SYSTEMS

Water for Industry. Water for People.™

High Recovery Solutions for Every Drop.

Managing Scale Formation at High Water Recovery

October 28th, 2019

UTEP

MI SYSTEMS **END® Technology**

Maximum Recovery. Minimum Energy.™

MI SYSTEMS

CORPORATE MISSION

IMPROVE
Reliability on Challenging Waters

INCREASE
Water Utilization

REDUCE
The Cost of Supply and Disposal

TRANSFORM
Traditional Water Treatment

EXCEED
Regulatory Compliance

REDUCE
Energy Use and Operating Expense

Get the Most Out of Every Drop

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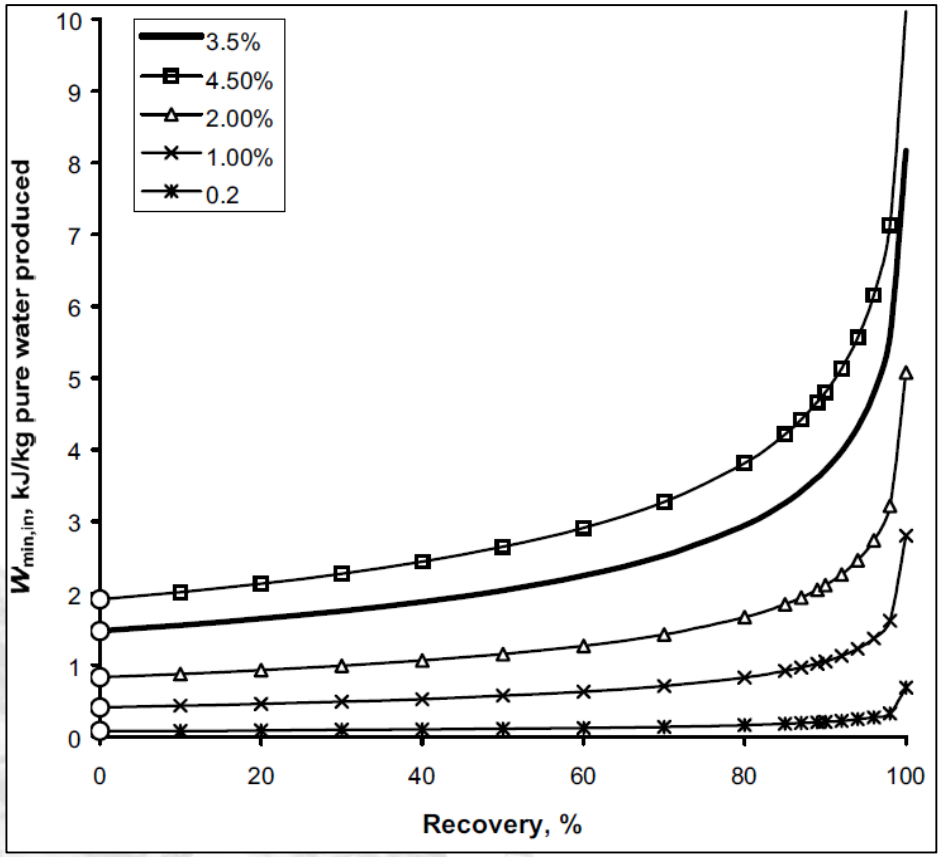
MI SYSTEMS

HIGH RECOVERY CHALLENGES

ENERGY AND SCALING

Energy Consumption



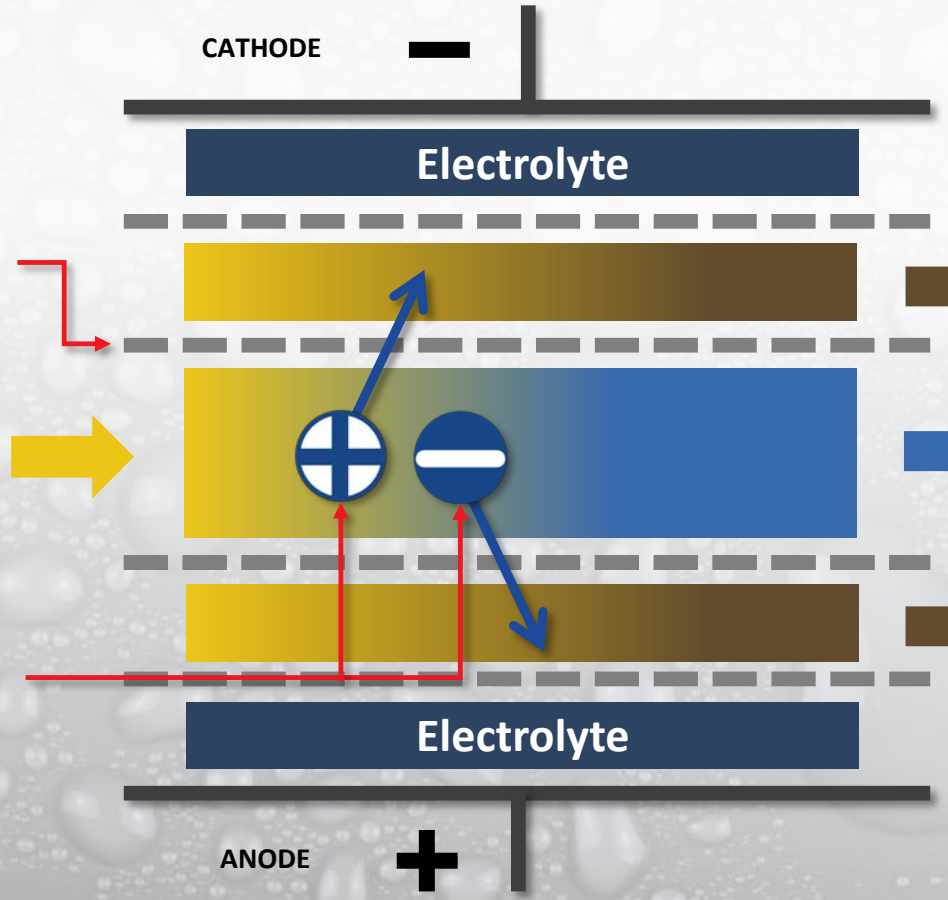
Scaling

- Low solubility salts (Ca, Mg, Ba, Str)
- Silica

Source: USBR Report. (2003). Desalination and Water Purification Research and Development Program Final Report No. 78.

ELECTRODIALYSIS REVERSAL

OPERATING PRINCIPLES



3 Semi-permeable membranes separate the water streams.

1 Contaminated water enters the END® electro-desalination cell.

2 Ions travel towards the electrodes.

4 Highly concentrated brine = low volume waste

5 With ions removed, the result is fresh product water.

4 Highly concentrated brine = low volume waste

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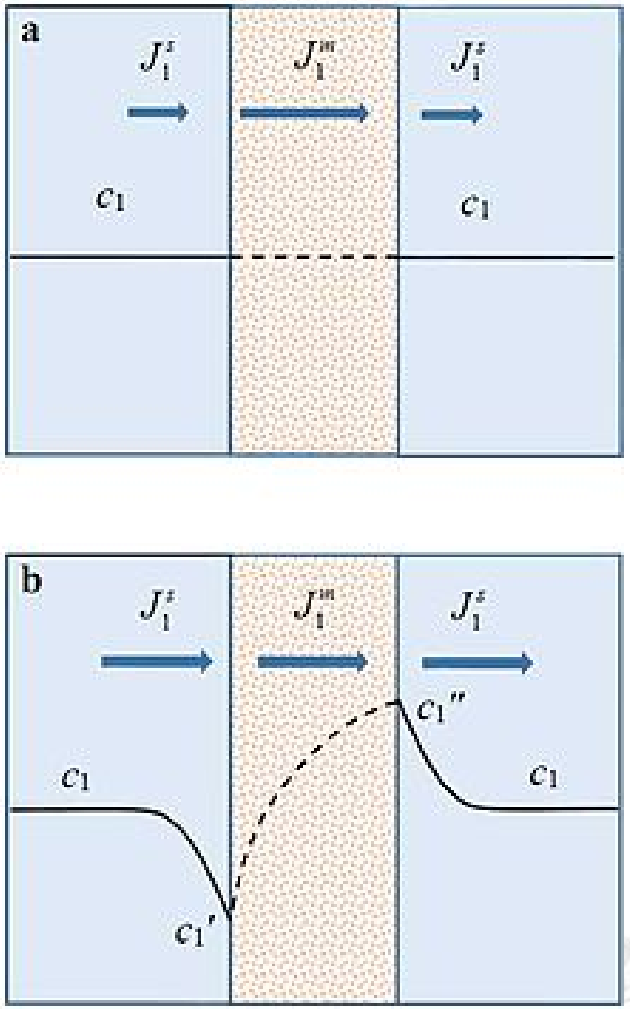
SCALE FORMATION

CONCENTRATION POLARIZATION

- Low voltage: ion transport to boundary layer balances transport through membrane

- High voltage: ion transport to boundary layer is deficient

- Managing ion transport is key to control scale formation



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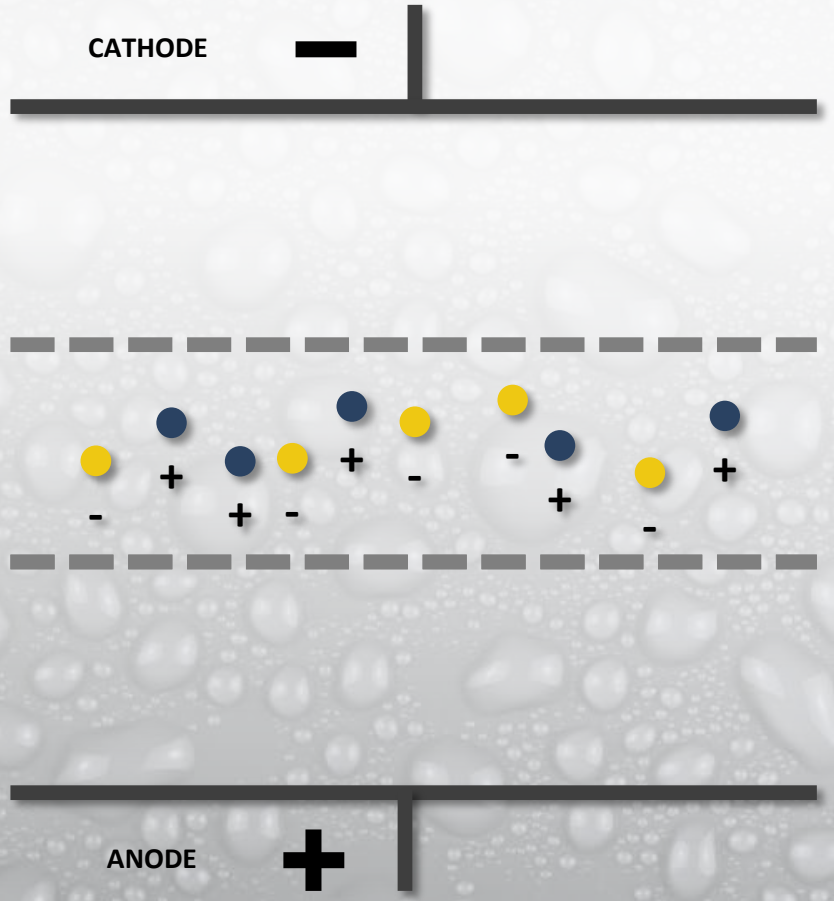
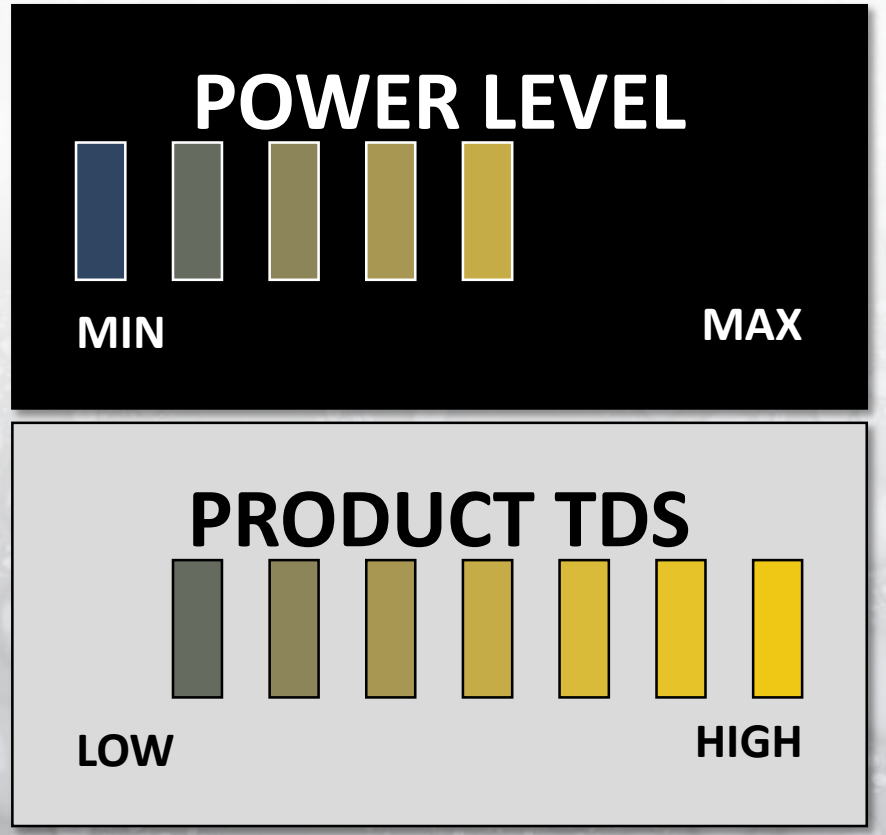
END® TECHNOLOGY

TUNED ION REJECTION

Salt Rejection can be ‘tuned’ to application requirements to **manage scaling** if total removal not required.





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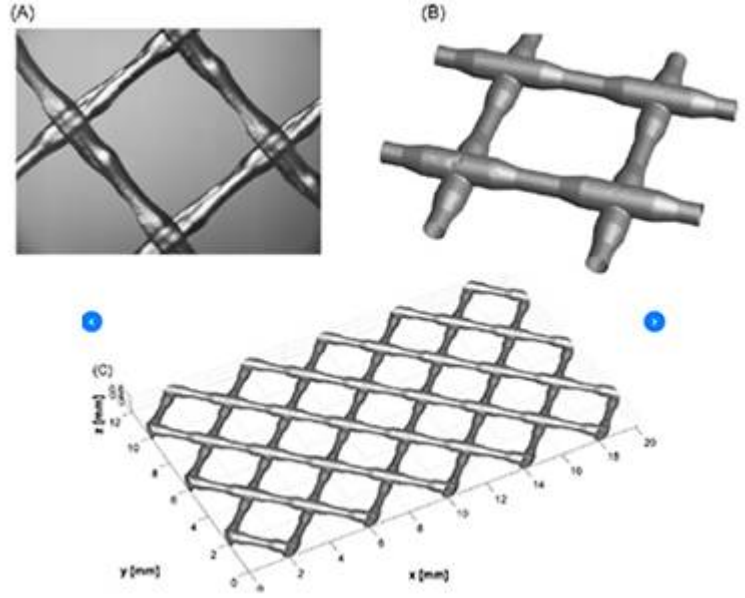
TRANSFORMING EDR

PROCESS AND COMPONENTS

- Ion exchange membranes
  - Electrical resistance
  - Water permeability
  - Permselectivity
  - pH stability
- Membrane spacers
  - Turbulent transport
  - Pressure drop
  - Scaling/Fouling
- Electrodes
  - Activation Energy
  - Corrosion



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TRANSFORMING EDR

END® TECHNOLOGY

- Combines **critical elements** of electrochemical cells and electrodialysis reversal.

- **END® Key Advancements:**
  - **Dissimilar anode/cathode electrode materials**
  - **State-of-the art ion-selective membranes**
  - **Proprietary membrane spacer geometry and materials**
  - **Advanced automation**

END® Technology
Treatment System

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END® TECHNOLOGY

CELL (STACK) DESIGN

END® Cell Stack

COMPACT AND LIGHTWEIGHT

- Approximately 30 lbs. and only 6 in. x 12 in.

SIMPLIFIED MAINTENANCE

- Push-fittings, Easy-to-Access Cells, and Modular Design

IMPROVED SAFETY

- Low voltage reduces operator risk during maintenance.

ROBUST OPERATION

- Multi-cell system design = **Minimized Downtime**

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BGNDRF PILOT

BRACKISH GROUNDWATER

Contaminant	Units	Concentration
TDS	mg/l	1165
Conductivity	µS/cm	1766
Ca	mg/l	41
Mg	mg/l	11
SO4	mg/l	643

- 5.5 m^3/day installed capacity
- Operated 15 months

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SYSTEMS

BGNDRF PILOT

RESULTS

"The END® system was able to achieve a higher recovery and greater average conductivity reduction than the competitive system."

	END™	Kirimi et al.[1]
Conductivity Reduction	**68-70%**	55-60%
Hydraulic Recovery	**91-92%**	87-88%
Total Normalized SEC (Desal Only)	**0.10-0.11 kWh/m³/mS/cm**	0.17-0.19 kWh/m³/mS/cm

[1]-L. Kirimi, L. Abkar, M. Aghajani, A. Ghassemi, Technical feasibility comparison of off-grid PV-EDR and PV-RO desalination systems via their energy consumption, Separation and Purification Technology 151 (2015) 92-94.

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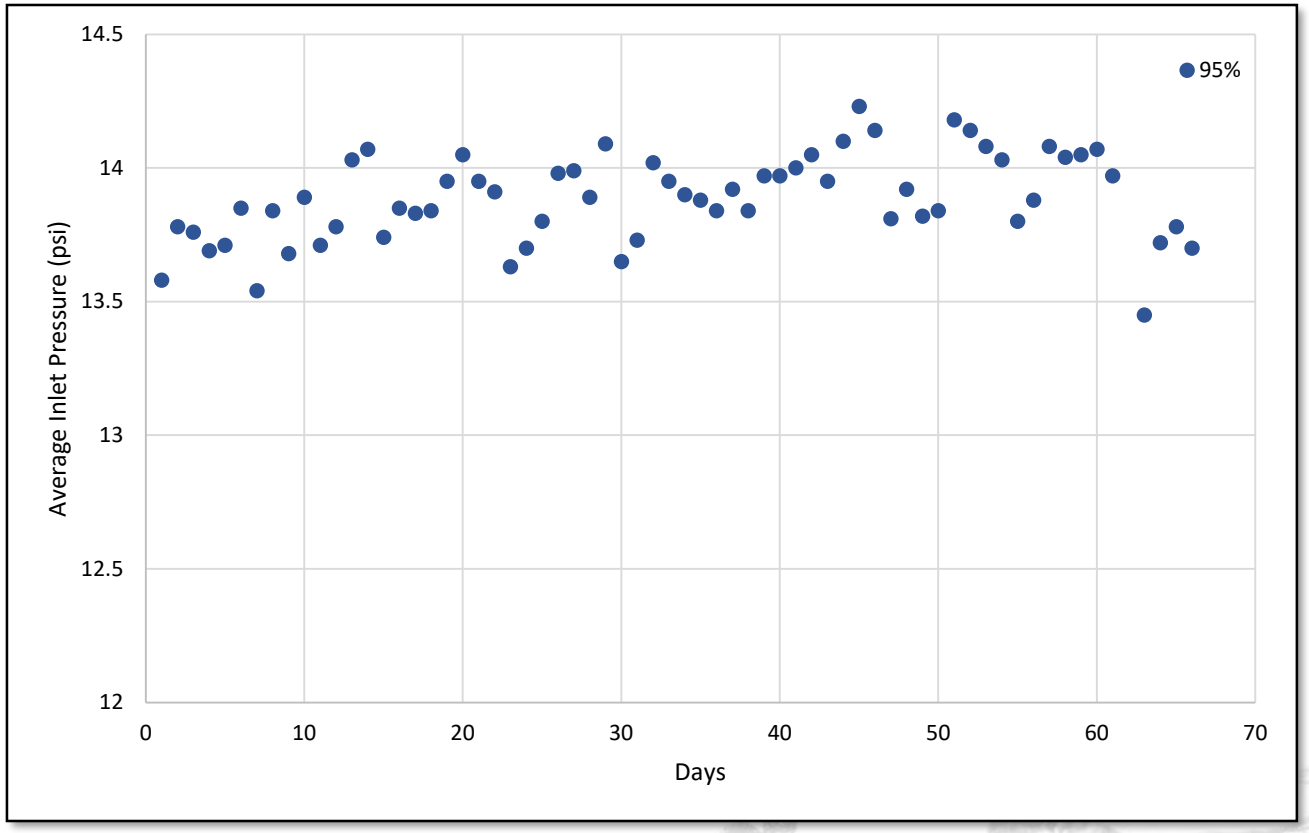
RESULTS

- Chemical usage
  - Lower than RO due to reversal feature
- Built in CIP for low maintenance
- Fully automated for low labor requirements
- Compact footprint



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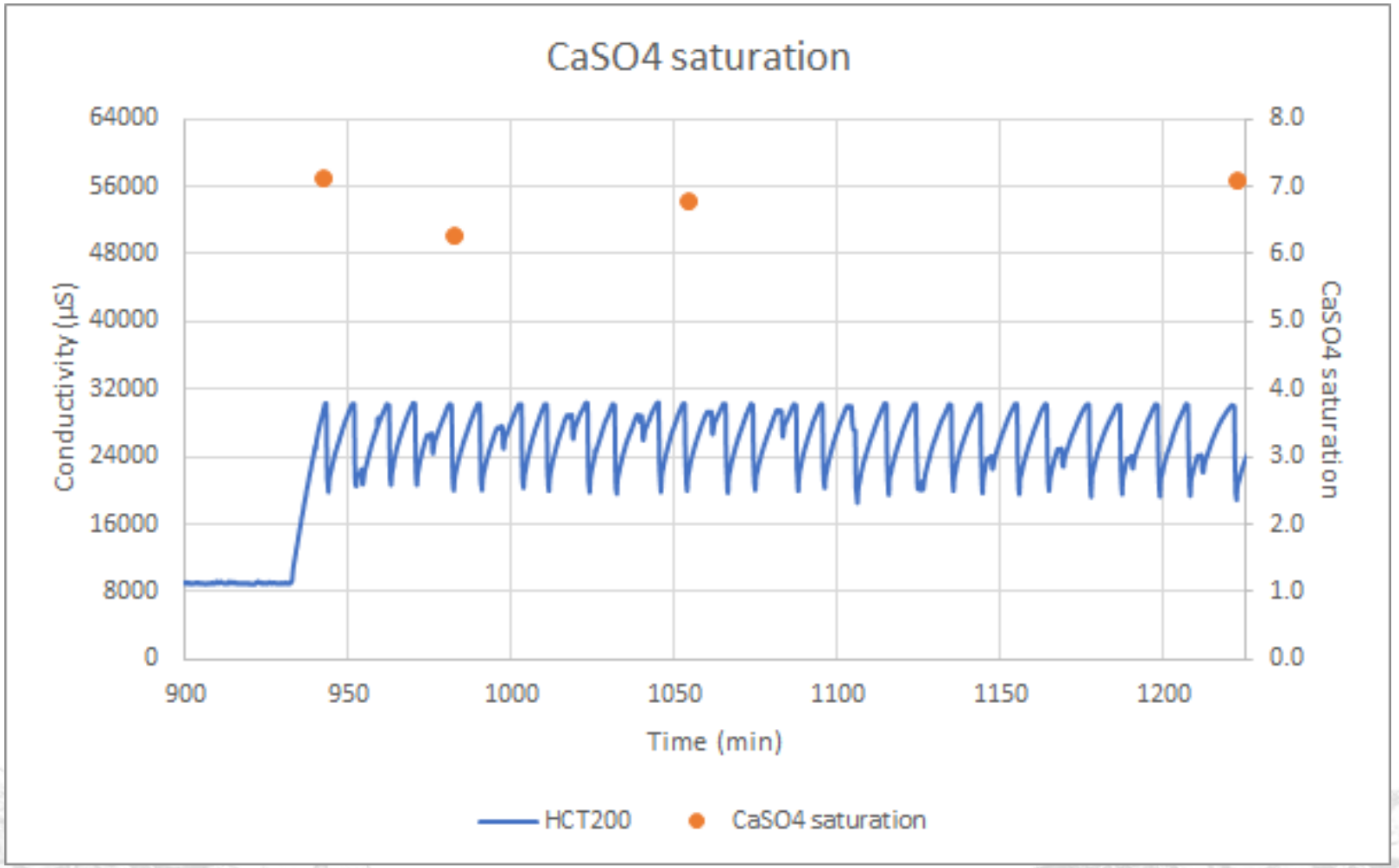
PUSHING BOUNDARIES

CALCIUM SULFATE



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PUSHING BOUNDARIES

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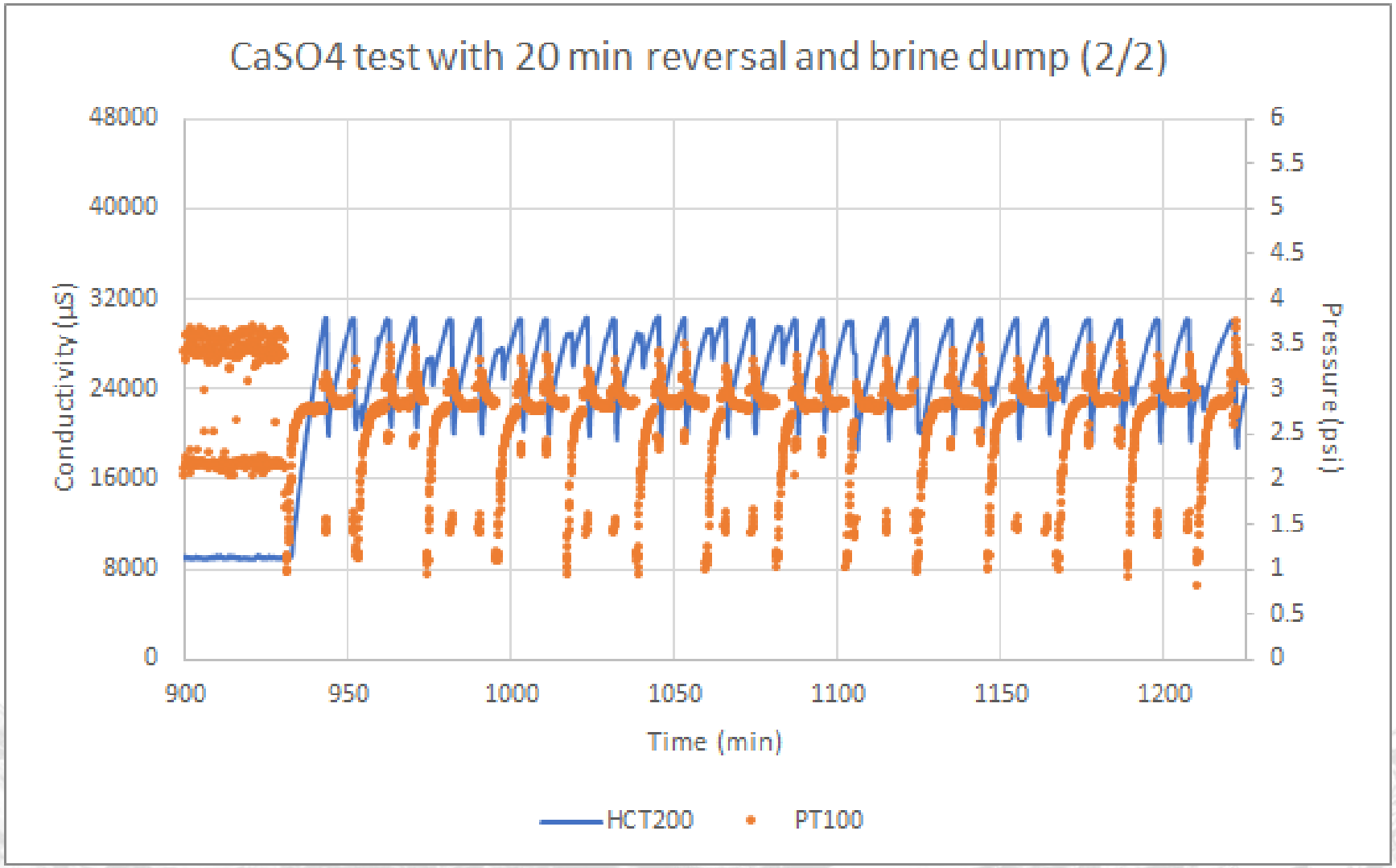

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END® TECHNOLOGY WHERE IT'S USED

END® Technology is used anywhere mineral removal or concentration is required.

APPLICABLE INDUSTRIES

- Food & Beverage
- Mining
- Power
- Chemical Processing (CPI)
- Oil & Gas
- Municipal Drinking and Wastewater
- Industrial Process and Wastewater

SOLUTIONS

- Process Makeup
- **RO Brine Recovery**
- Boiler Feedwater
- **Cooling Tower Makeup/Blowdown**
- Desalination
- Zero Liquid Discharge

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MI SYSTEMS

APPLICATION

RO BRINE RECYCLE

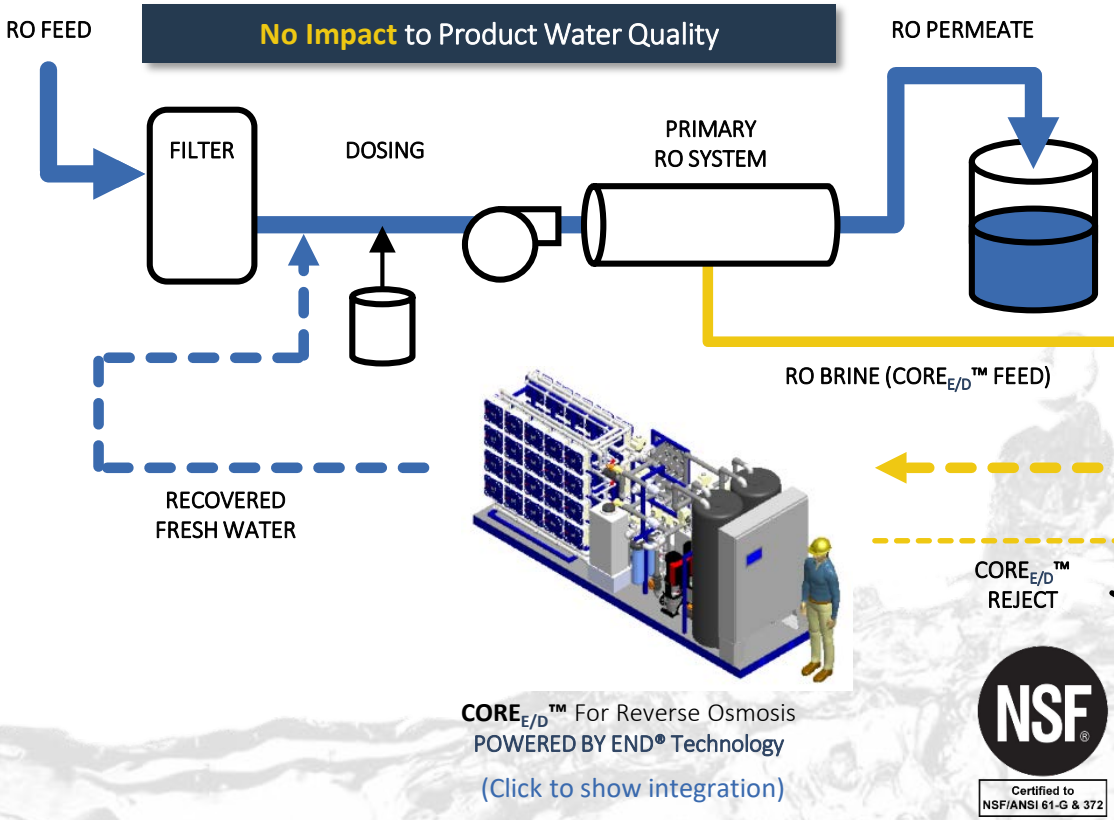
U.S. Top 50 Craft Brewery

Challenge: Operates a 65% recovery RO. Poor water utilization and rising sewer costs erode operating margins.

Solution: **CORE$_{E/D}$™**, Powered by END® Technology, reduces reject stream from **50 gpm to 2.5 gpm**. Operates at **0.12 kWh/m3** with 566 mg/L TDS feed.

Result: Owner will see 18 mo. ROI and benefit from increased sustainability and higher margins on **98.2% overall recovery**.

PARAMETER	CONVENTIONAL RO/NF	AFTER ADDING CORE$_{E/D}$™	CORE$_{E/D}$™ BENEFIT
RECOVERY	60-80%	90-99%+	**UP TO 98% WASTE REDUCTION**
REJECT STREAM	20-40%	1-10%	



CORE$_{E/D}$™ For Reverse Osmosis
POWERED BY END® Technology

(Click to show integration)

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LEARN MORE

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- MI Systems on the Web

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