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Reducing Environmental Impact in Desalination

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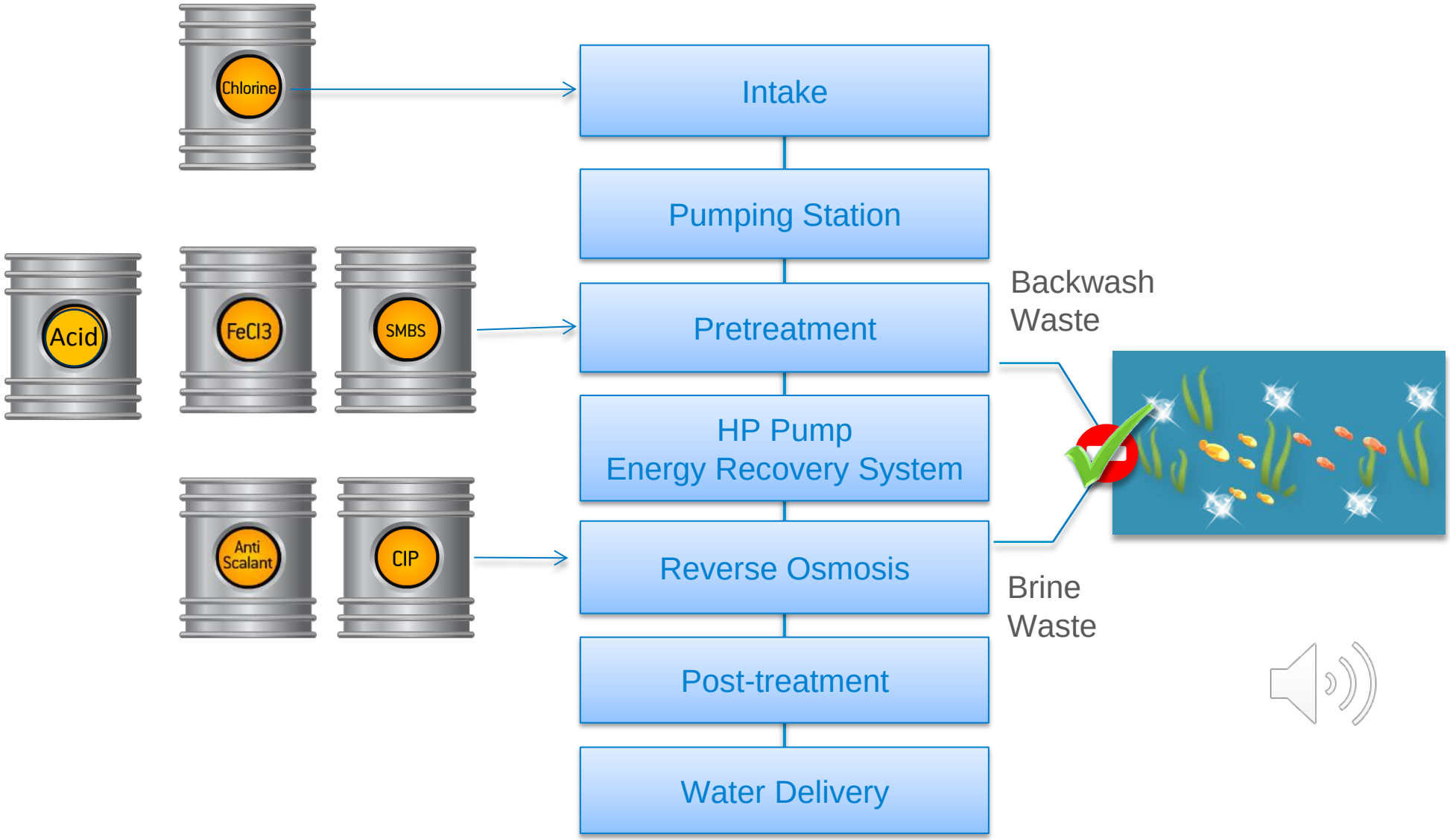
Main Goals of Desalination Plant Design

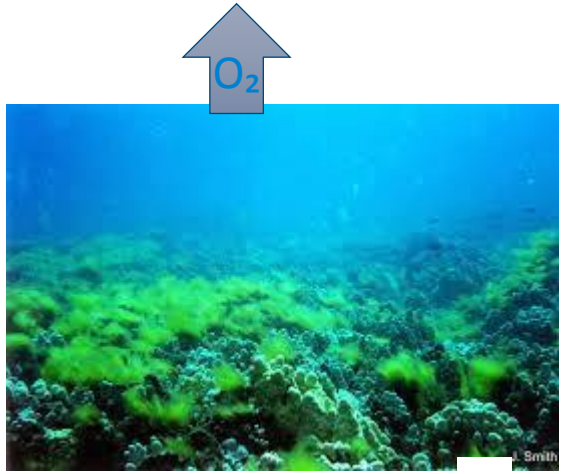
- Safe working conditions for staff
- Environmentally friendly operation
- Keeping the RO membranes clean
- Low power consumptions
- Low water cost

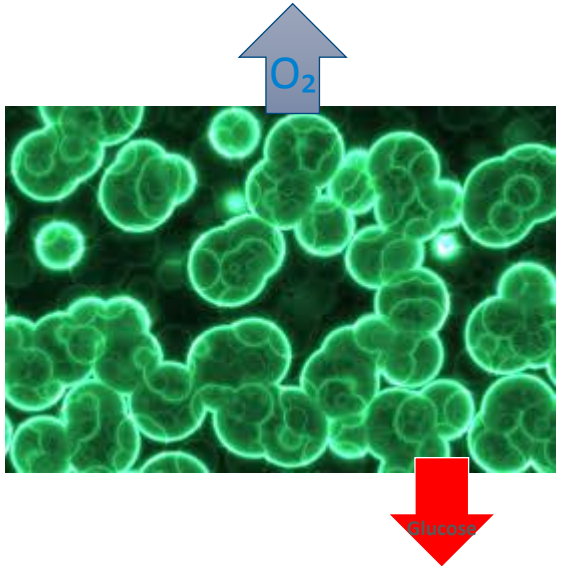
Chemicals in Conventional SWRO Plant Design

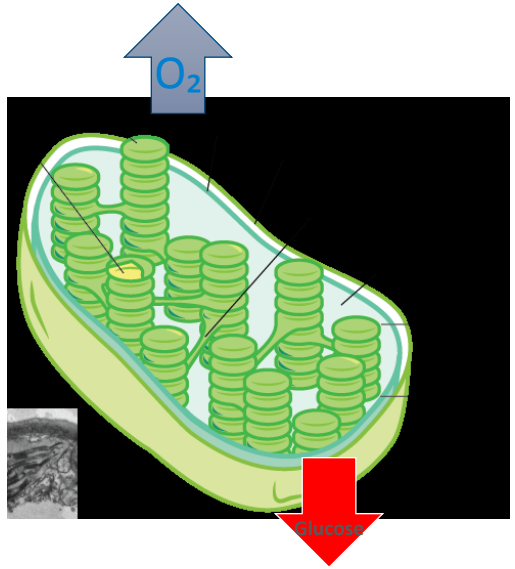


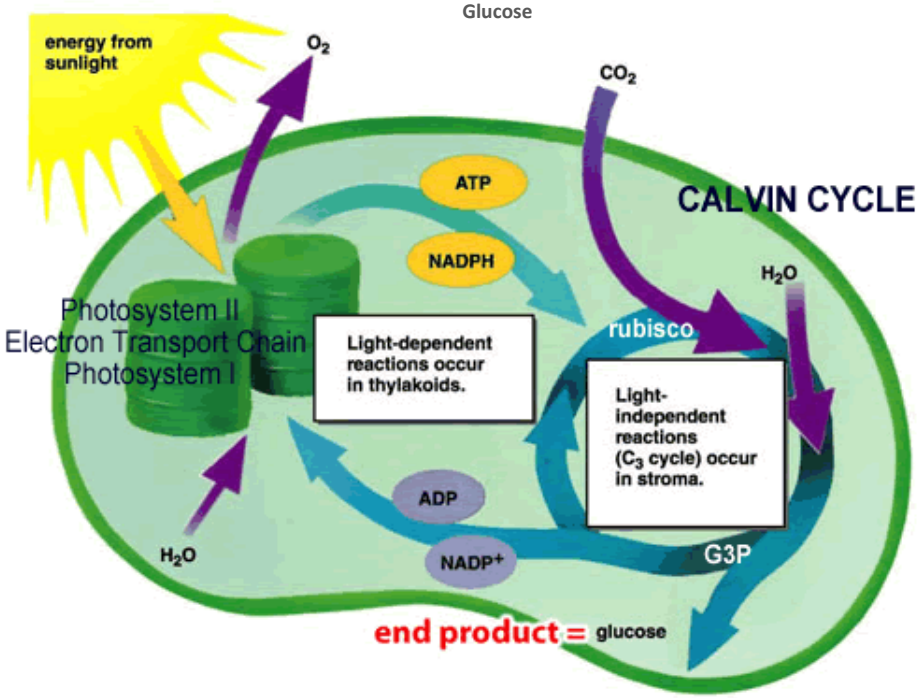
Super-saturation of Oxygen in Seawater

Used in pretreatment for safe and environmentally friendly operation





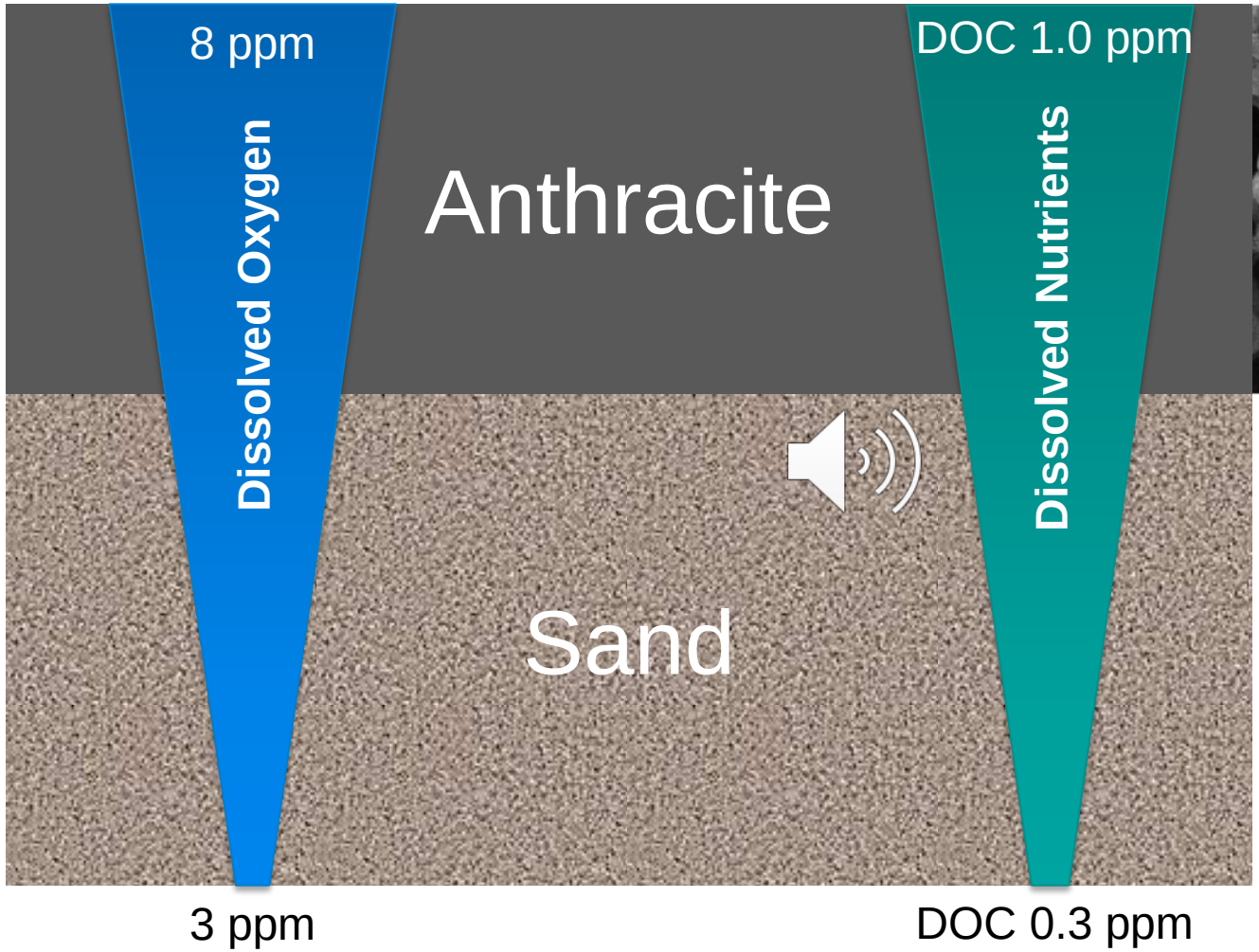


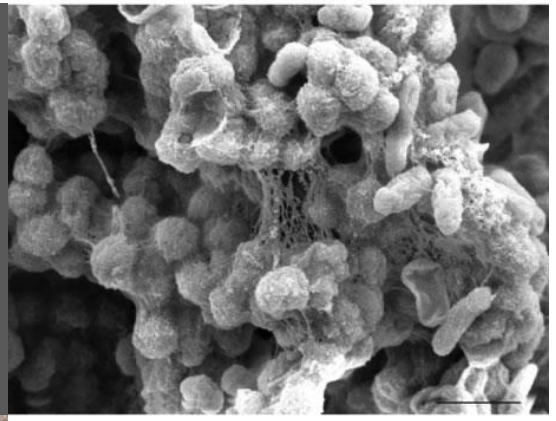


High concentration of oxygen and glucose in seawater due to photosynthesis

Media Filtration

- Bacteria consume nutrients and oxygen



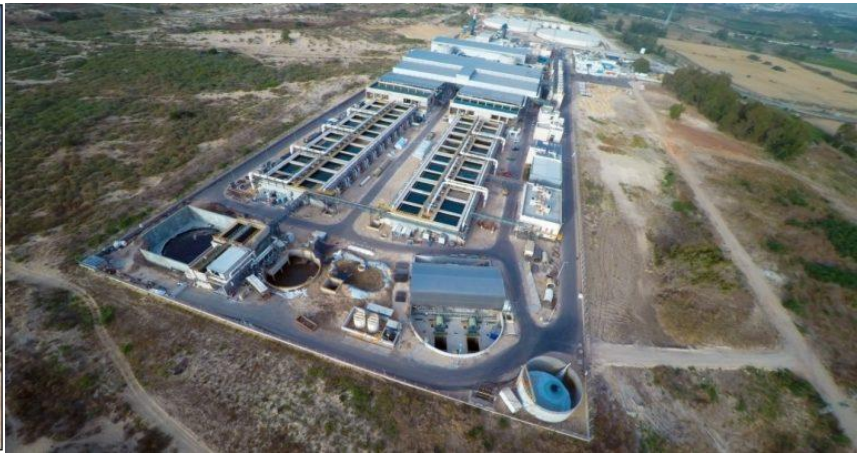


Pressure Center Design

Low power consumptions, low water cost achieved by Pressure Center Design

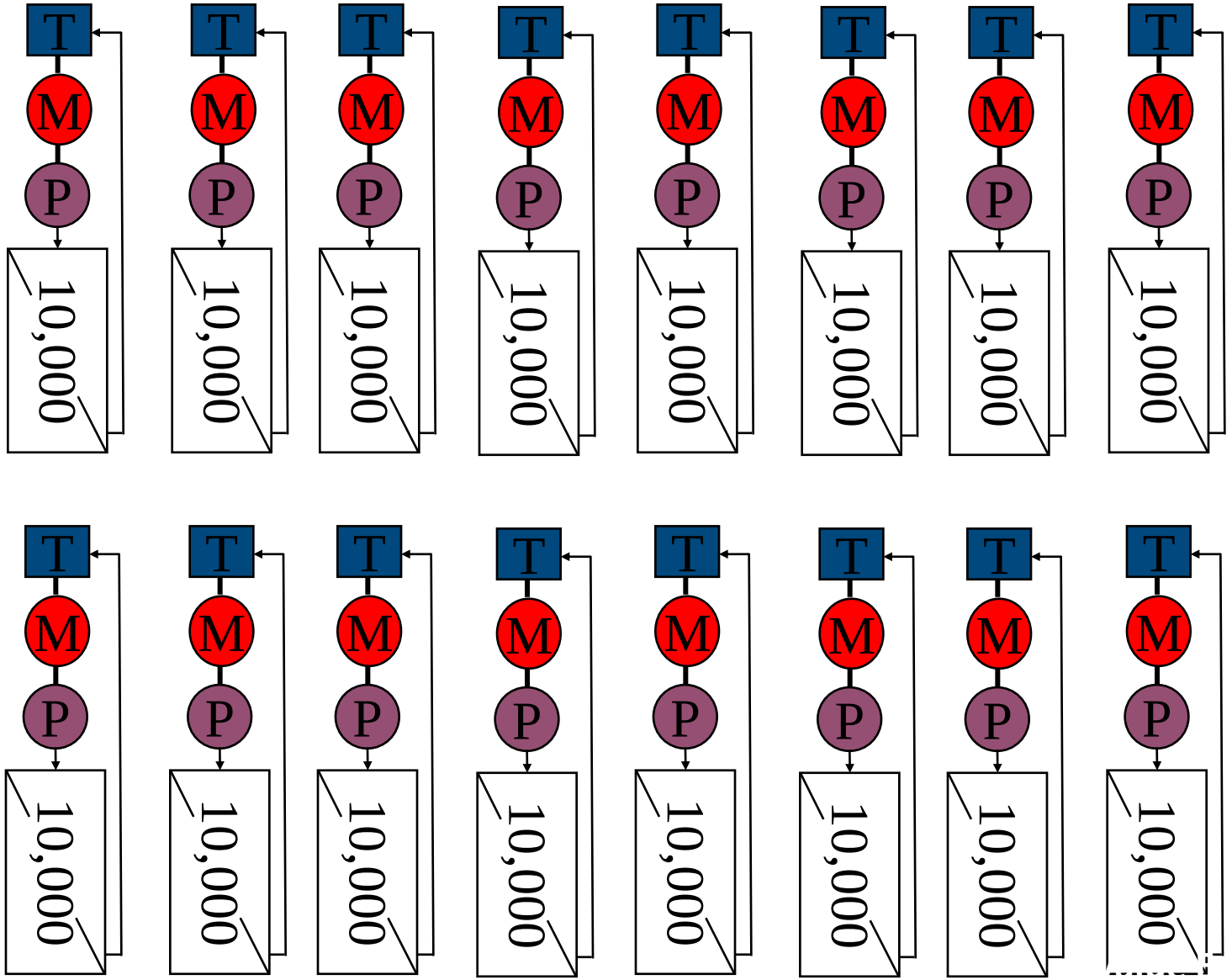
Ashkelon 400,000 m^3/day

Hadera 500,000m^3/day

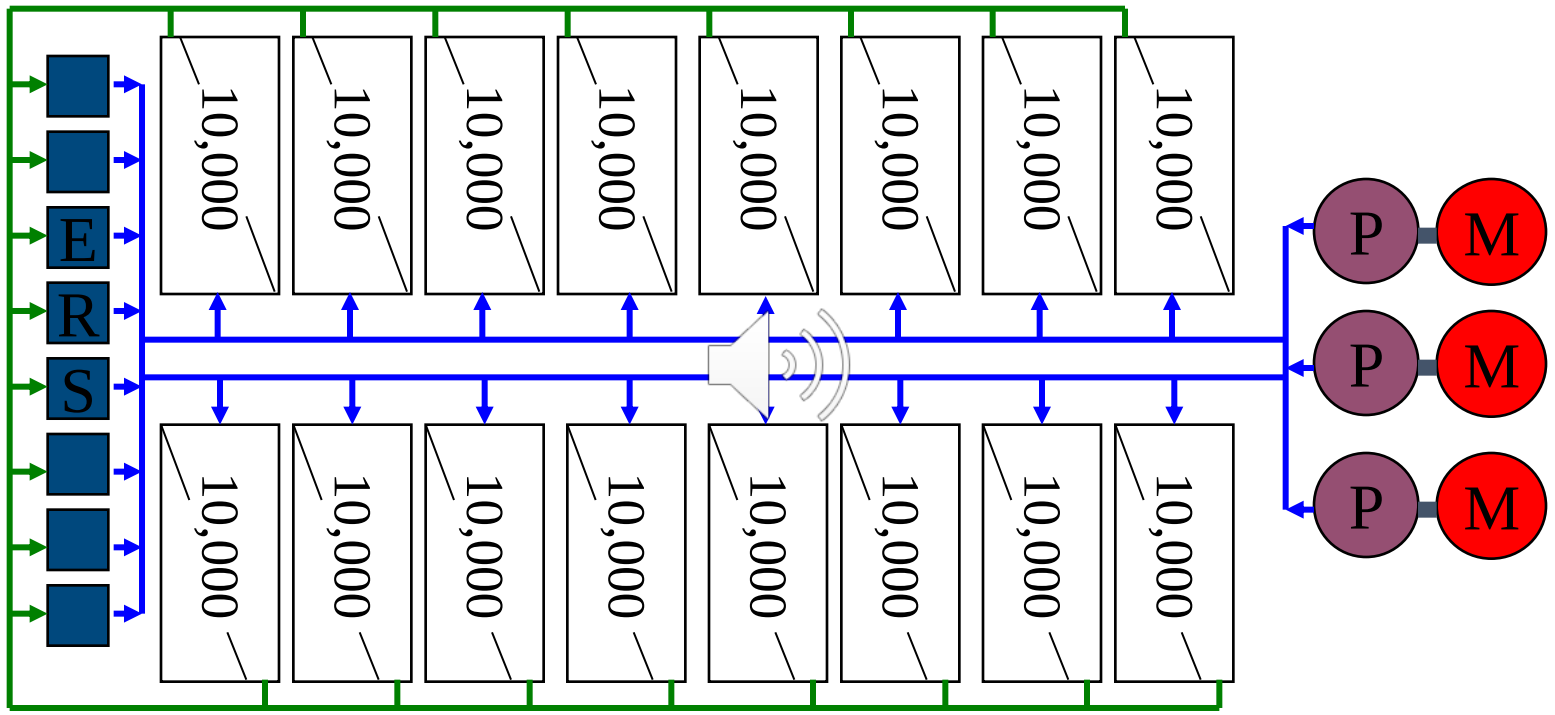


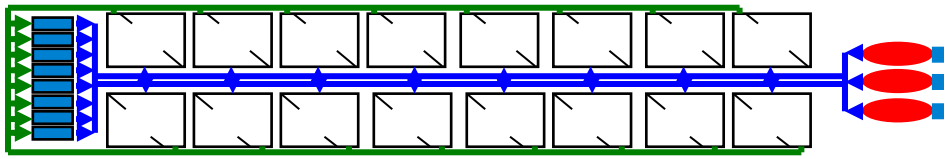
Sorek 600,000 m^3/day

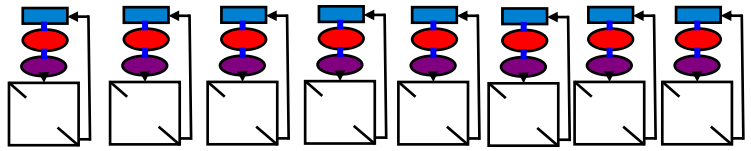
Conventional RO Plant Design: membranes, pump, motor, ERS



Pressure Center Design







Optimum Size of one RO Bank

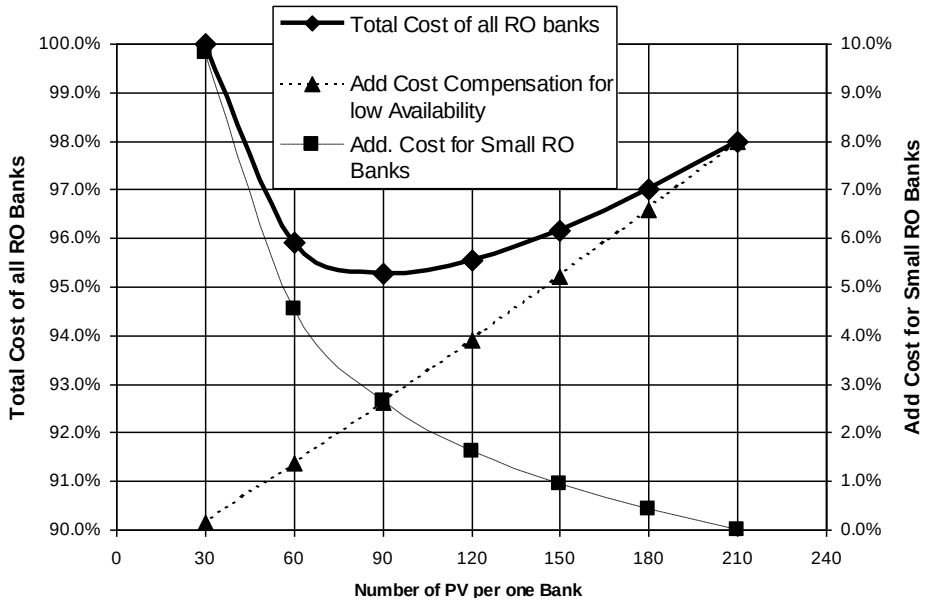
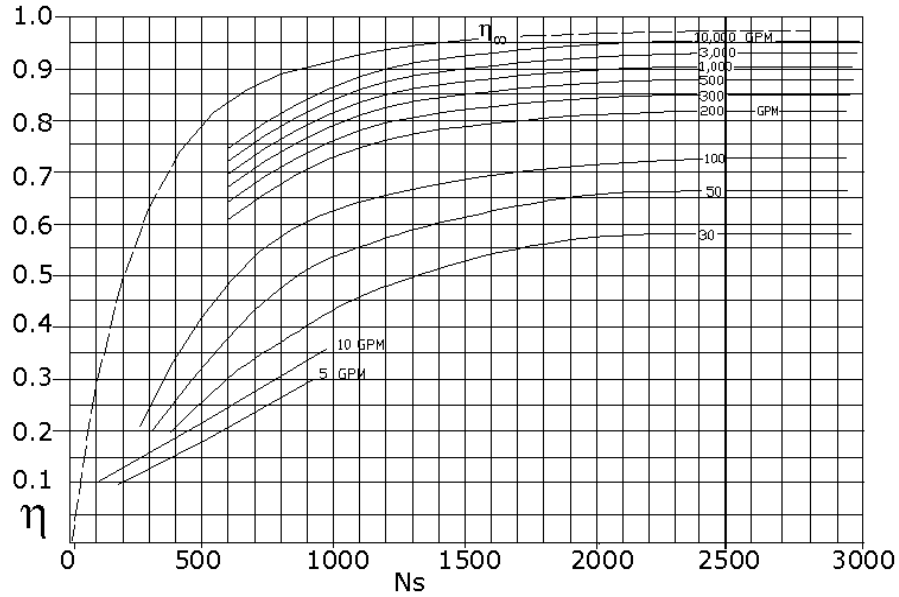


Figure 3 Pump efficiency as a function of specific speed and capacity.



Keeping RO Membranes Clean

- Physical methods instead of harsh chemicals
  - Direct Osmosis High Salinity - **DOHS**

    and
  - Direct Osmosis Cleaning - **DOC**

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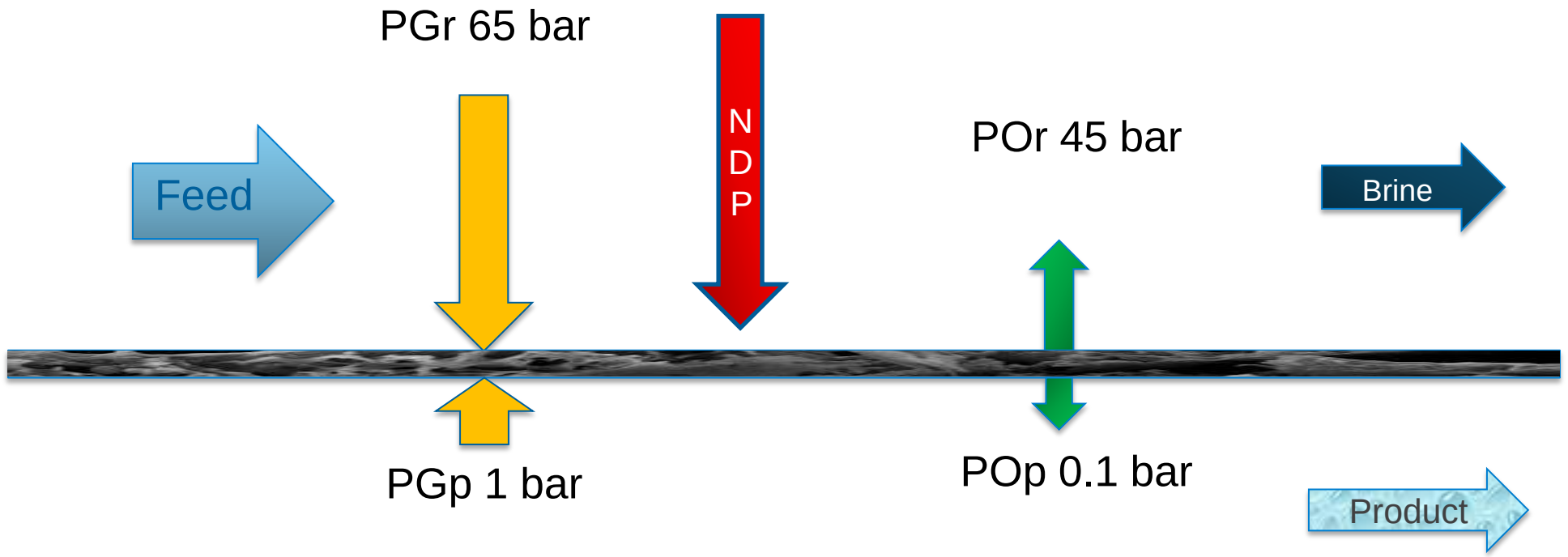
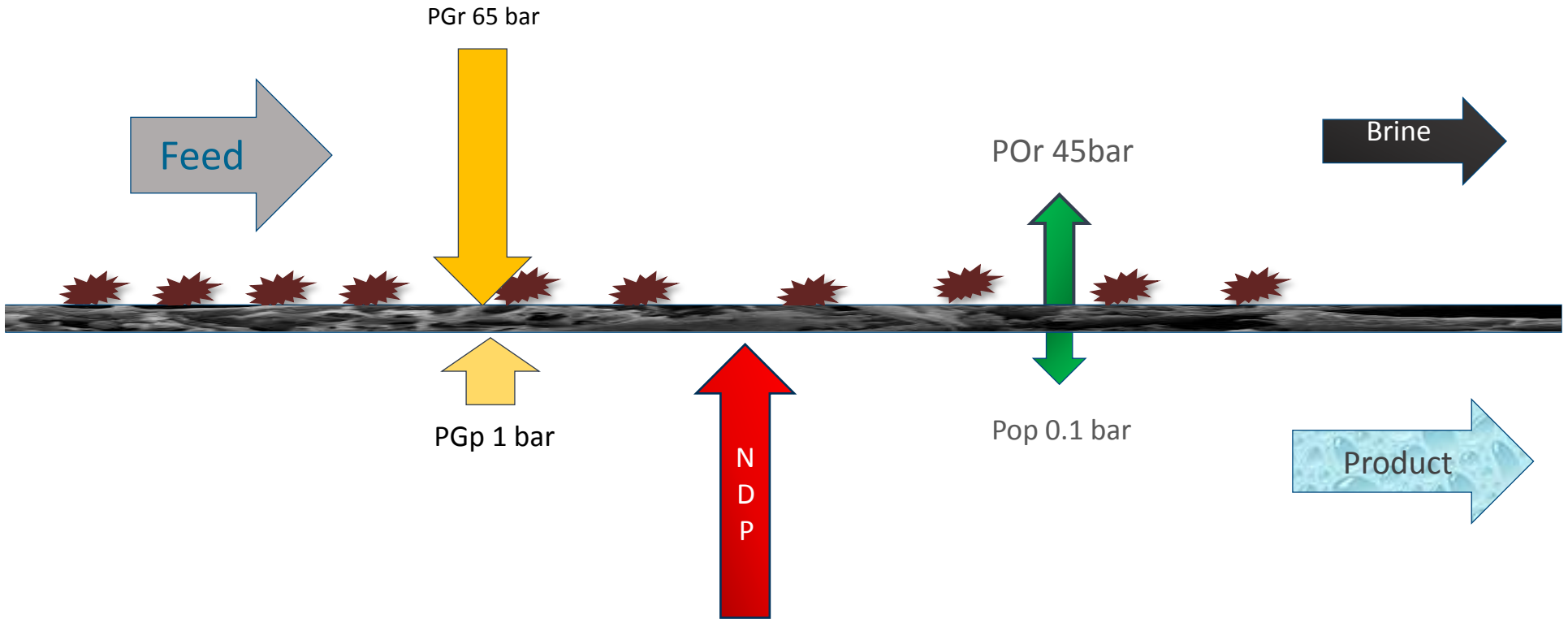
Normal RO Process



NDP_{RO} = PGr-POr-PGp+Pop

NDP_{RO} = 65 – 45 - 1 + 0.1 = **+**19.1 bar

DOHS – Direct (Forward) Osmosis High Salinity Osmotic Backwash



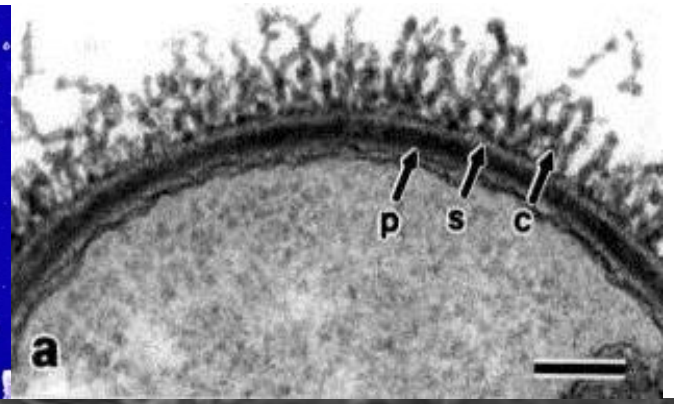
NDP_{RO} = PGr-POr-PGp+Pop

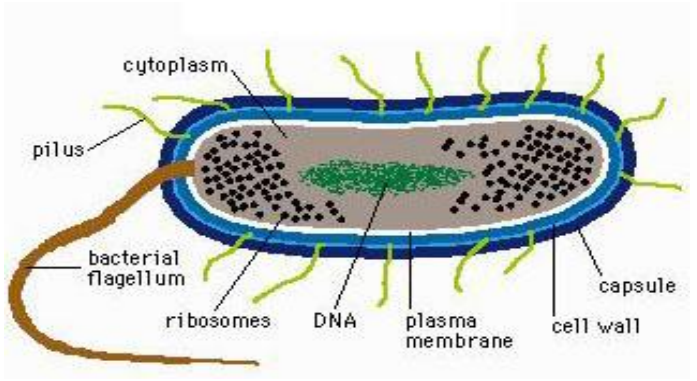
NDP_{RO} = 65 - 45 - 1 + 0.1 = **+** 19.1 bar

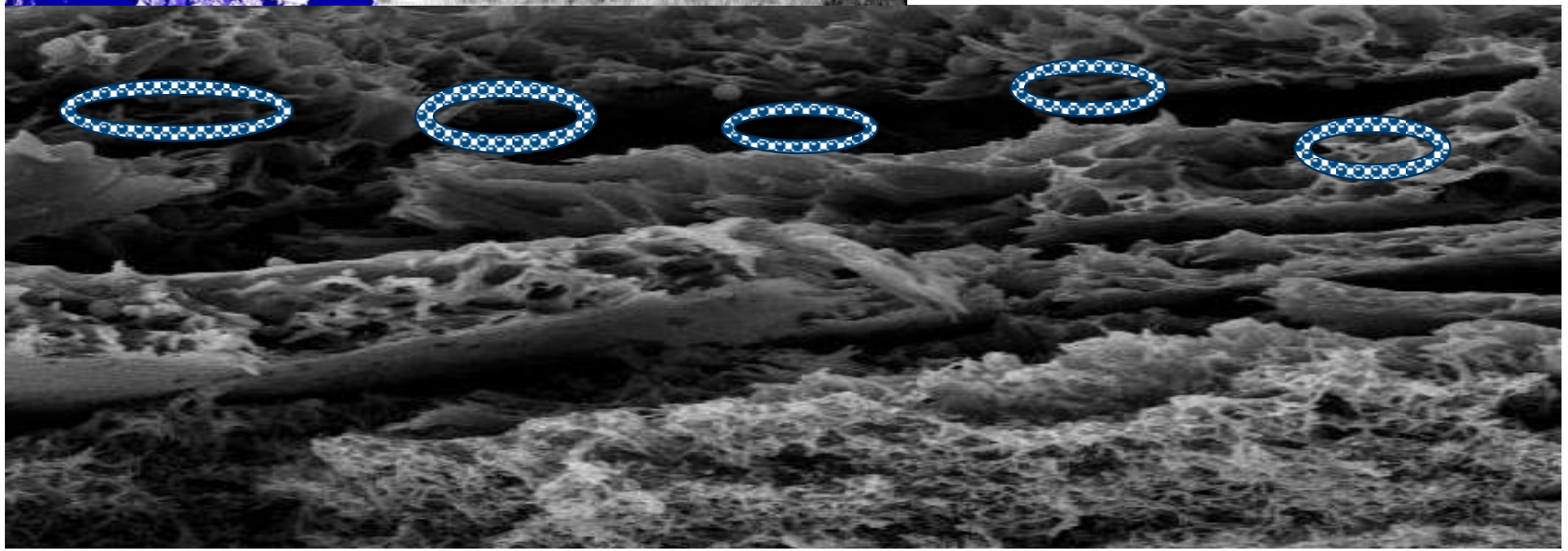
$NDP_{DO\ (FO)}$ = 65 - **100** - 1 + 0.1 = **-** 35.9 bar

USA Patent 7658852; Israeli Patent 169883; Singapore Patent; 153812 Australian Patent 2005254337;
Patent GB 2519880; PCT/IB2015/055665; WO/2016/024179;

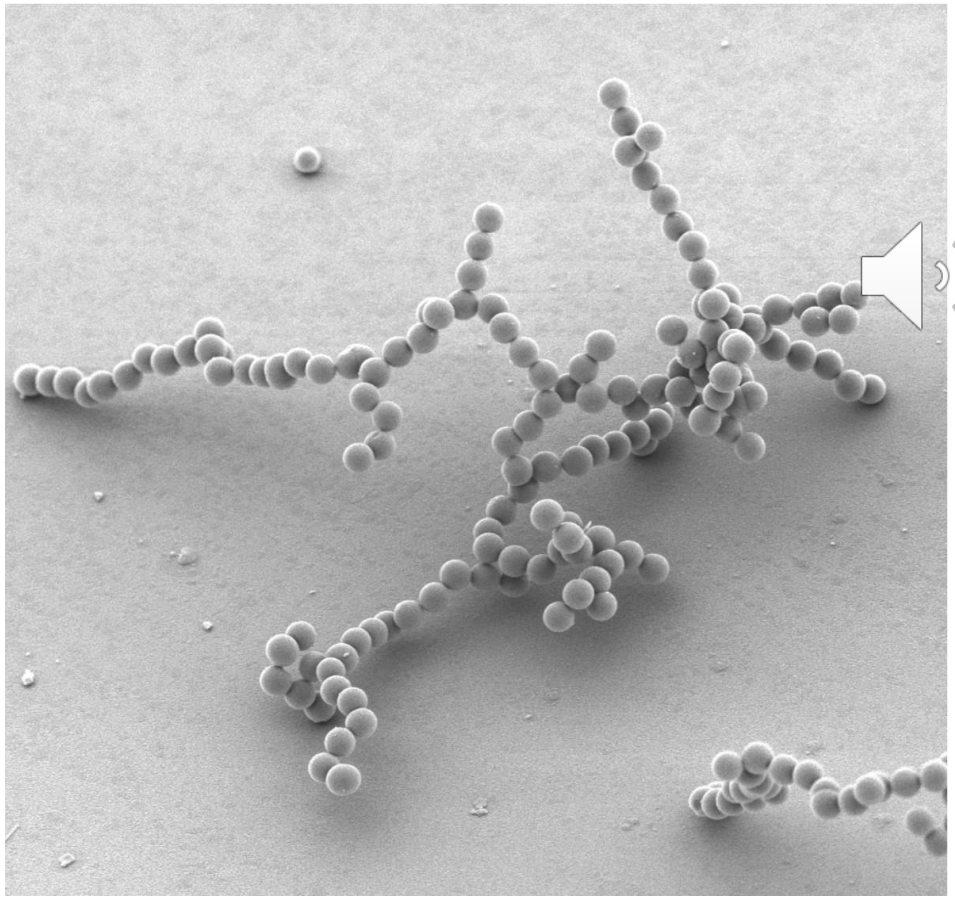
Osmotic Dehydration of Bacteria

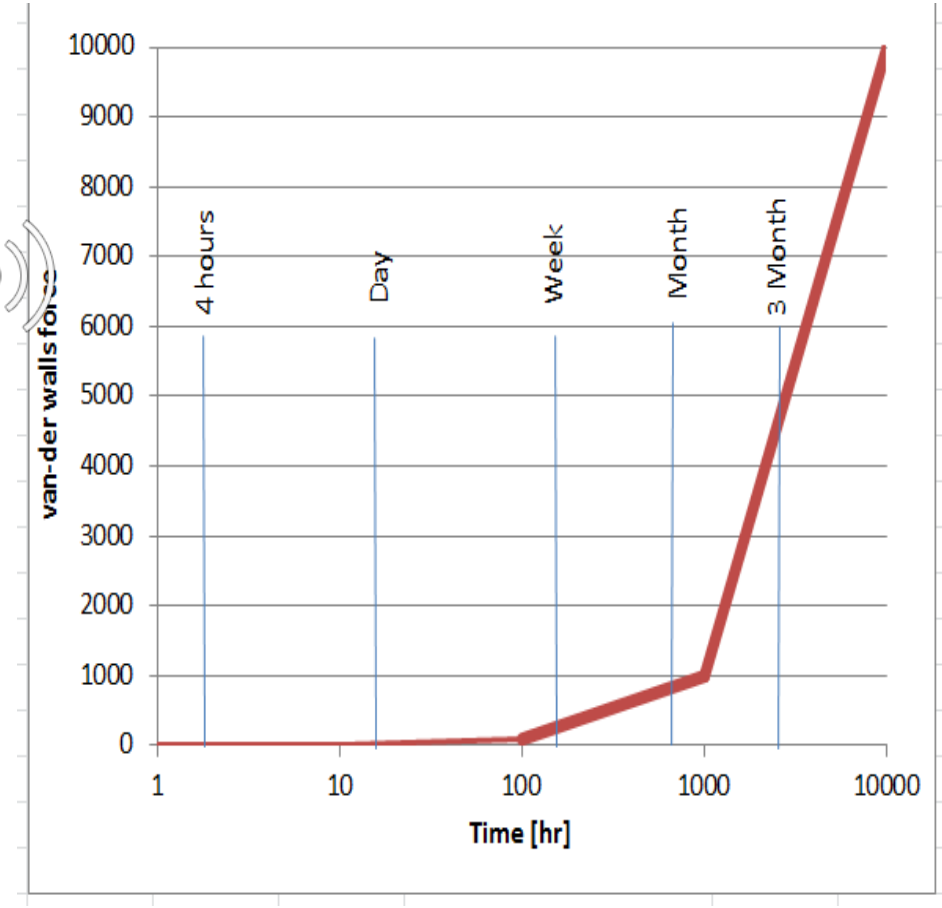




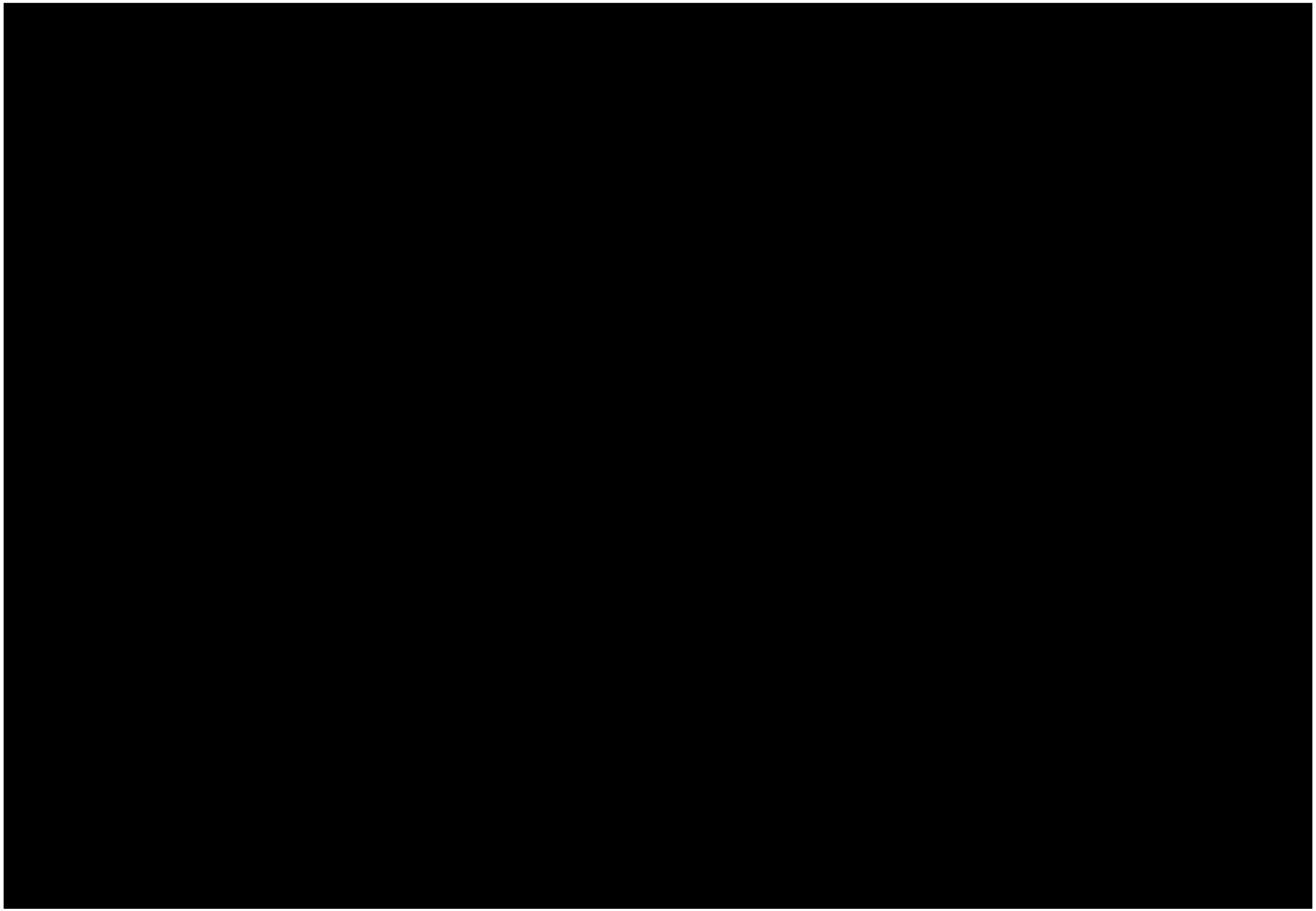


Frequent removal of particles before a strong Van der Waals interaction is created with the surface





RO Membrane Direct Osmosis Cleaning

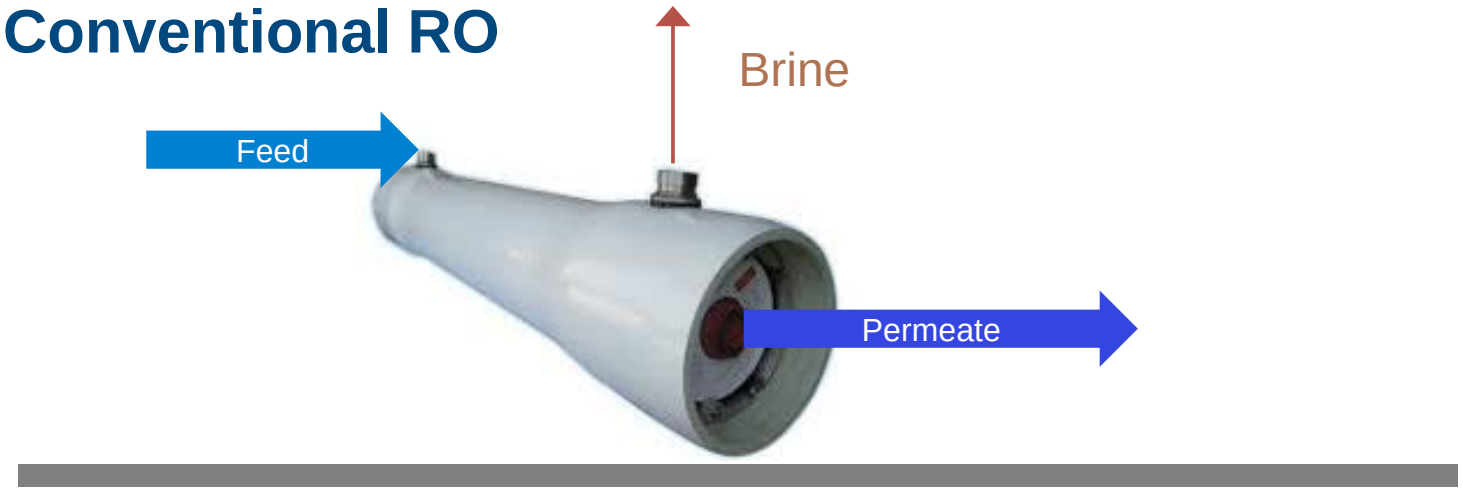


Pulse Flow RO Technology Implementation

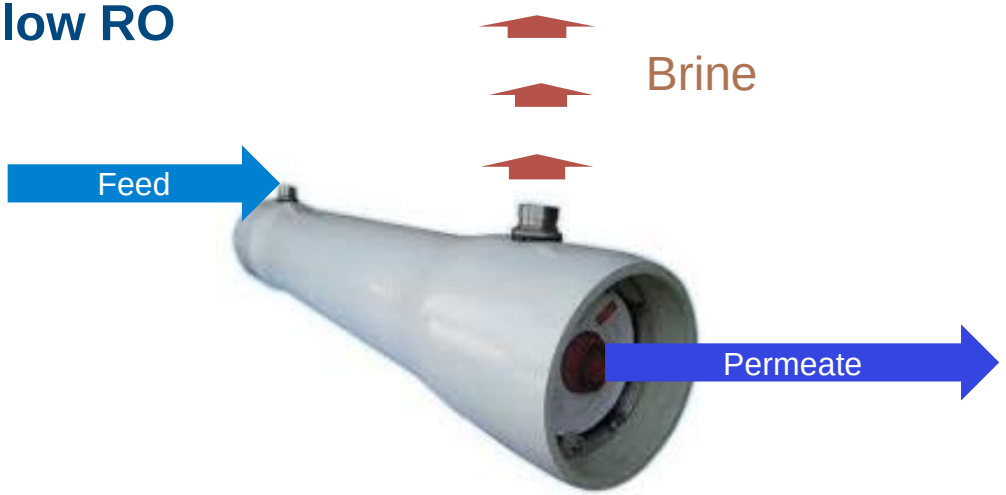
- In wastewater applications allows:
  - Chloramine free water reuse desalination
  - Up to 95% recovery in single stage operation
  - High flux operation 28 LMH
  - 100% transmission of UV light
  - 20% saving in water cost

- In brackish water applications allows:
  - Extremely high recovery operation

Conventional RO

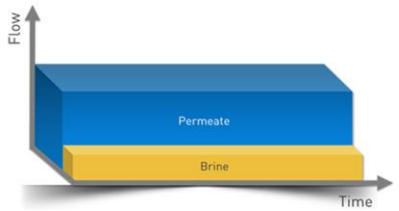


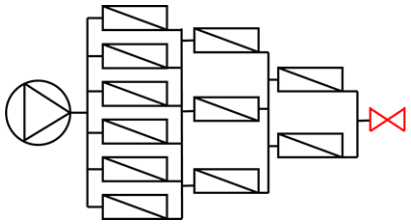
Pulse Flow RO



Conventional RO vs Pulse Flow RO

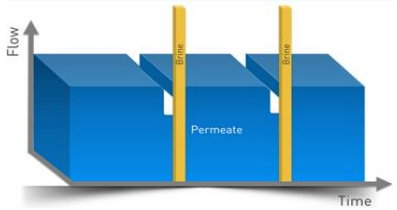
Continuous brine discharge

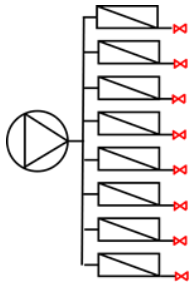




90% Recovery
Multi stage

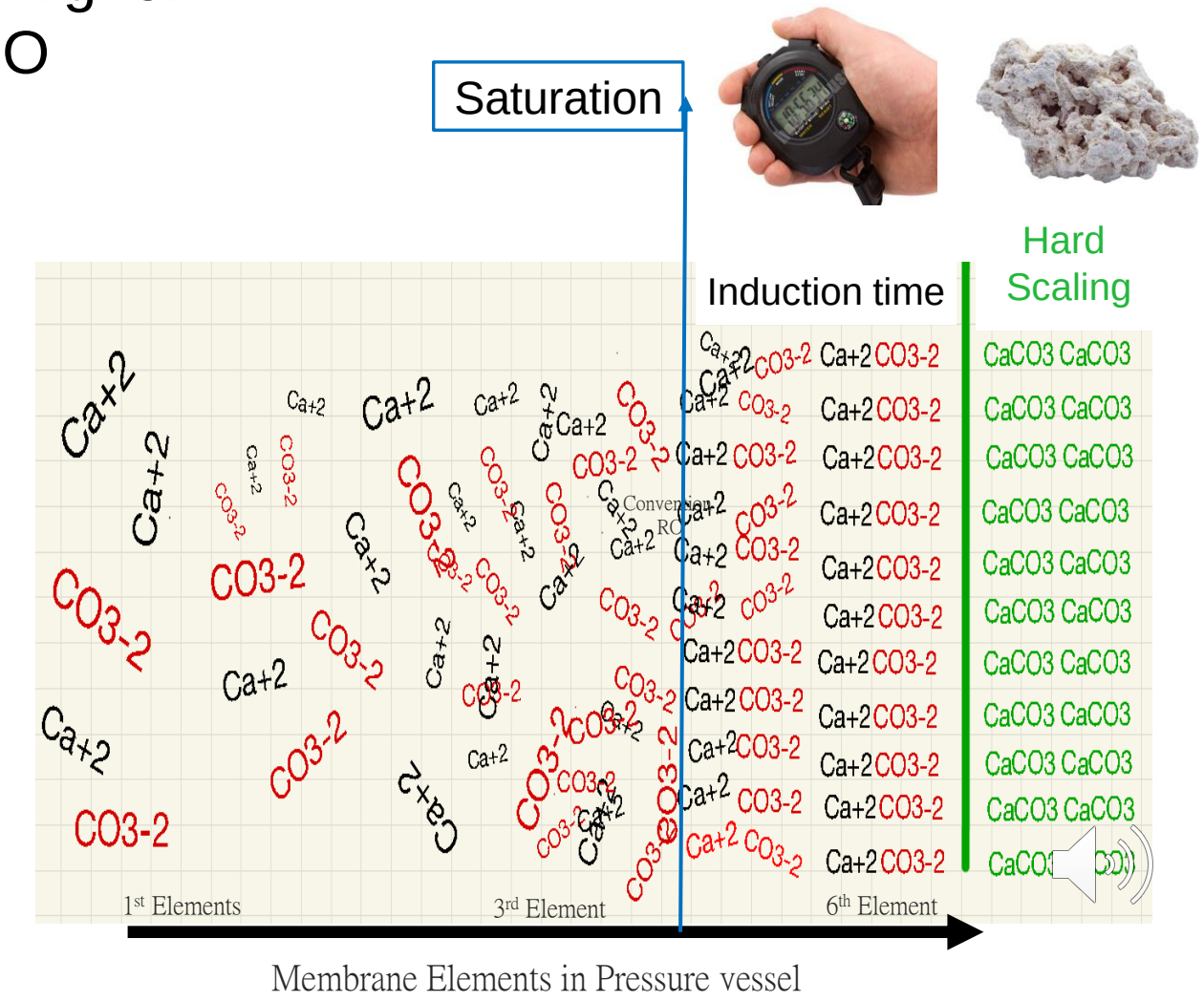
Brine discharge in pulses



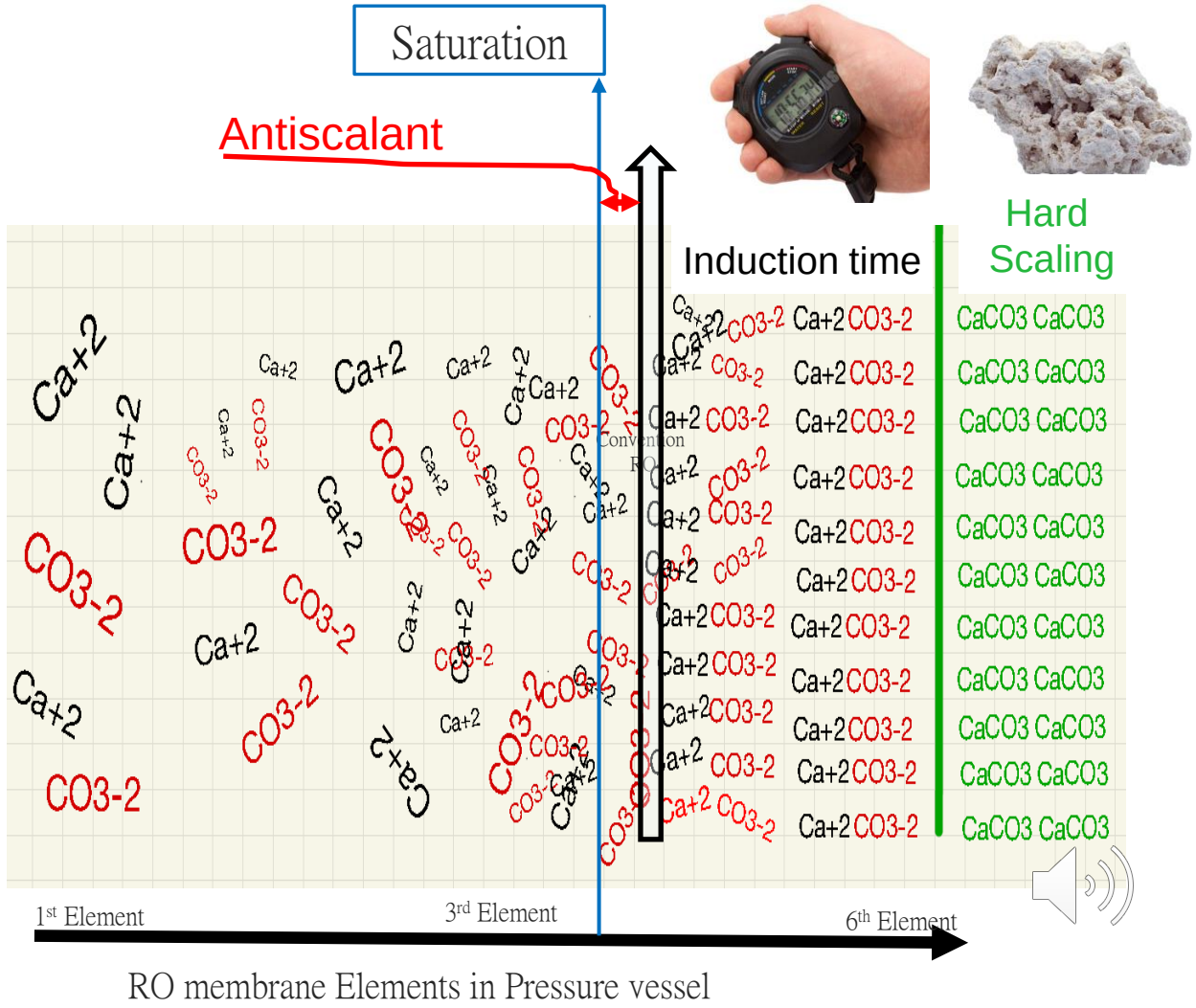


95% Recovery
Single stage

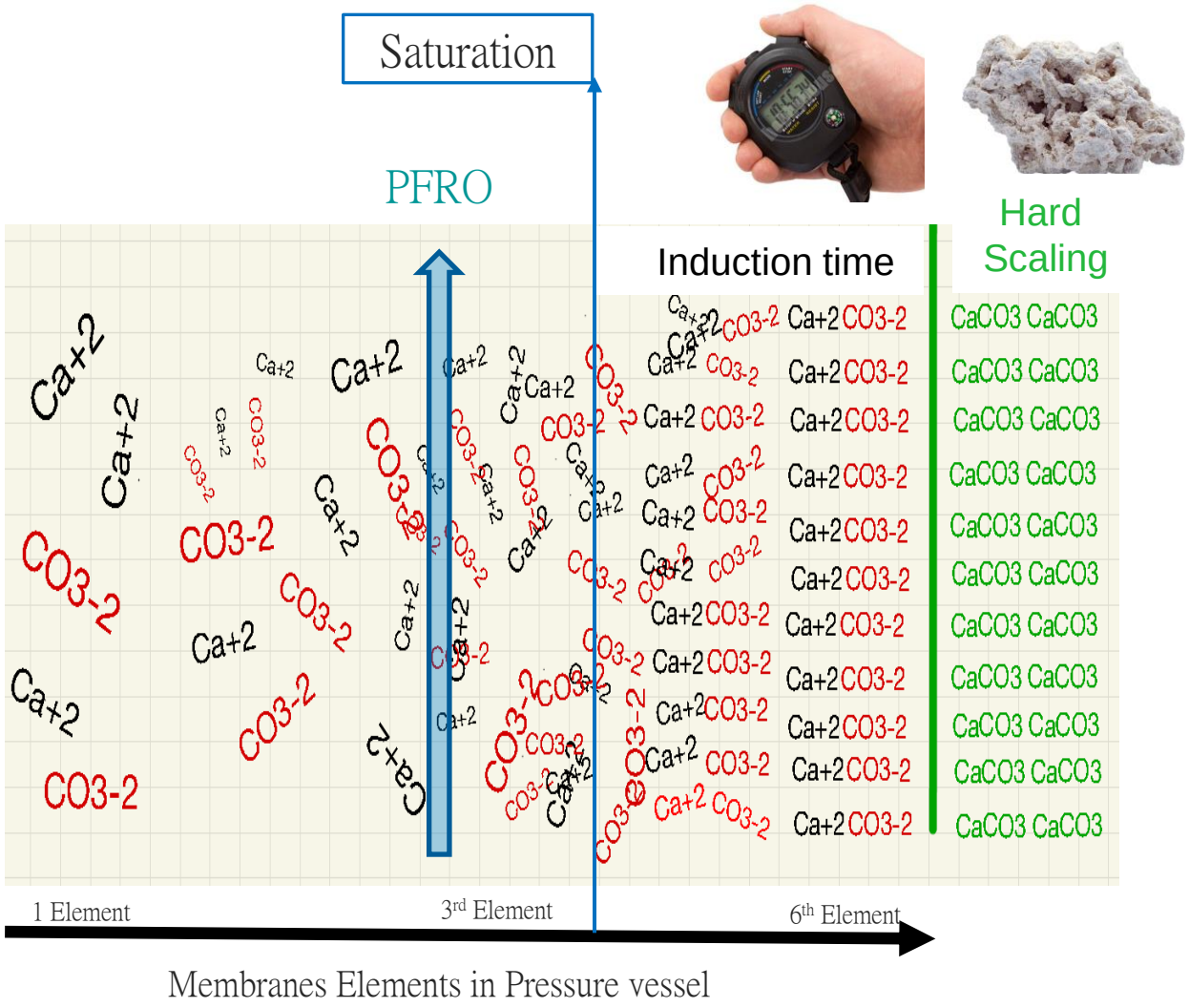
PFRO can reach significantly higher recovery than conventional RO



In conventional RO the induction time is endless



Pulse Flow RO
Higher recovery



PFRO Wastewater Demonstration Plant. Pismo Beach CA

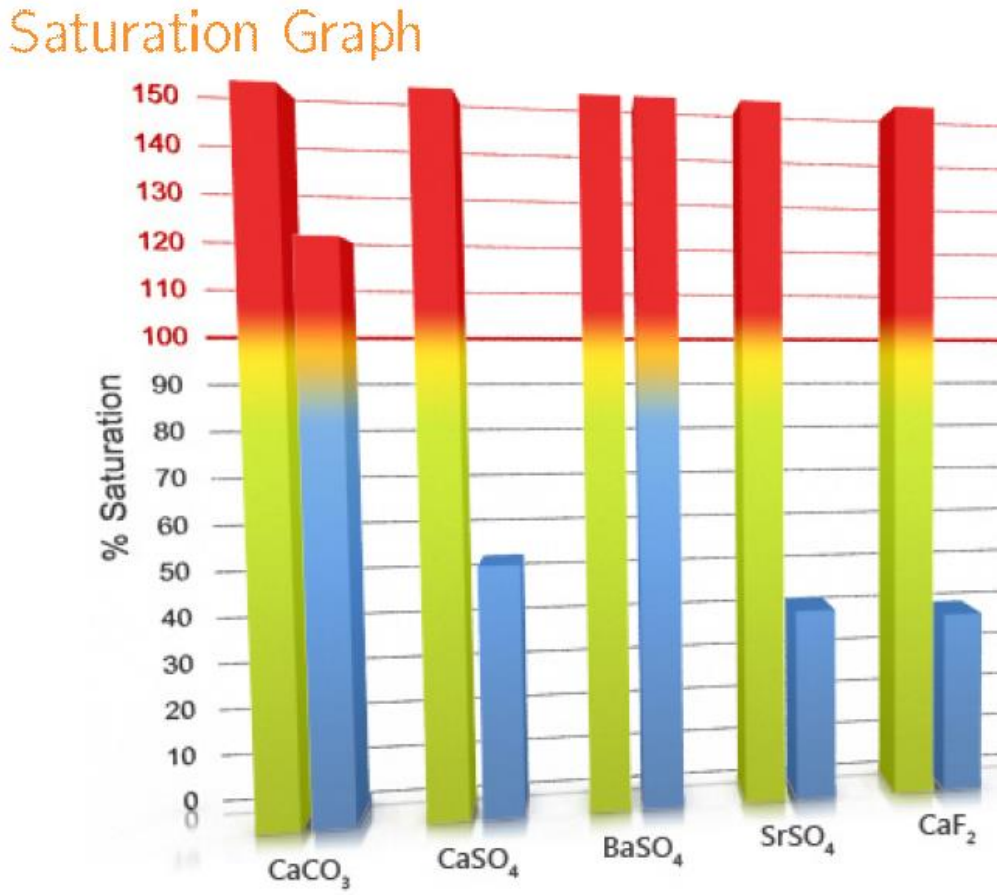
- Under the supervision of Carollo Engineers Inc
- The source - secondary effluent, municipal wastewater
- 86% recovery, no chloramine dosing

PFRO Brackish Water application
City of Abilene TX

- 80% recovery over final City brine

PFRO Demonstration Plant Abilene

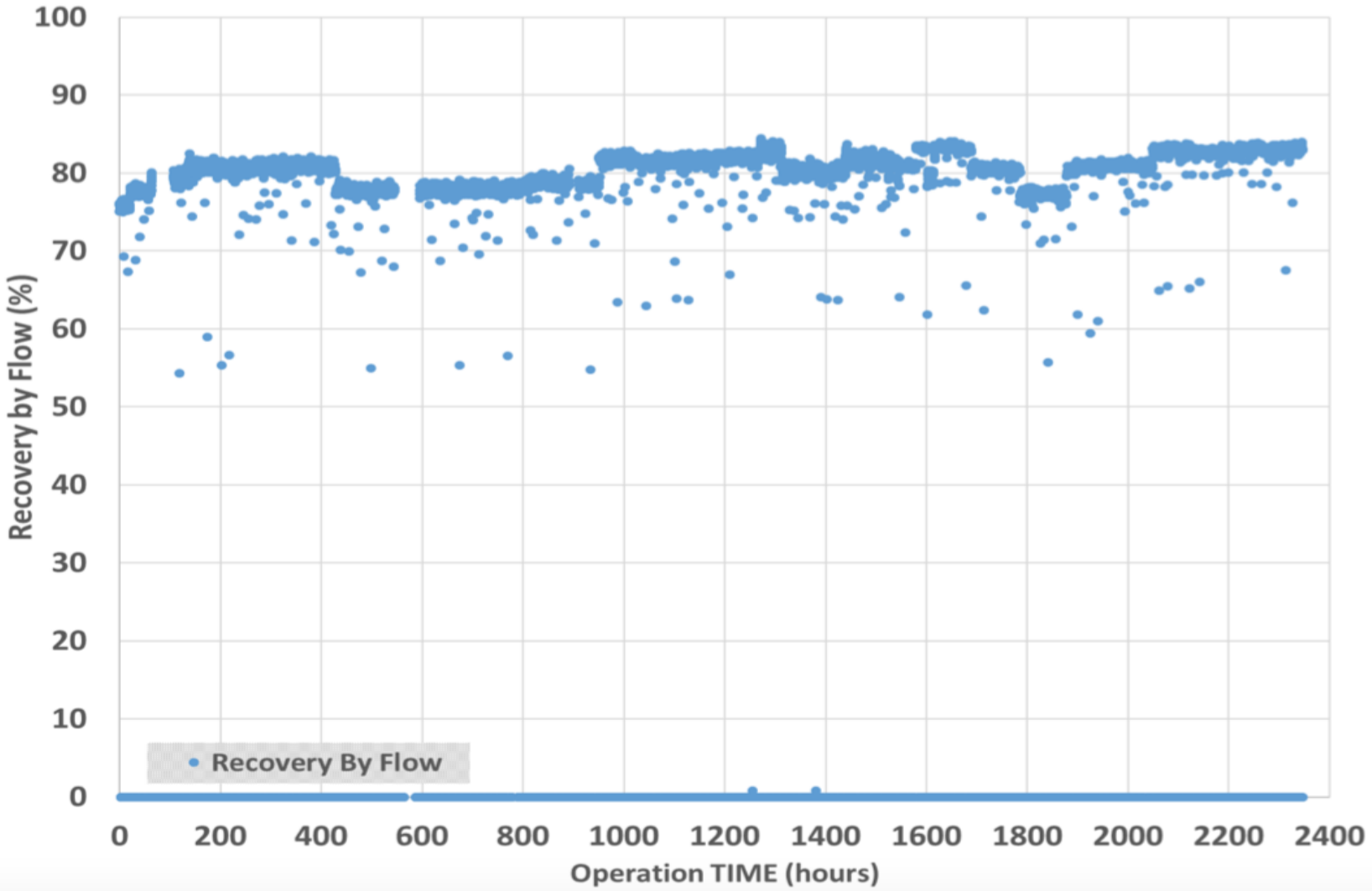
- Brackish water application
- 80% recovery over final City brine



Scaling Indices

	$CaCO_3$	$CaSO_4$	$BaSO_4$	$SrSO_4$	CaF_2	$Ca_3($
Conc. Untreated	222.30	409.17	51632	404.91	5249	0.

Recovery (%). Abilene



Specific Flux (GFD/PSI) Abilene

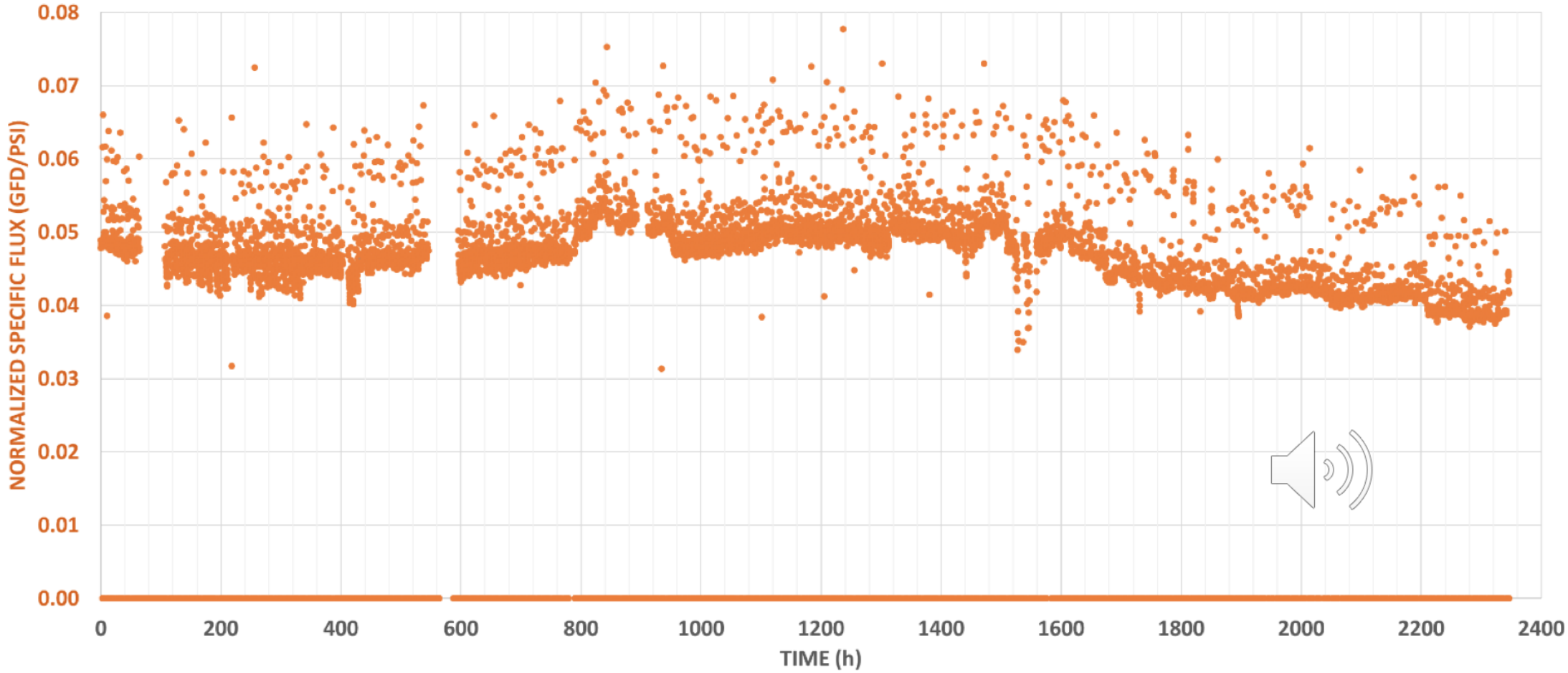


Figure 11: Specific Flux vs. Time

Product Conductivity

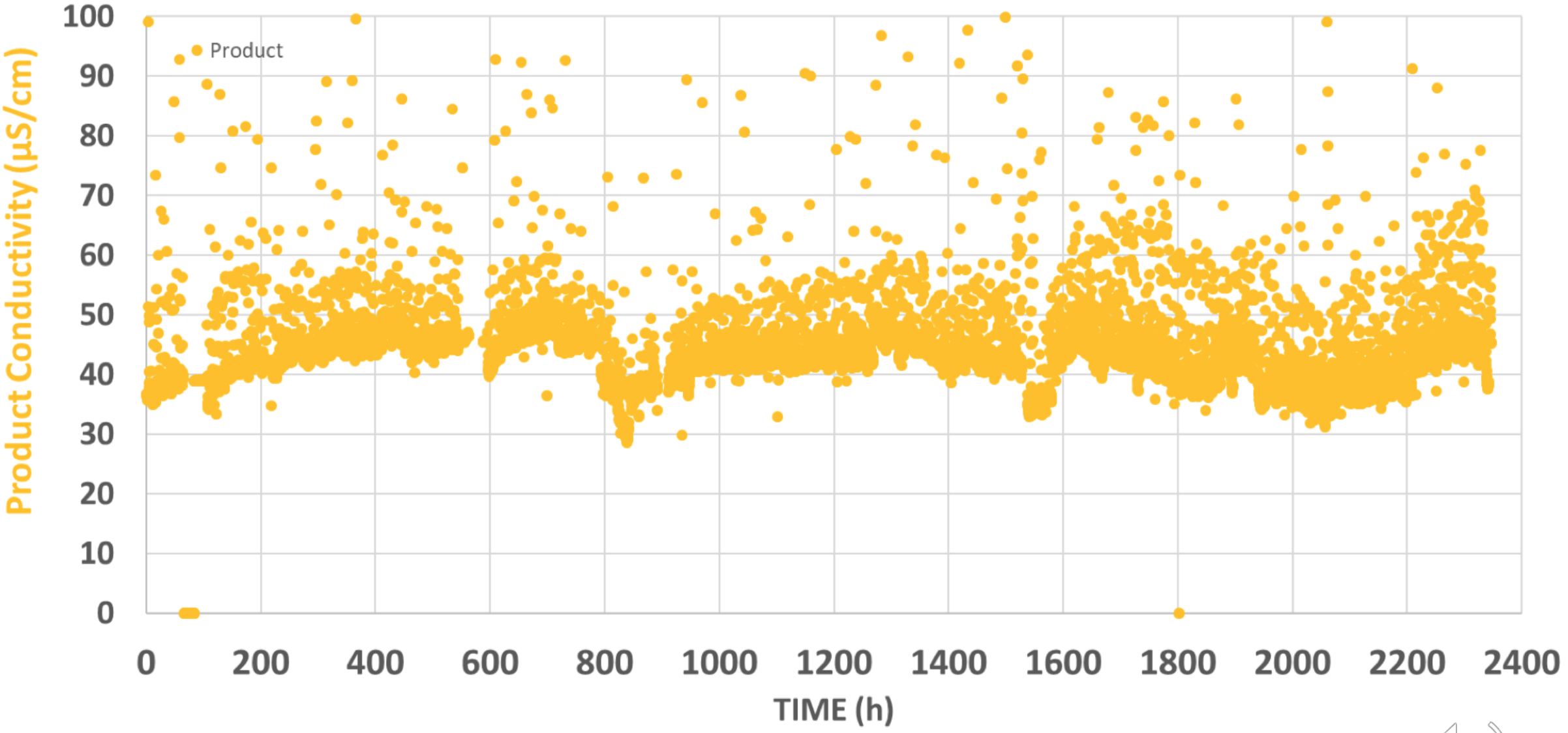


Figure 10: Permeate Conductivity vs. Time

THANK YOU

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