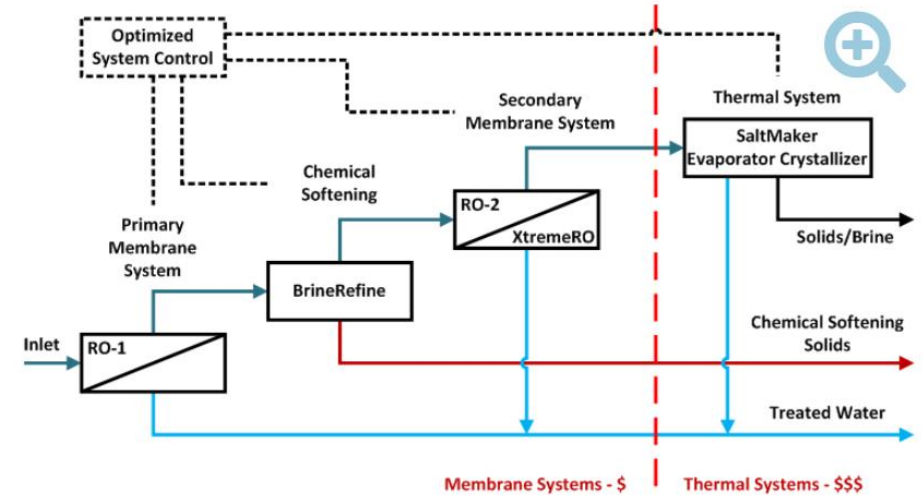


Extreme High Recovery without Scaling



ZLD / MLD

- Extreme high recovery can be used before evaporators / crystallizers and filter press in order to achieve Zero Liquid Discharge
- Still today require very high CAPEX and even higher OPEX
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Thank You!