ED brine concentration

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SUEZ Water Technologies and Solutions

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Contents

Neil's BGNDRF connection

- Neil relocated with family to Las Cruces (NMSU) 2010-2012
- ONR-funded collaboration: Industry – NMSU – BOR
- Improving brackish groundwater desalination technology
- EDR was the focus of testing (some RO/NF near the end)
- Pilot testing utilized full sized commercial membranes and spacers

- Evaluate pulsed electrodialysis (PED) **DUD!**
- Collect systematic data that would eventually form the basis of a new process model for EDR (NEWatsys)
- Push limits of salt removal and recovery (can we break EDR?)
- Evaluate different anion exchange membranes
- Support NMSU students in their thesis work / experimentation

Work with NMSU students

- 7 Masters students (we hired two of these)
- 1 PhD student
- 2 postdocs

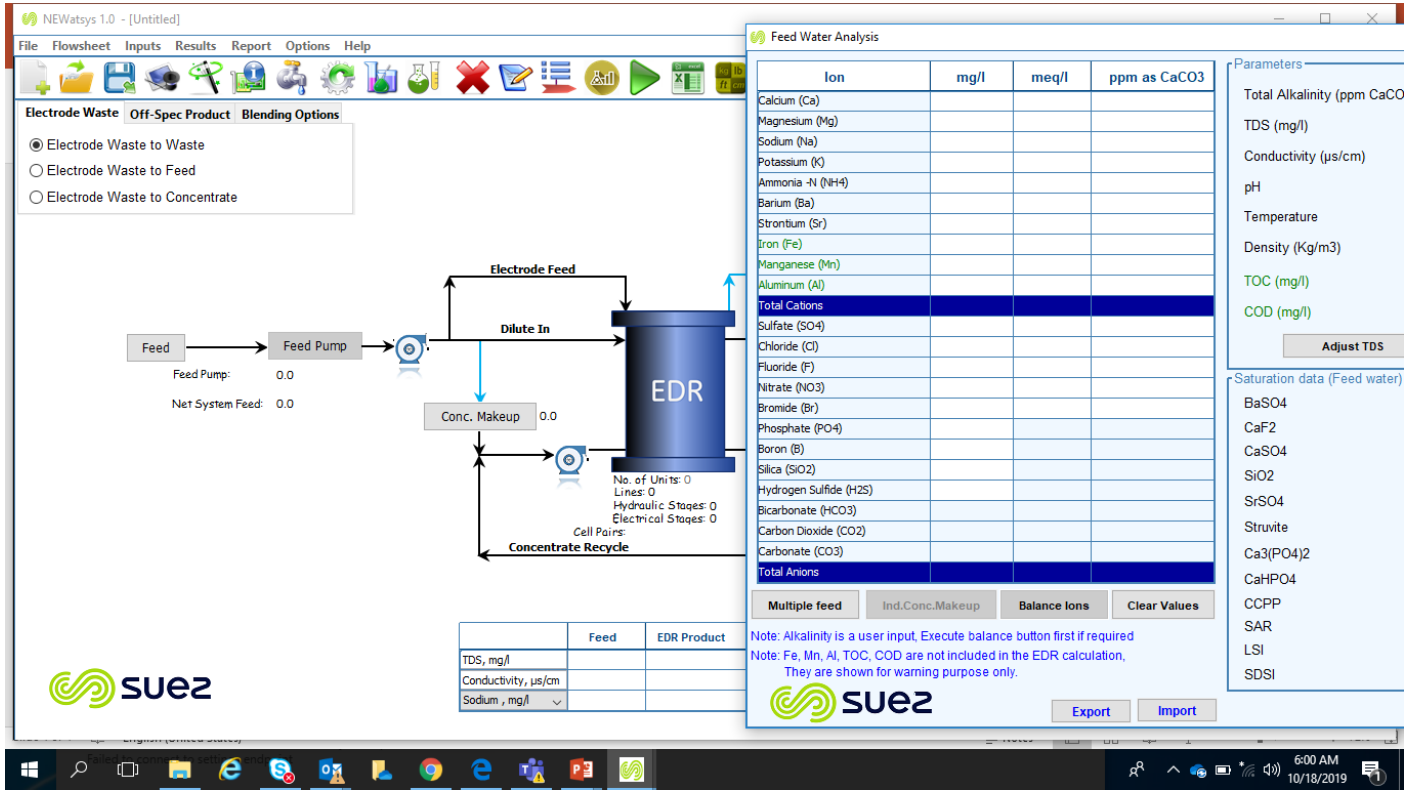
Assisted in formulating and executing experimental plans, analyzing data, editing theses / presentations

Great support from BGNDRF staff!

BGNDRF testing and NEWatsys

- V – I – Q – T interrelationships
- Specific ion removal rates (> 1000 water samples analyzed)
- Limiting current thoroughly studied and defined
- AR204 – AR908 – “fouled AR204” membrane comparison testing

NEWatsys V1.0 released Feb 2019

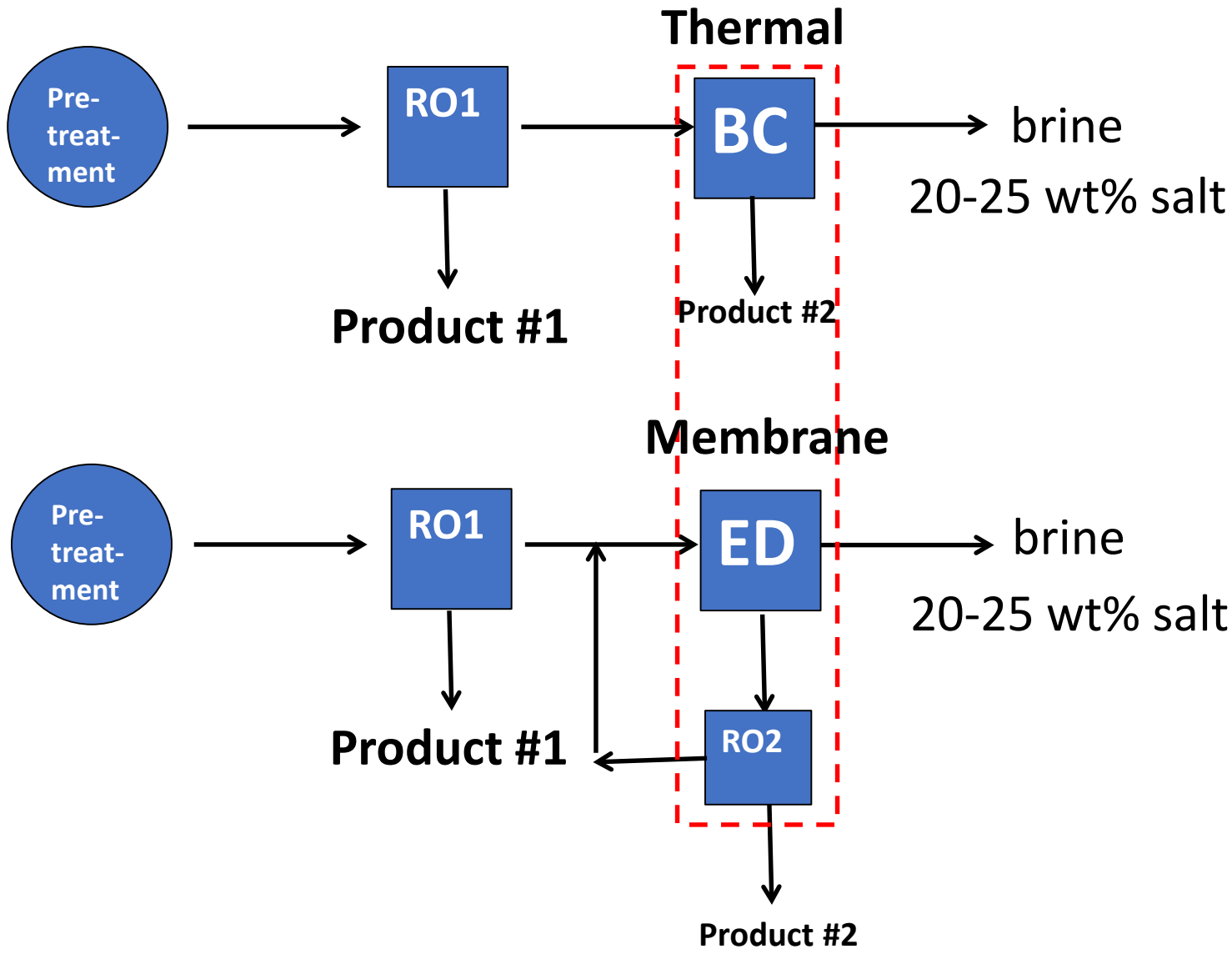


SUEZ internal

Some recent developments in ED/EDR at SUEZ

- Thinner, lower resistance membranes
- Improved carbon electrodes
- More efficient spacer and stack designs
- High recovery EDR and RO-EDR processes for wastewater recycling
- Reverse electrodialysis (RED) for seawater desal
- ED brine concentration (EDBC)

Our ambition: Membrane processes replace thermal processes for high TDS desalination

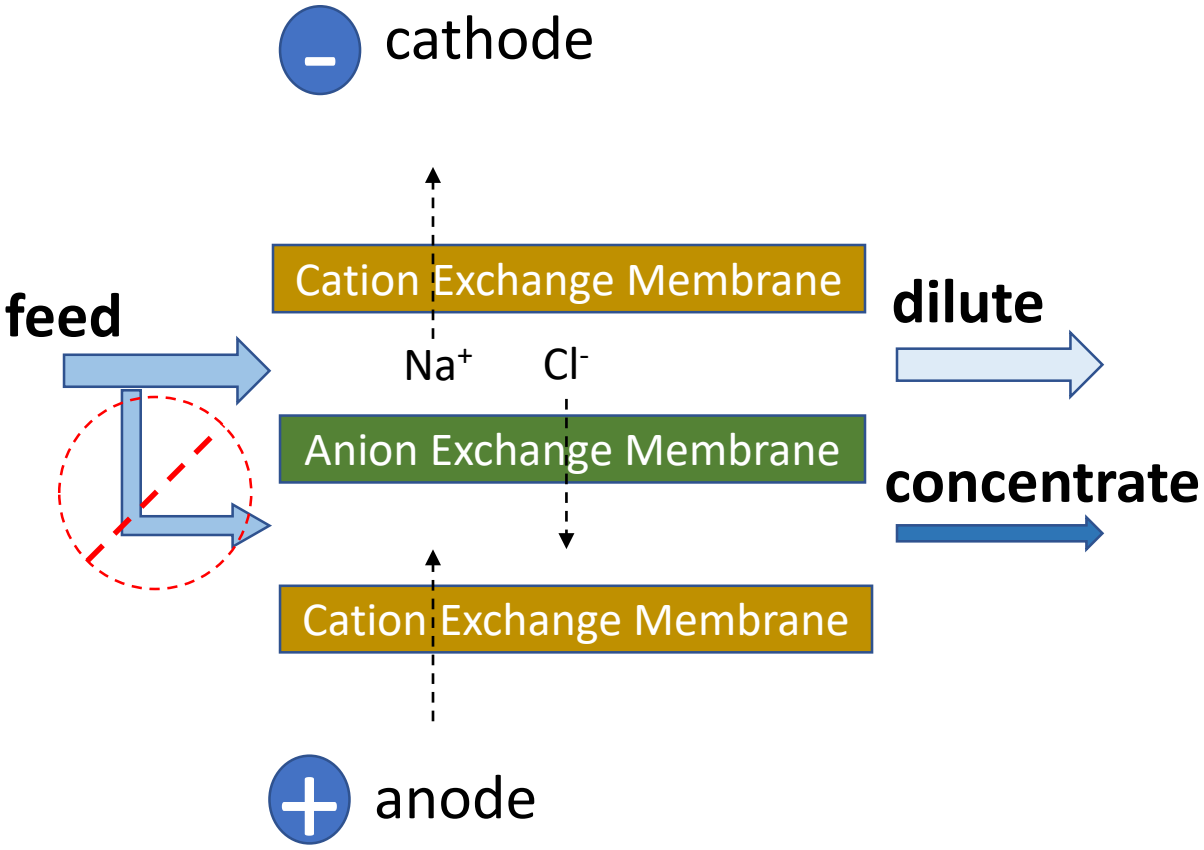


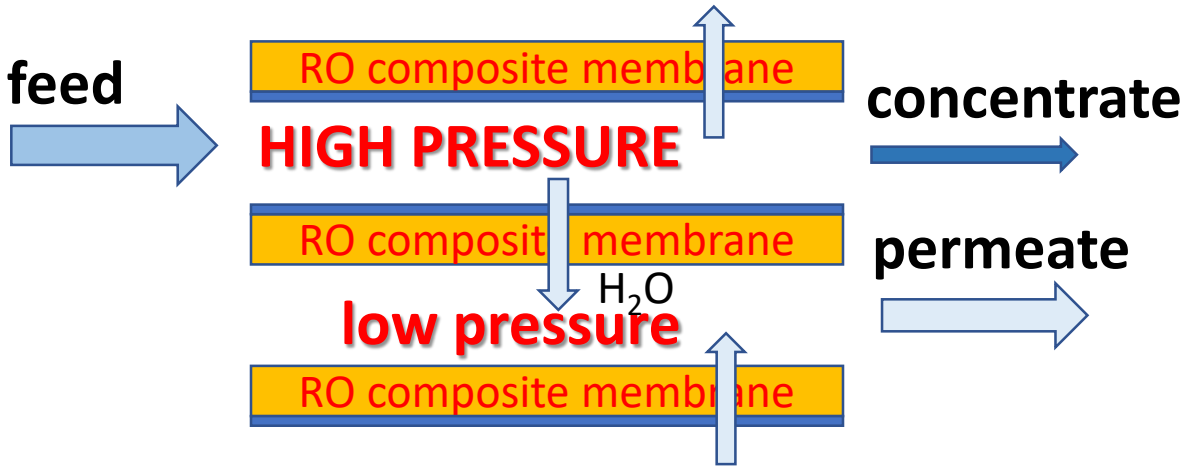
Thermal: Phase change, exotic metallurgy

Membrane: No phase change, standard materials

Are membranes up to this challenge?

ED and RO – a refresher





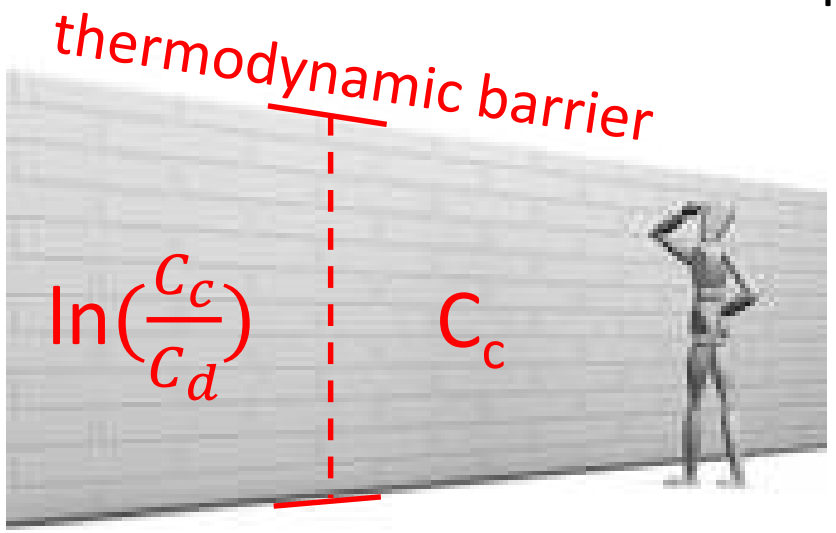
ED: The de – salting technology

RO: The de – watering technology

ED: a top candidate for high TDS desalination …

ED: less sensitive to highest concentration

$$\Delta V \propto \ln(\frac{C_c}{C_d})$$

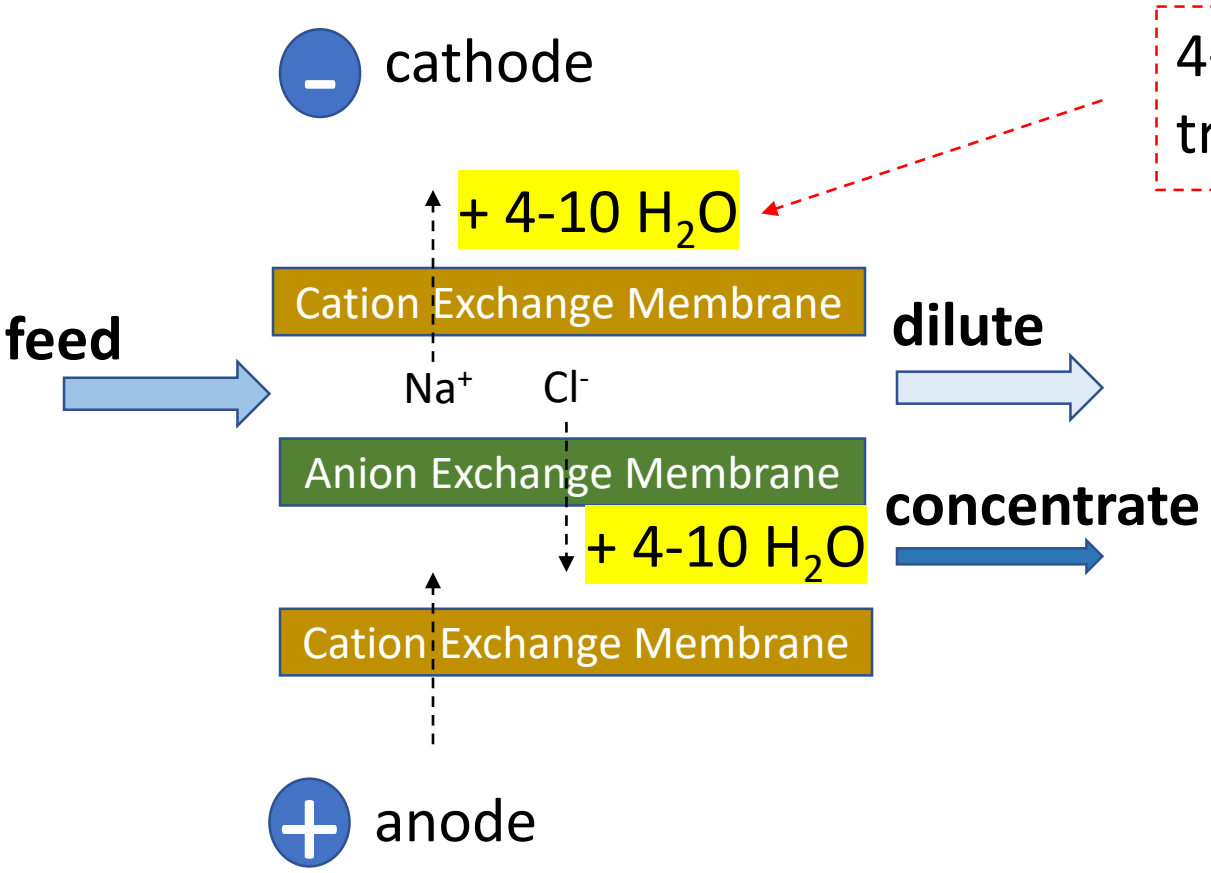


RO: very sensitive to highest concentration

$$\Delta\pi \propto C_c - C_d \approx C_c$$

ED may be used to go to much higher brine concentrations than conventional RO

… if IX membrane properties are optimized



4+ water molecules transferred with every ion!

Water transfer limits maximum attainable brine concentration

<u>Good BC membranes usually have</u>:

- Low water content (<30 wt%)
- Low thickness (<100 µm)

EDBC data for concentrating seawater (literature)

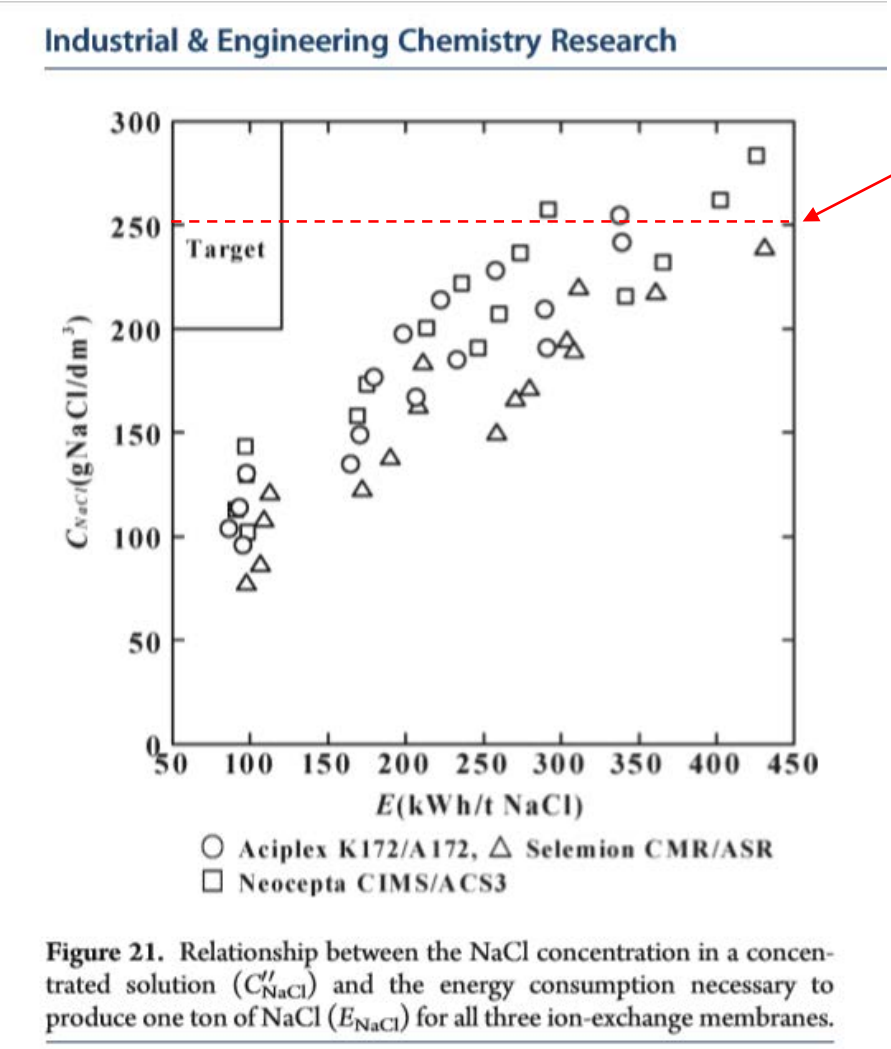


Figure 21. Relationship between the NaCl concentration in a concentrated solution (C''_{NaCl}) and the energy consumption necessary to produce one ton of NaCl (E_{NaCl}) for all three ion-exchange membranes.

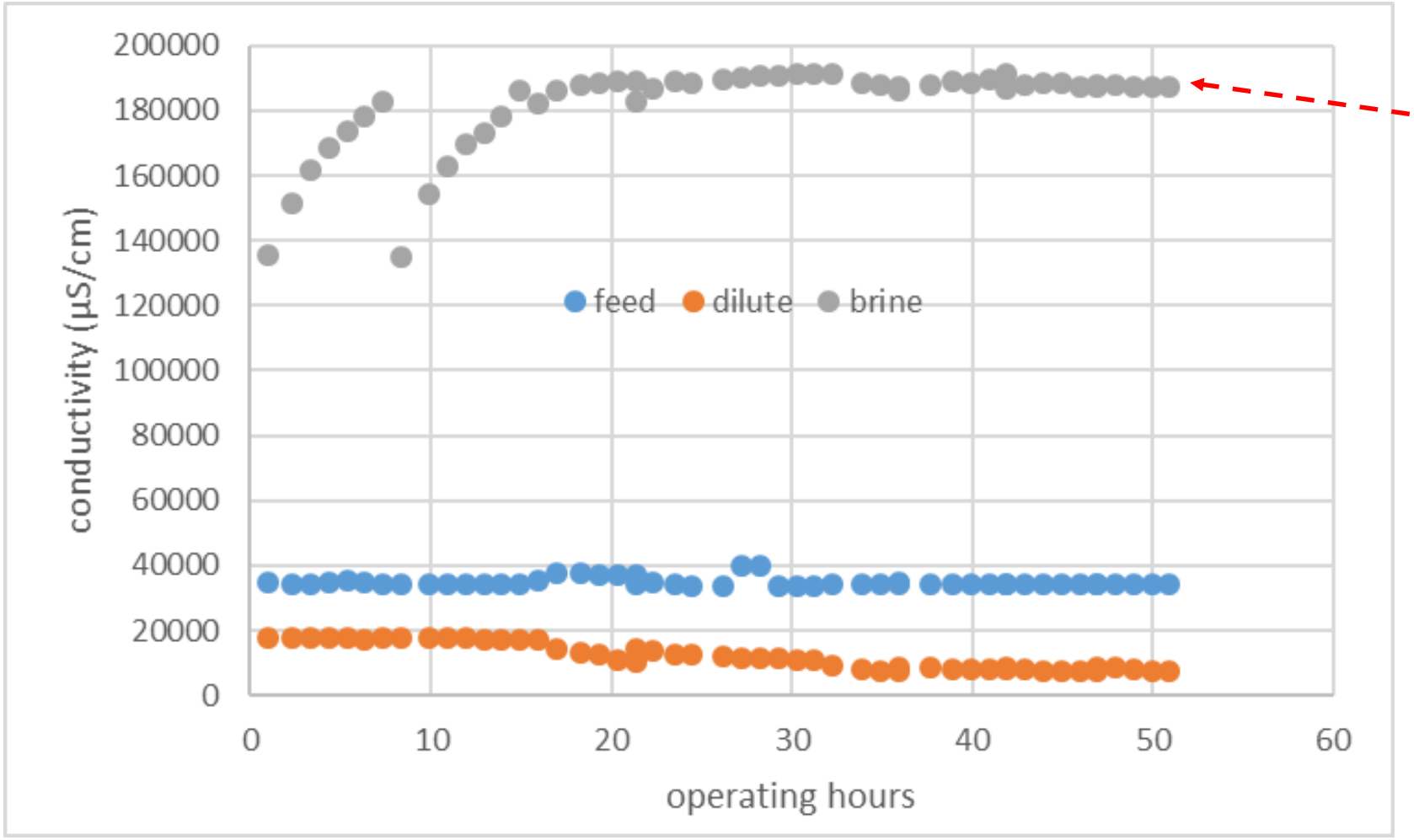
Y. Tanaka, I&EC Res. 50 (2011) 7494-7503

250,000 ppm NaCl!

Awesome demonstration of the capability of EDBC to attain very high brine concentration.

Run at industrial scale for 60 years

SUEZ EDBC in China (non-optimized): High recovery of industrial WW RO brine

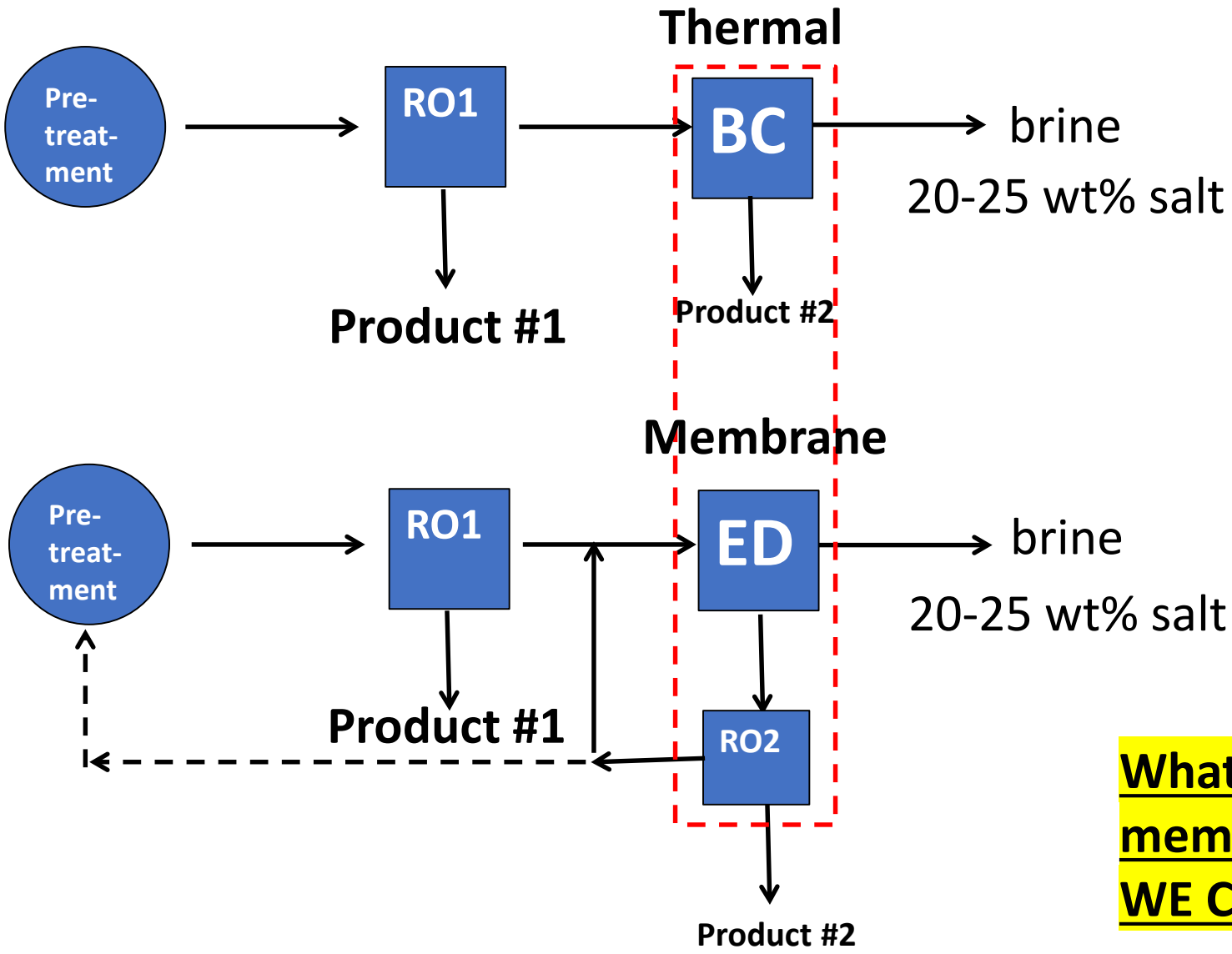


190 mS/cm ED brine conductivity

165,000 ppm / 15 wt% if this were NaCl

More complex and fouling prone than seawater

It comes back to techno-economics



Thermal: high energy consumption, high CapEx

Membrane: Reduced energy consumption? Reduced CapEx?

What will it take for membranes to beat thermal? WE CAN QUANTIFY

Thankyou for your attention

Questions?