

Singapore International Water Week 2022

April 17th

Brine Concentration Beyond 200 ppt Know How and Experience

Keith Lampi, President

Fluid Technology Solutions (FTS) Inc.

Albany, Oregon USA

Fluid Technology Solutions, Inc (FTS H2O)



Headquarters in Oregon, USA

- Membrane technologies and systems for high water recovery
- Projects in USA, EU, Middle East, Asia Pacific
- Specialists in enhanced desalination, mineral recovery, organic recovery, wastewater and effluent recycling

FTS develops membrane systems to support Water Reuse, Mineral Recovery, and the Circular Economy



Fluid Technology Solutions, Inc (FTS H2O)



In 1996 the FTS technical team delivered a 150 m³/day leachate treatment facility with primary objectives of high permeate quality and water recovery > 90%

Using SWRO, max NaCl concentration of 70 g/L reject TDS was possible. Forward Osmosis requires about 15 g/l TDS differential for operation, resulting in max 55 g/l TDS leachate concentrate using SWRO as the draw solution recovery process, meeting recovery target for 5,000 mg/l TDS leachate feed



In drier months after system start-up, leachate feed TDS exceeded 10,000 mg/l - to meet 90% recovery on this feed, and give some headroom, required draw solution TDS was 140,000 mg/l

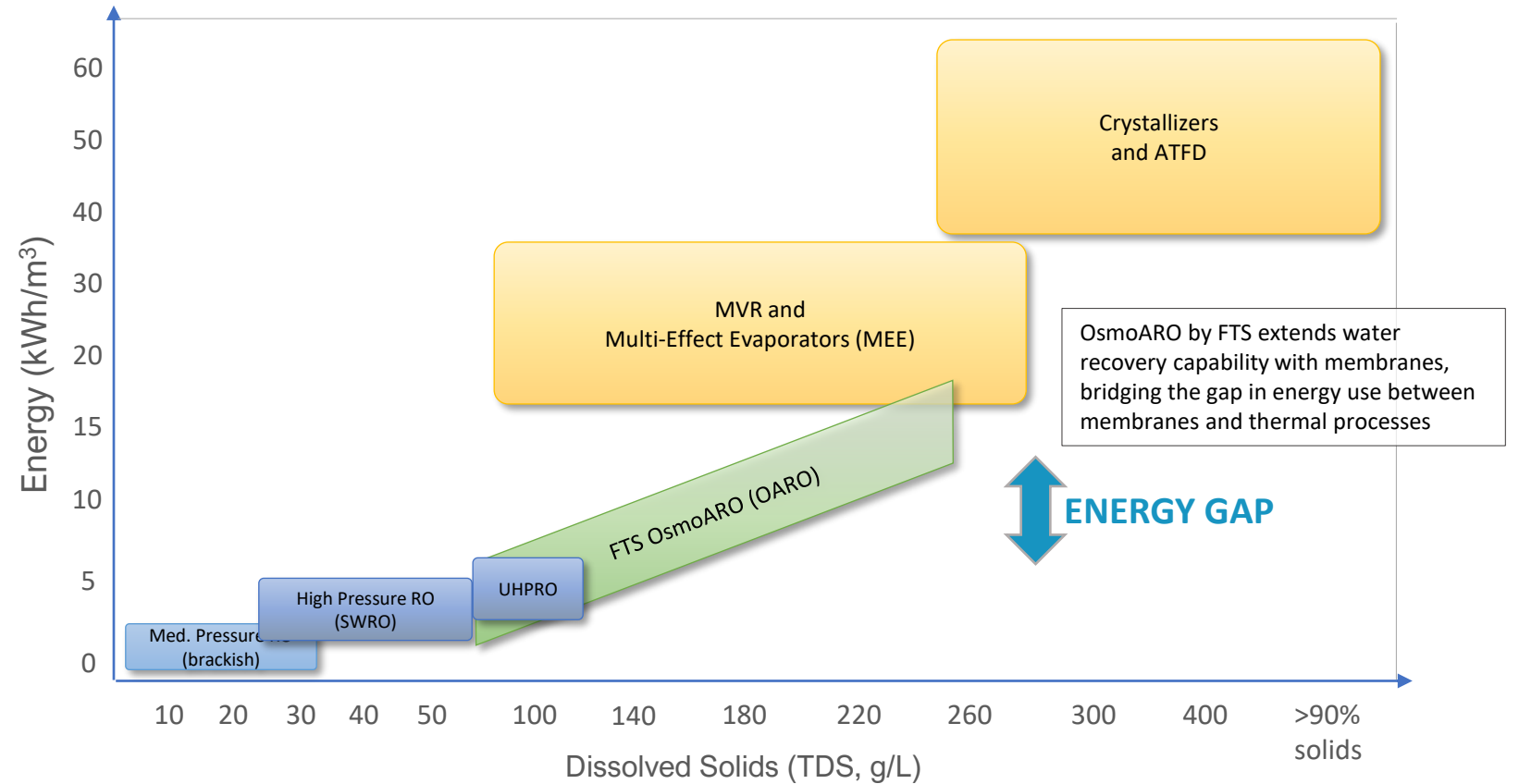
FTS combined FO and SWRO experience to develop and deploy OsmoARO: 70 - 80 bar operating pressure to reach reject TDS of 140,000 mg/l and higher

OsmoARO Process Solution for High Brine Concentration

PROVIDING A LOW ENERGY MEMBRANE ALTERNATIVE TO THERMAL BRINE CONCENTRATION

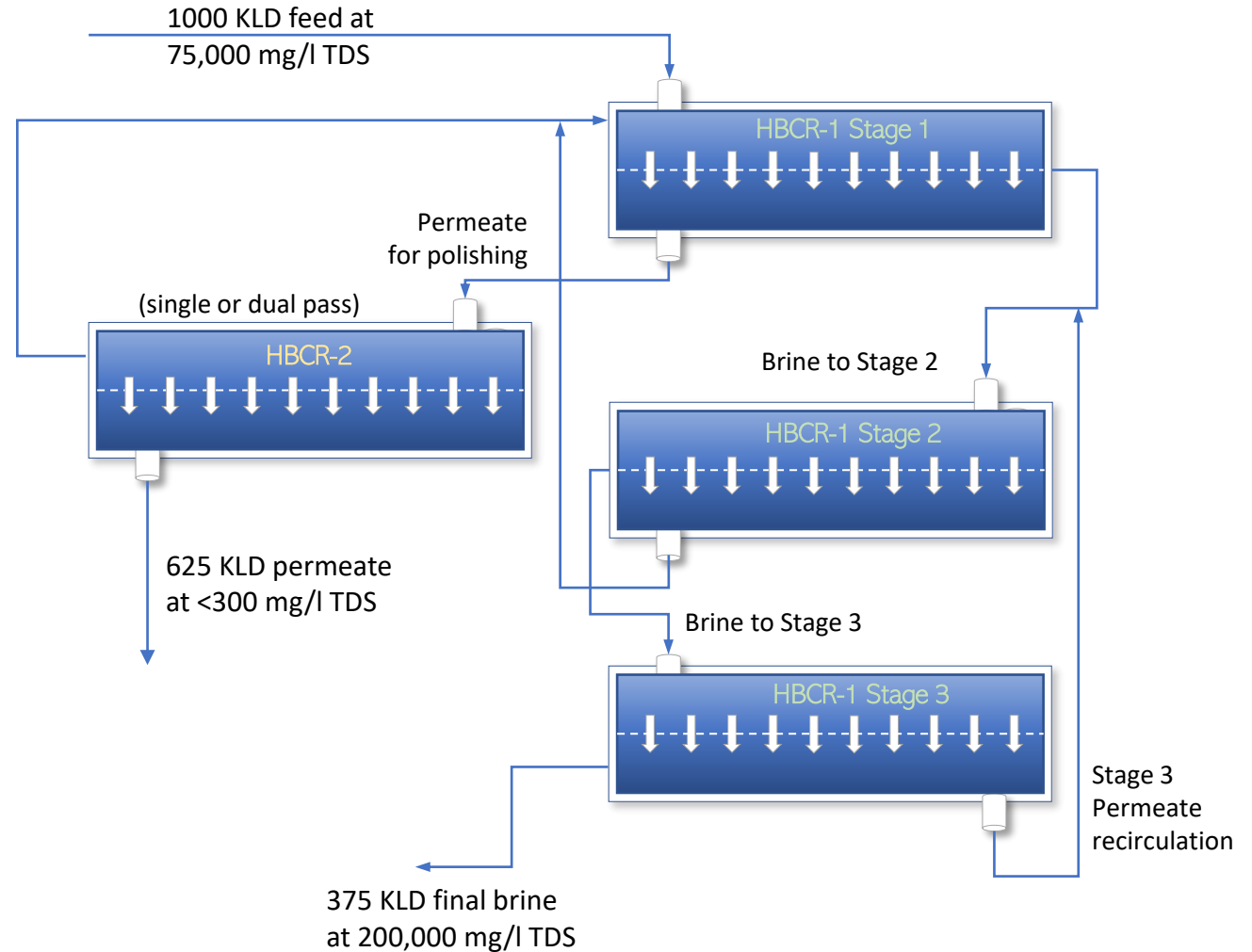
The Golden Rule of Brine Concentration

The further up the concentration curve, the higher the energy penalty



OsmoARO Process Description

- Using osmotic principals of RO and FO
 - Combining high pressure and osmotic delta between feed and permeate sides of a semi-permeable membrane
 - Membranes allow enough salt permeation for a saline permeate, managing osmotic delta to allow ongoing brine concentration
- RO process proceeds in a cascading fashion as long as concentration delta across membrane is lower than pumping pressure
- 70 – 80 bar operating pressure drives the process
- “Intermediate” permeate produced in the OARO array is polished to final permeate in a SWRO array

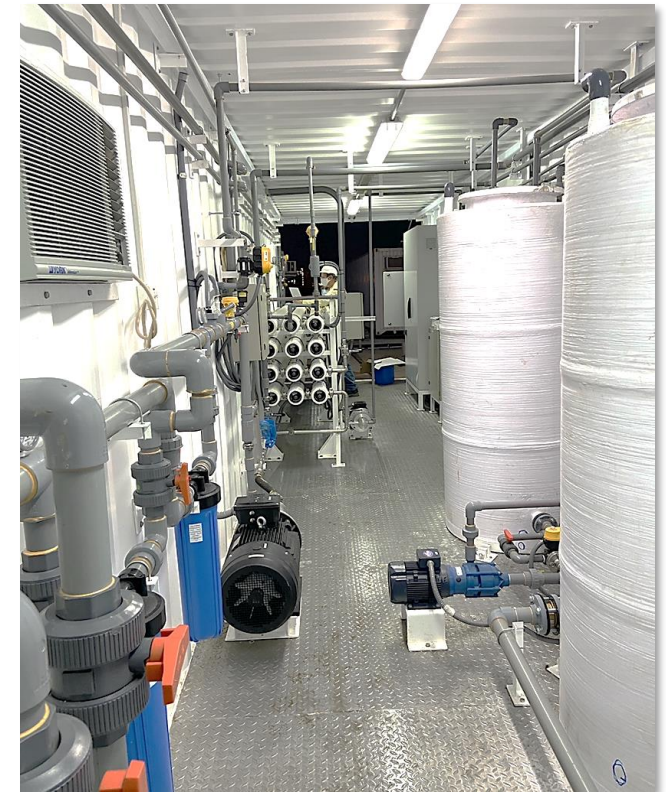


OsmoARO Brine Concentration Pilot Plant – Al Jubail, KSA

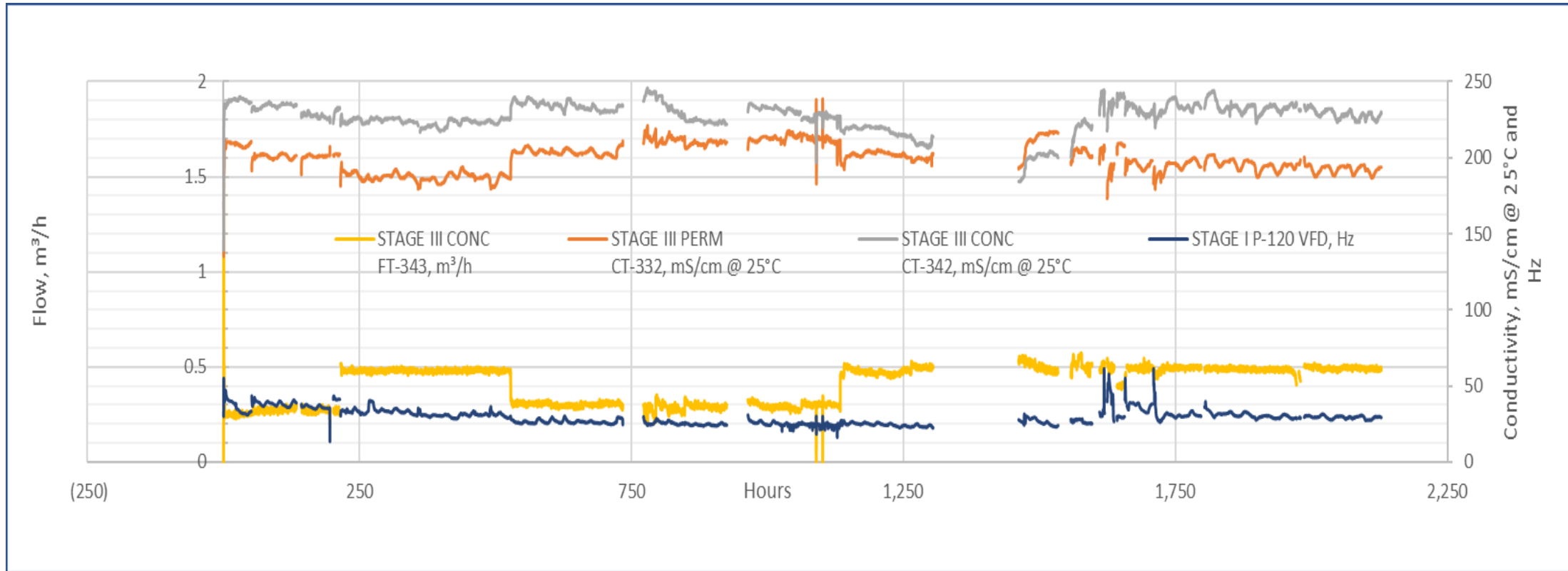
NaCl brine concentration of SWRO reject demonstration project at the Desal Technology Research Institute of the SWCC, Al Jubail, KSA

- Demonstrating salt brine production for chlor-alkali from SWRO reject
- Concentration of up to 250 g/l brine with the OsmoARO process of FTS H2O
- Pilot operations are ongoing for 15 months since Jan. 2021 -

Parameter	Feed Ave.	Concentrate Ave.
Temperature, °C	25.0	37.7
pH	7.4	4.0 to 7.8
Calcium, mg/L	465	1,401
Magnesium, mg/L	600	1,808
Sodium, mg/L	27,441	82,303
Potassium, mg/L	758	2,274
Strontium, mg/L	14	42
Bicarbonate, mg/L	141	424
Sulfate, mg/L	25	75
Chloride, mg/L	45,394	136,186
Fluoride, mg/L	19	57
Nitrate, mg/L	5	15
Boron, mg/L	12	36
Bromide, mg/L	126	378
TDS of Brine, mg/L	75,000	225,000



OsmoARO System Operating Data



Stage I, II, III pressures and temperatures under VFD and chiller controls

Summary

- ❑ FTS has over 20 years of OsmoARO experience producing high brine concentrations in combination with complimentary membrane processes
- ❑ Current market conditions justify OsmoARO as a stand-alone technology achieving up to 250 g/l of NaCl at 70 bar
- ❑ OsmoARO is well suited for salt production in addition to water recovery

- ❑ In cooperation with DTRI (Al Jubail, KSA), pilot testing of the FTS brine concentrator system confirms stable performance over time at the target brine levels required for commercial chlor-alkali facility
 - Operation from February 2021 until present
 - Continuous production of 225 g/l TDS brine or higher
 - Stable membrane performance of 15 l/mh over time
 - Process flow and design reflects commercial objectives
 - Significant OPEX and CAPEX savings compared to thermal alternatives

Thank You!

Recognition to DTRI and Dr. Al Amoudi for sponsoring the pilot operations reported in this presentation

Thank You to the organizers of SIWW 2022, Session Facilitators, Presenters and Attendees

Follow-up questions please contact:

Keith Lampi

President

Keith.Lampi@ftsh2o.com

www.ftsh2o.com

John Tracy

VP Sales and Marketing

John.Tracy@ftsh2o.com