Texas Desal 2017
NEXED EDR Technology Demonstration
22nd September 2017

AGENDA

- Evoqua Overview
- NEXED EDR Technology Development Background
- NEXED Technical Overview
- Evoqua / AccelerateH2O / UTEP Collaboration
- Demonstration Site Overview

Evoqua Overview

Our Brands…

NEXED EDR Technology Development Background

Evoqua Electrochemical Desalination

- Project began as a technology development endeavor through funding from Singapore government agencies EWI (of PUB) and EDB
- Technology development phase from 2008 to 2011 culminating in a 50 m^3/day demonstration system
- Collaborative project between Singapore and US R&D teams
- Seawater desalted at 1.65 kWh/m3
- Received approval to construct a new 1,892 m3/day (0.5 MGD) demonstration plant

EVOQUA WATER TECHNOLOGIES

NEXED EDR Technology Development Background

October 2008-2010: Began R&D with Singapore EWI and commissioned Demo

December 2011: Product Development Phase Approval

June 2015: Factory established in Cleantech Park (Singapore) for NEXED

November 2015: RO Reclaim and well water NEXED pilot installed at Evoqua Manufacturing Facility

January 2016: NEXED Module product launch, commercially available to the market

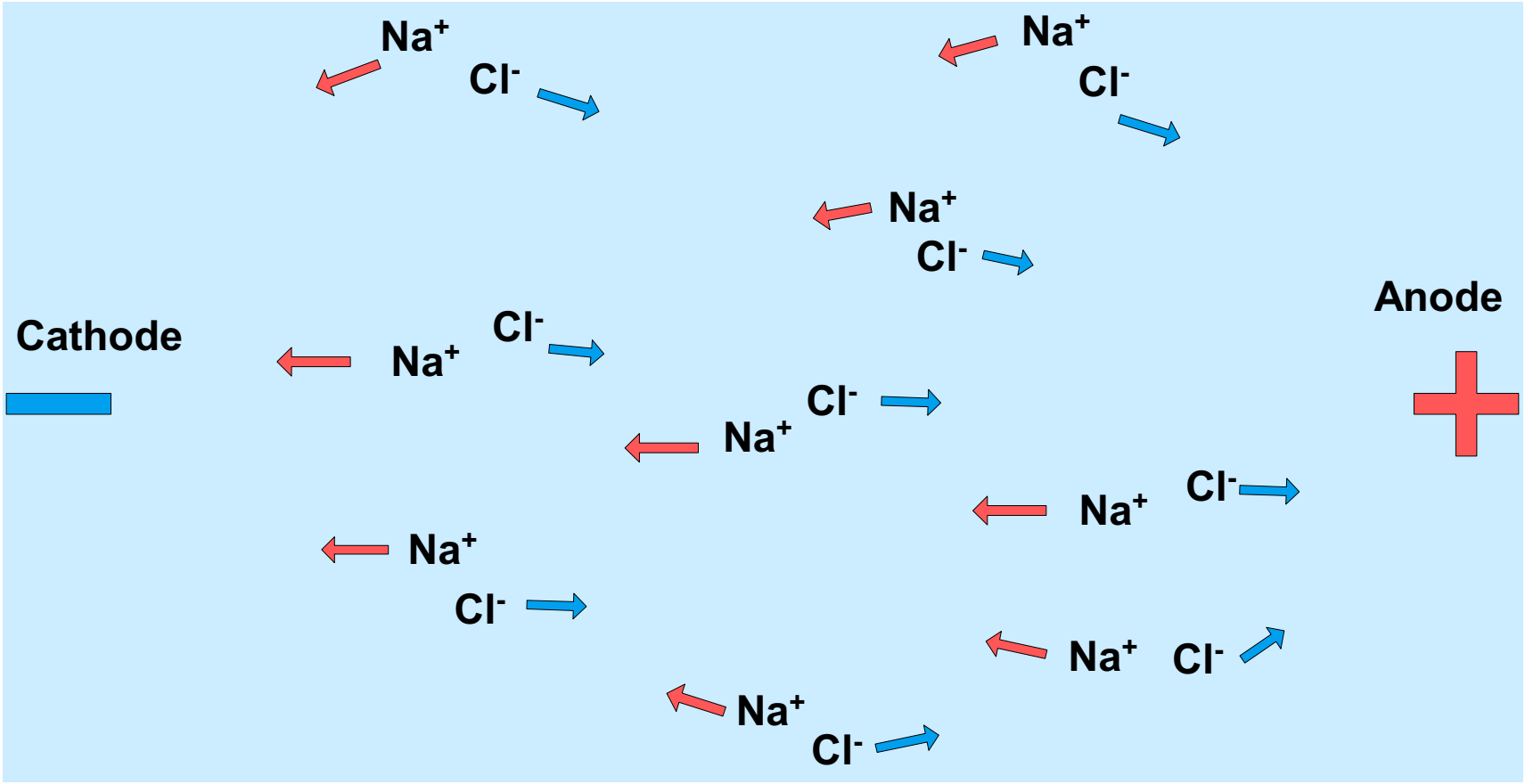
March 2016: First commercial sale in USA for RO Reclaim Application

CURRENT STATUS

- **8 Pilots / Demonstrations completed or in operation**
- **Continuous R&D Investment to Optimize Performance and Cost Position**
- **Business Development focus on 'Select' Applications**

NEXED Technical Overview

Salt Movement in Solution with Electric Field



Opposite charges attract

Like charges repel

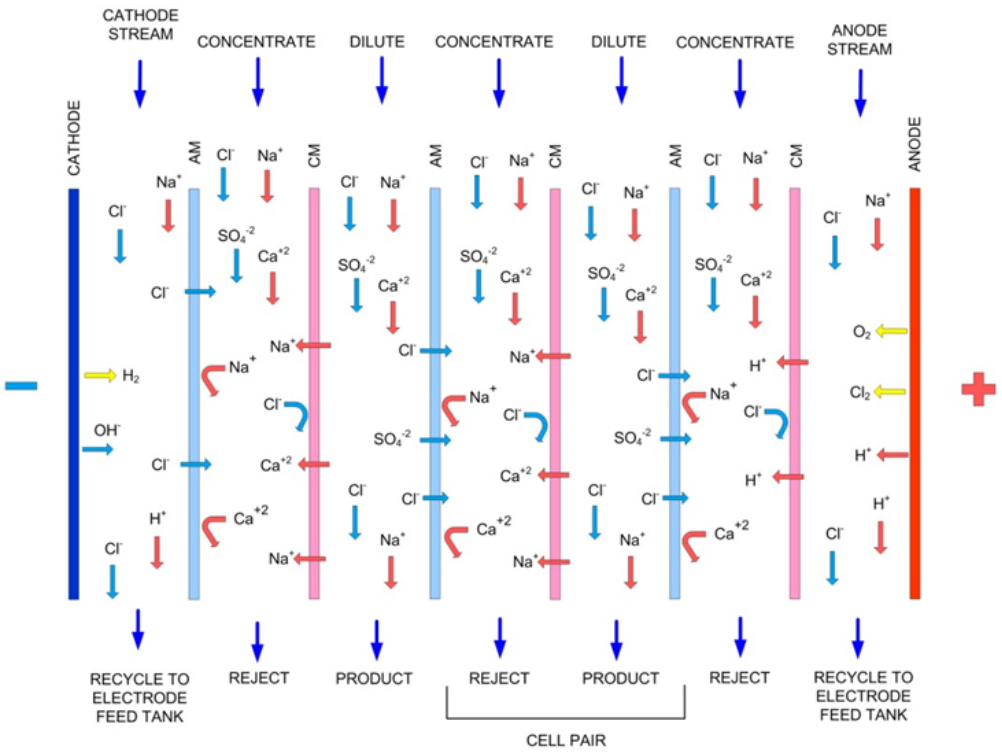
Anions migrate towards anode

Cations migrate towards cathode

NEXED Technical Overview

Add Ion Exchange Membrane

Electrochemical Desalination (ED)



- Electricity drives the transport of dissolved ions such as Na^+ and Cl^-
- Ion Exchange Membranes (IEM) allow the removal of selected ions

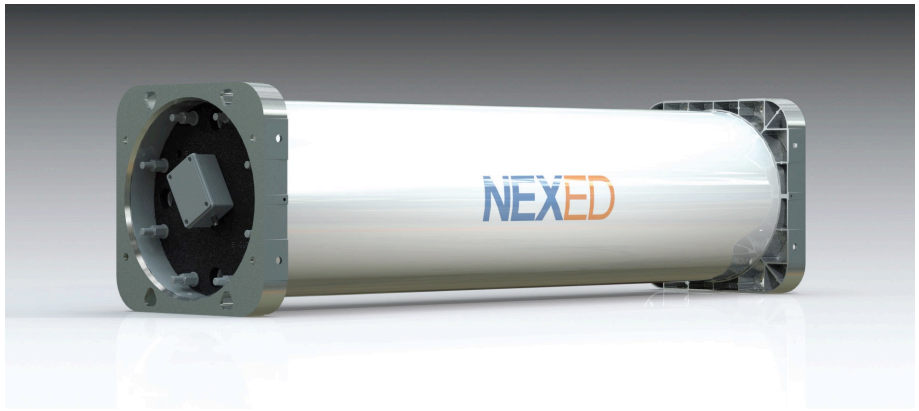
NEXED Technical Overview

NEXED Modules – EDR Designed as 'Desalting Engines'

Traditional assembly

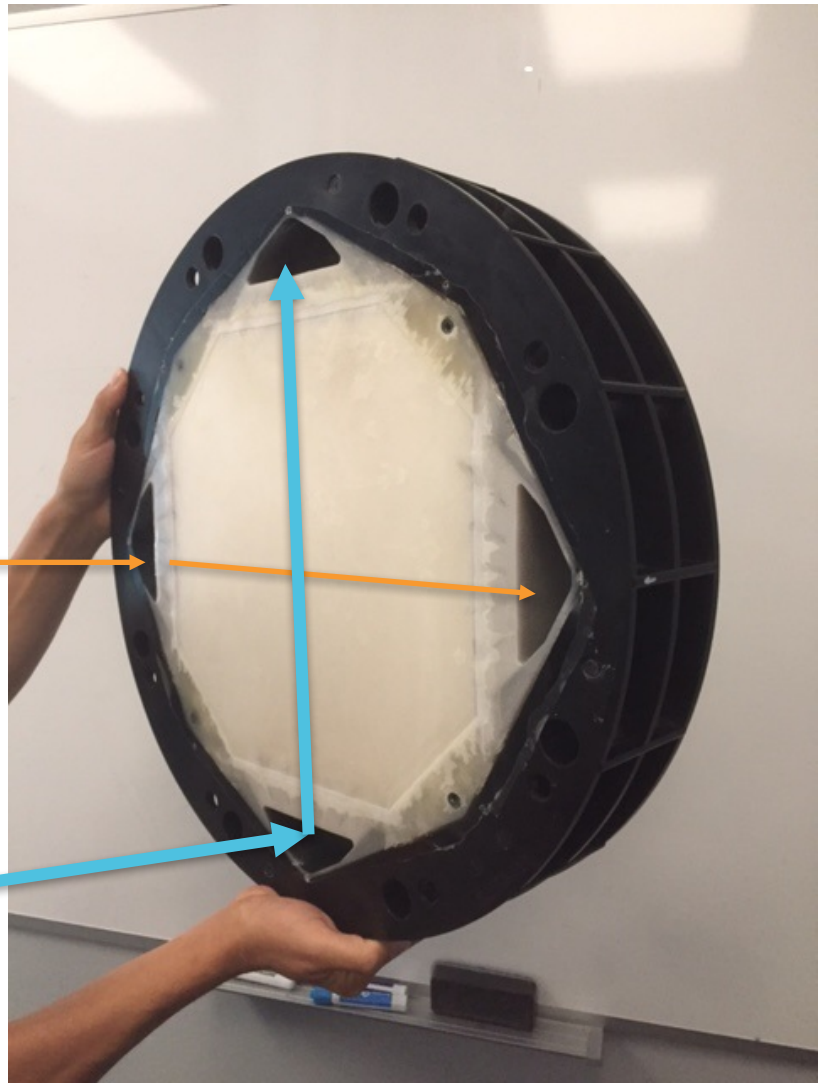
vs

Advanced building block design



'Innovative, next generation configuration of a commercially accepted and proven technology process'

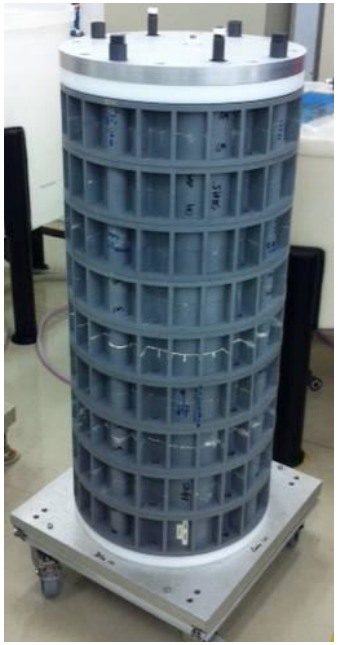
NEXED Sub-Block cross flow design

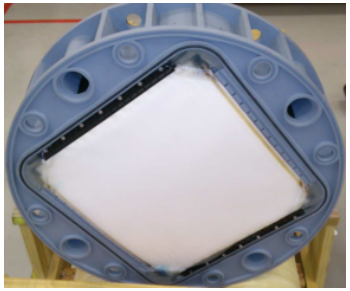


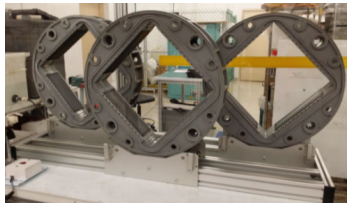
NEXED Technical Overview

Evoqua's NEXED® Technology 'Electrochemical Desalination'

Evoqua's EDR Module
~85% Membrane Utilization
Automatable Assembly
Molded Components

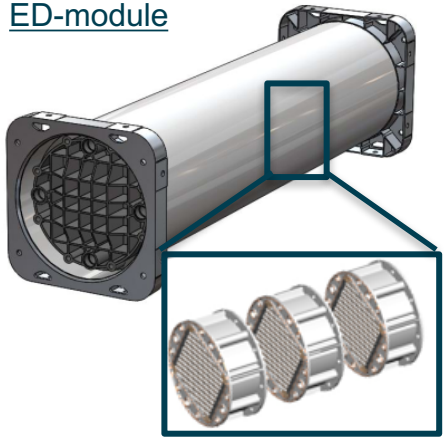






Detail

ED-module

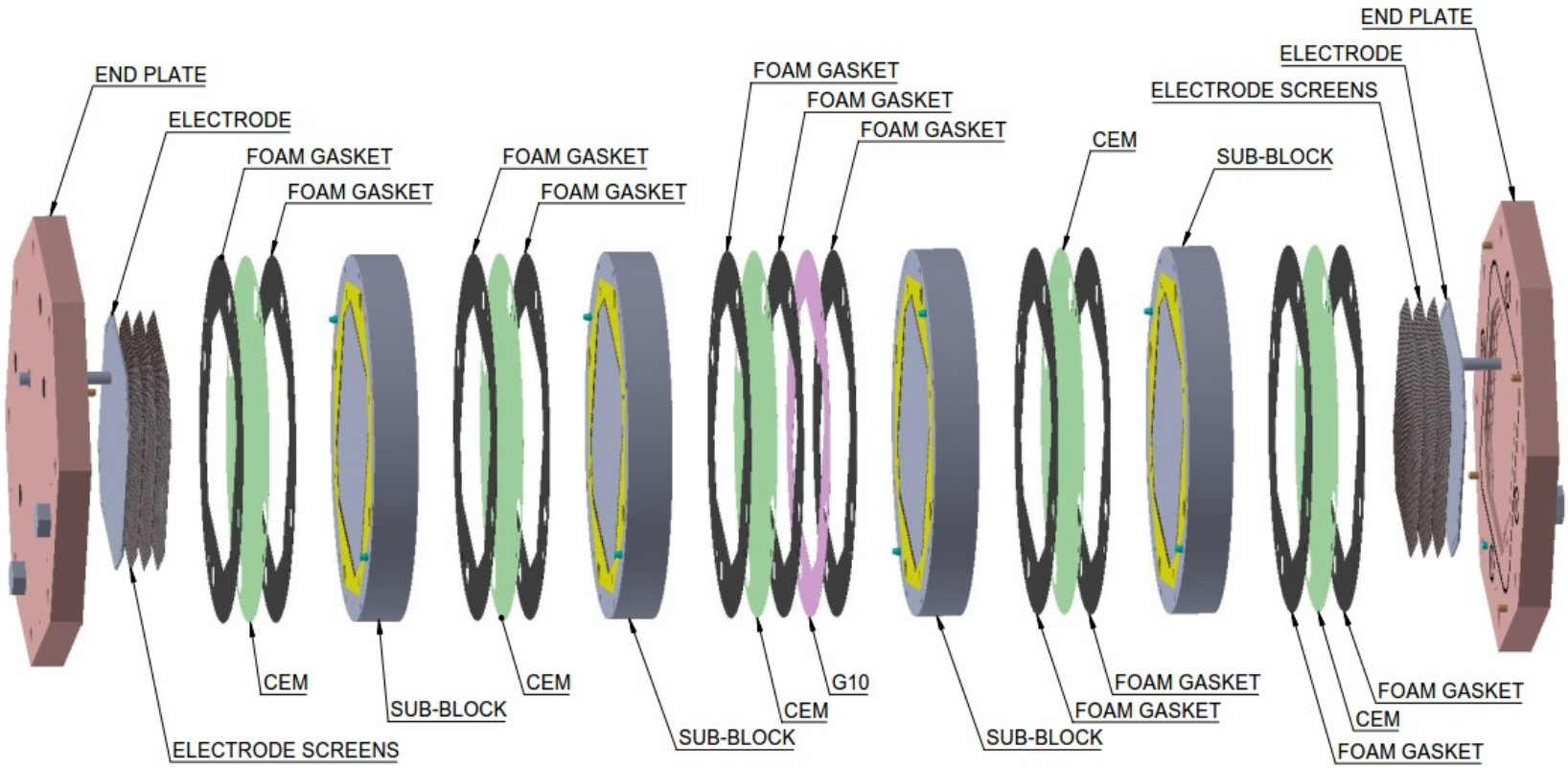


Sub-blocks
- 4 – NexED3
- 16 – NexED12

Preliminary result:	Evoqua-ED	RO
NaCl Feed (ppm):	1,800	1,800
Product @ 1 m^3/hr (ppm):	430	54
Reject (ppm):	17,000	8,800
Recovery:	91%	80%
Energy (kw.hr/m^3):	0.73	>1

NEXED Technical Overview

NEXED Module Internal Design

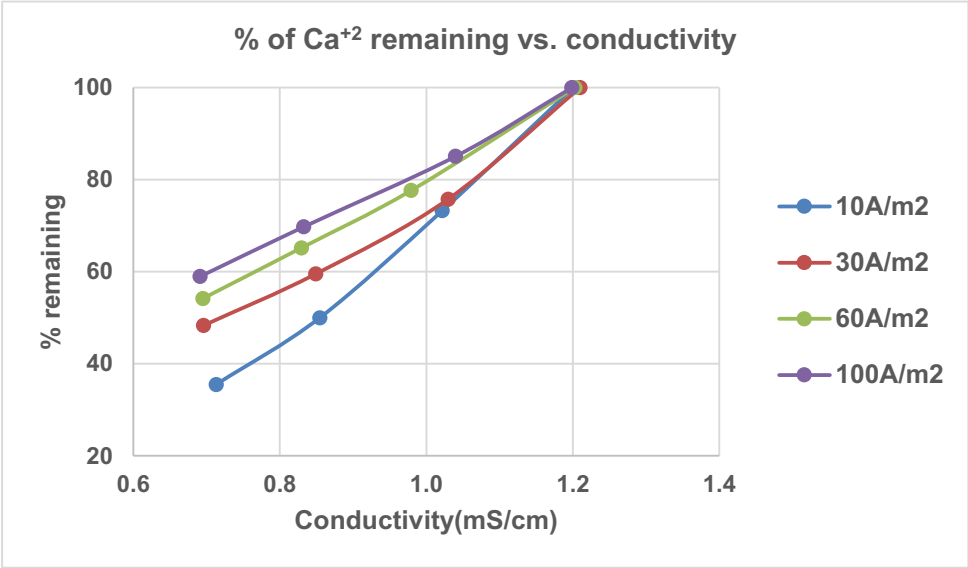


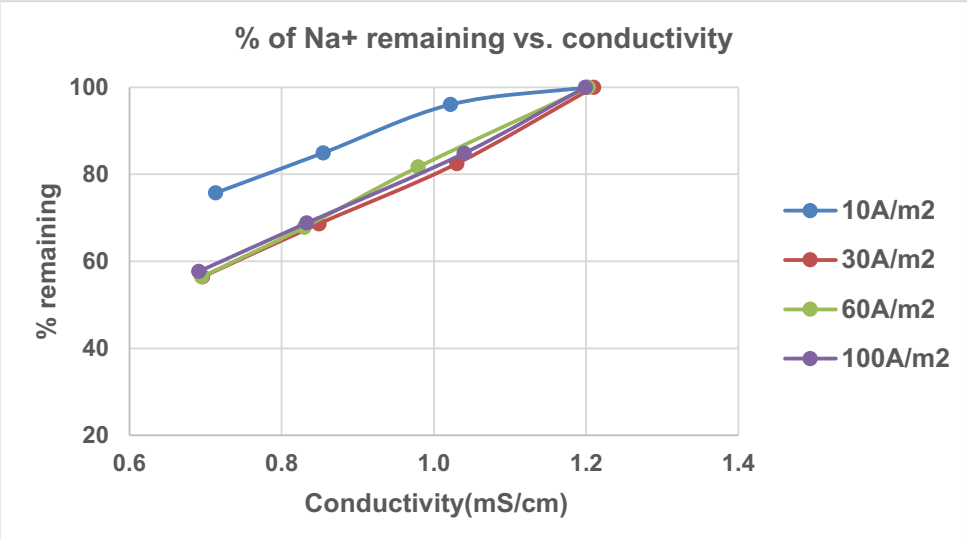
Example of test results with a simulated well water

Cations	Concentration	Units
Ca2+	95.9	mg/L
Na+	143.1	mg/L
Anions	Concentration	Units
HCO3-	165.1	mg/L
Cl-	257	mg/L
SO42-	52	mg/L

Total hardness: 239.6 mg/l $CaCO_3$
LSI: 0.53

- Ca+2 is preferentially removed at low current densities
- % removal of Na^{+} and Ca^{+2} converge as the current densities increase

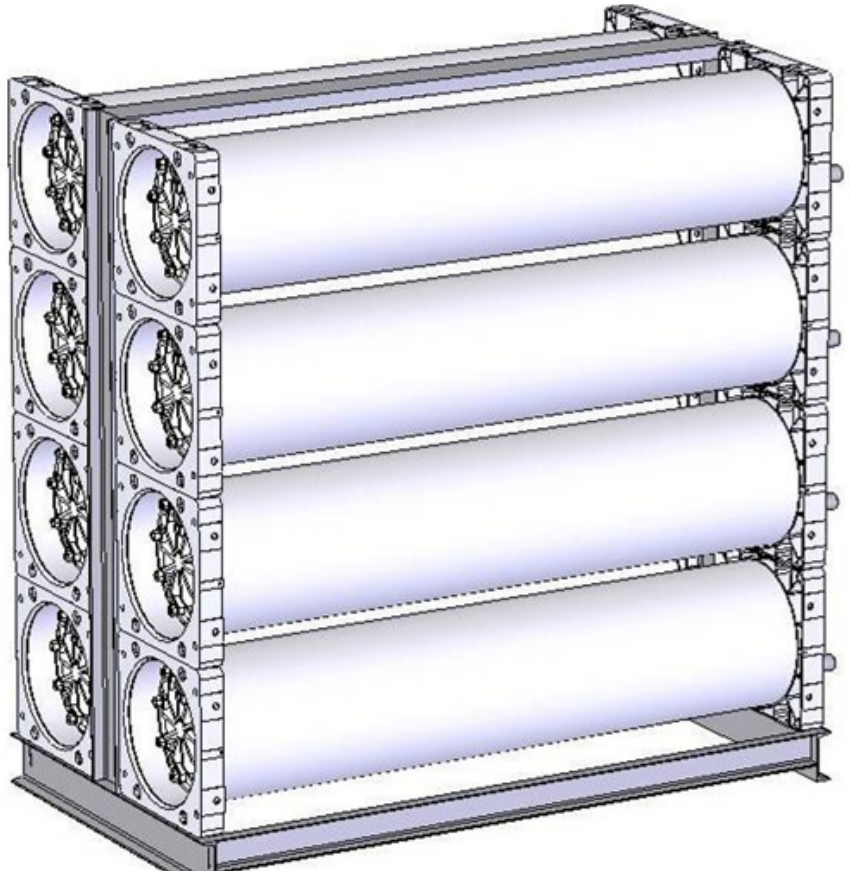




NEXED Technical Overview

NEXED Advantages over Conventional EDR

1) Modular design – modules are stackable allowing for 100 m3/hr (440 GPM) in 4'W x 6'L x 8'H space
2) Up to 30% less energy with thin low energy membrane
3) Cost competitive automated design
4) OEM model allows for efficient custom system design
5) Membranes designed for high cleanability
6) Adaptable internal configuration for optimized solutions



NEXED Technical Overview

NEXED Advantages over Reverse Osmosis

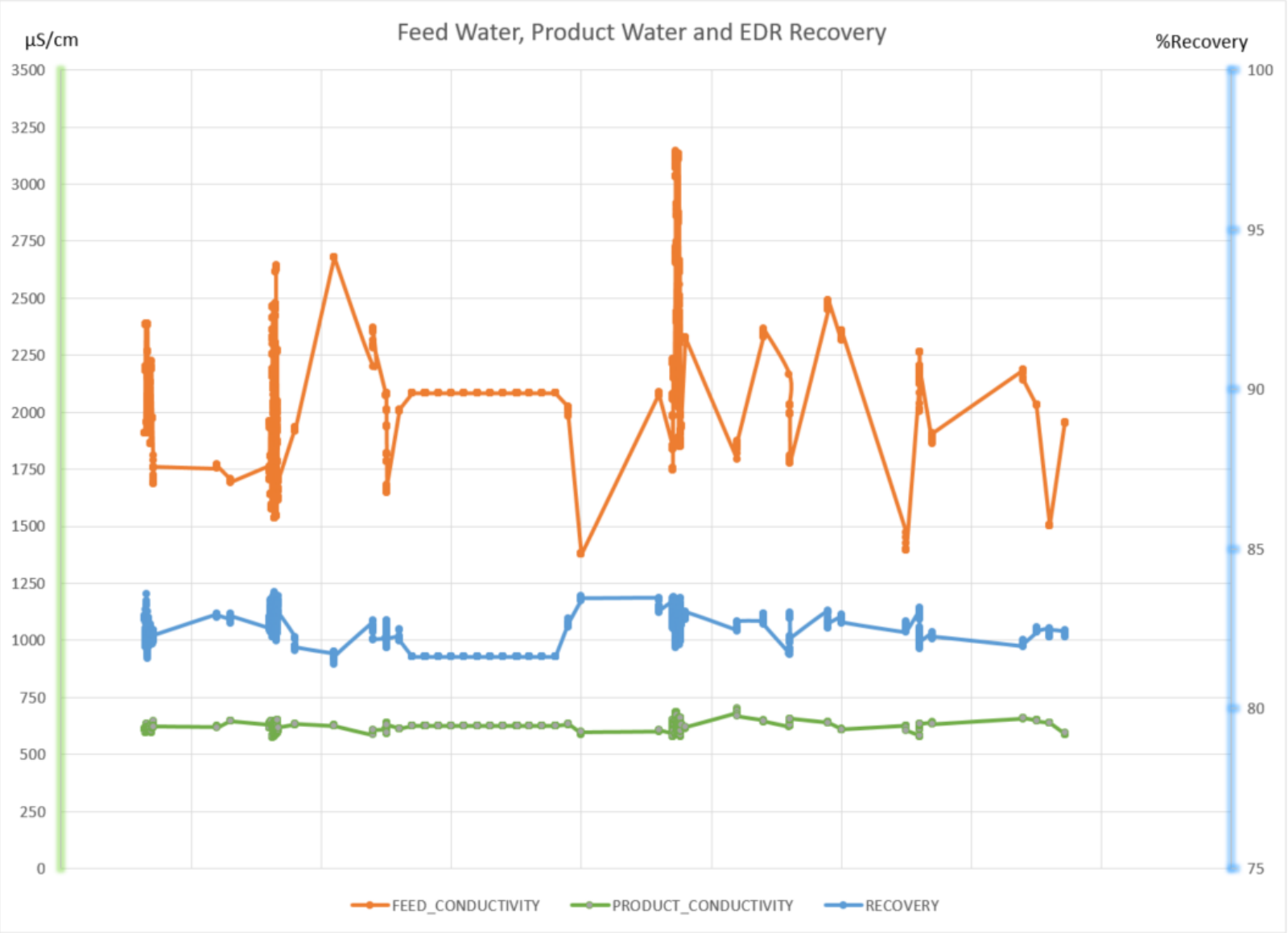
Less Biofouling potential	⟷	Not RO membrane filtration
Less silt fouling	⟷	Not RO membrane filtration
Less operating costs	⟷	Reduced CIP and maintenance
Resistant to process upsets	⟷	High ability to recover and clean
Less space requirements	⟷	Stackable modules
Can be optimized for low energy, high recovery or small footprint.	⟷	Adjustable, designed according to site specific needs
Reduced costs and maintenance	⟷	Low pressure design
Real time adjustment of salt removal	⟷	Tunable, adjustments in electrical current effects product water quality

NEXED Technical Overview

NEXED 'Sweet Spot'

- Feed TDS <7000 mg/l
- High recovery, 75-95%.
- Salt removal rates of 70 - 95%.
- High silica feed water
- Feed water with <0.3 mg/l Fe, <0.1 mg/l Al & Mn, with $CaCO_3$ & $CaSO_4$ below saturation.
- Difficult applications for RO

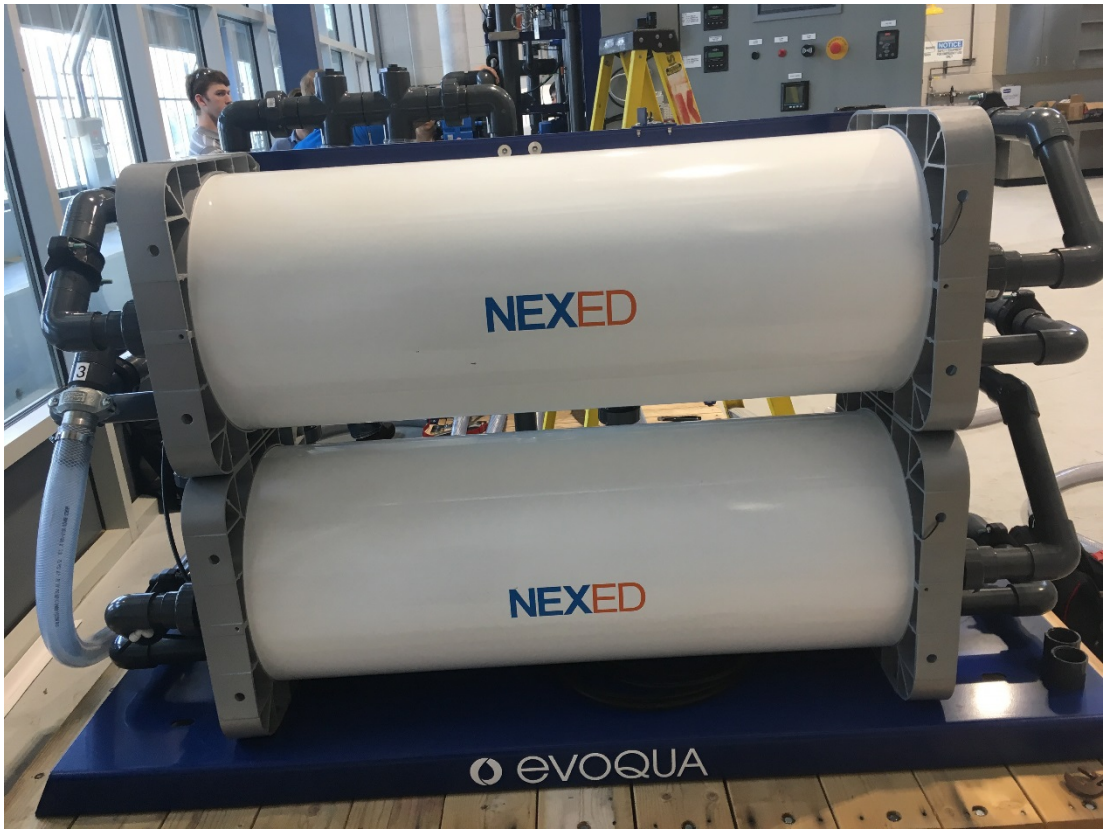
System by Master Service Provider for North America



NEXED™ Applications
Desalting for recovery, reuse and recycle

Applications include:

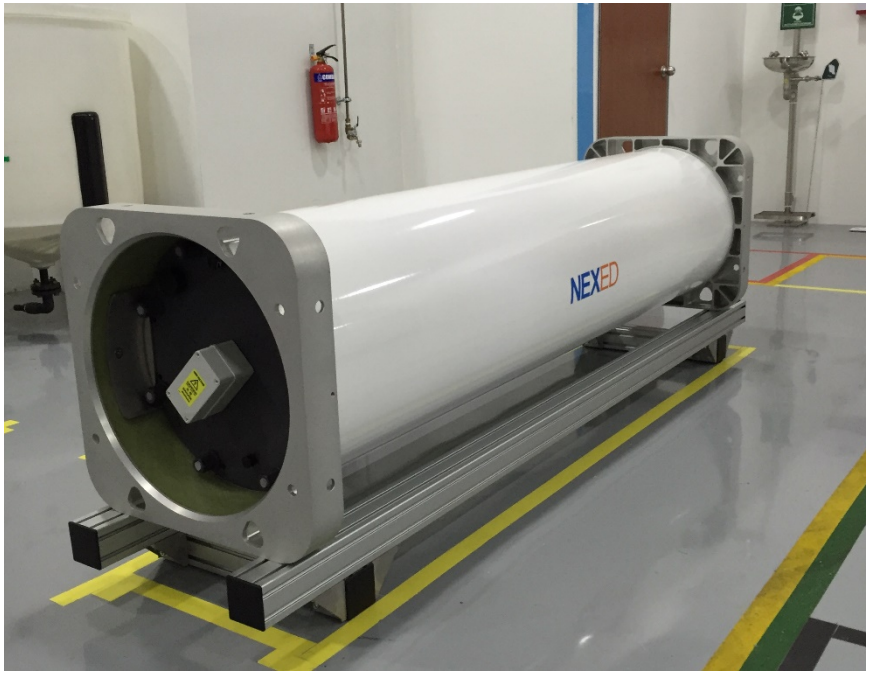
- Brackish water TDS reduction
- RO reject recovery
- Cooling tower blowdown
- Wastewater reuse
- Variable salinity applications
- Hardness Removal (Softening)



NEXED Technical Overview

Evoqua has Solved Major Technology Gaps

- **Broadening the applicability of Electrochemical Desalting techniques**
- **Cost driven and designed for automation**
  - New Low Energy Membrane
  - New Module design
  - New Process design



Demonstration Site Overview

Kay Bailey Hutchison Desalination plant

el paso WATER

Reverse Osmosis Train

Feed Pumps

Salts

Cartridge Filter Casing

TecH$_2$O Center Exhibit Hall

Research Facility

- The El Paso Water Kay Bailey Hutchison Desalination plant has the largest design capacity in the state (27.5MGD), and is the largest inland desalination plant in the world
- 16 production wells and 16 blend wells feed groundwater from the Hueco Bolson Aquifer
- Pretreatment includes sand strainers, cartridge filters, and the addition of anti-scalant.
- There are 5 reverse osmosis trains constructed in a two-stage configuration, 48:24 pressure vessel array.
- Each train is designed to produce 3 MGD at 82.5 percent recovery.

Evoqua / AccelerateH2O / UTEP Collaboration

The technology demonstration project, execution of a multi-month operating cycle of Evoqua's NEXED technology on a pre-qualified, TCEQ permitted facility for brackish desalination and advanced water treatment.

- Technology Supply
- Project Direction
- Business Development & Commercialization

- Project Management
- Stakeholder Outreach / Marketing

- Site Operation & Management
- Technology Performance Monitoring, Reporting & Evaluation

Demonstration Site Overview

Evoqua NexSys Skid Mounted System Installation

- **Technical Details of the Installation**
- Flows – 25 gpm
- Configuration – 2-Pass (2-stage)

- **OPERATING PHASES**
- Phase 1 - Evaluation Begins, 88% System Recovery at 650 ppm
- Phase 2 - Highest Energy Savings, 82.5% Recovery Meeting Output of 650 ppm

TRANSFORMING WATER.
ENRICHING LIFE.

evoqua
WATER TECHNOLOGIES

Thank You for your attention

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