PX Q400 Introduction

Training

November 2022

Water Business Development

NASDAQ: ERII

AGENDA

- PX Q400 Overview
- Performance Comparison: PX Q300 vs PX Q400
- Economic Benefits of the Performance Improvements
- Field Testing
- Literature & Resources

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Product Overview

PX Q400 – STANDARD FEATURES AND BENEFITS

Highest capacity, highest efficiency and lowest mixing PX

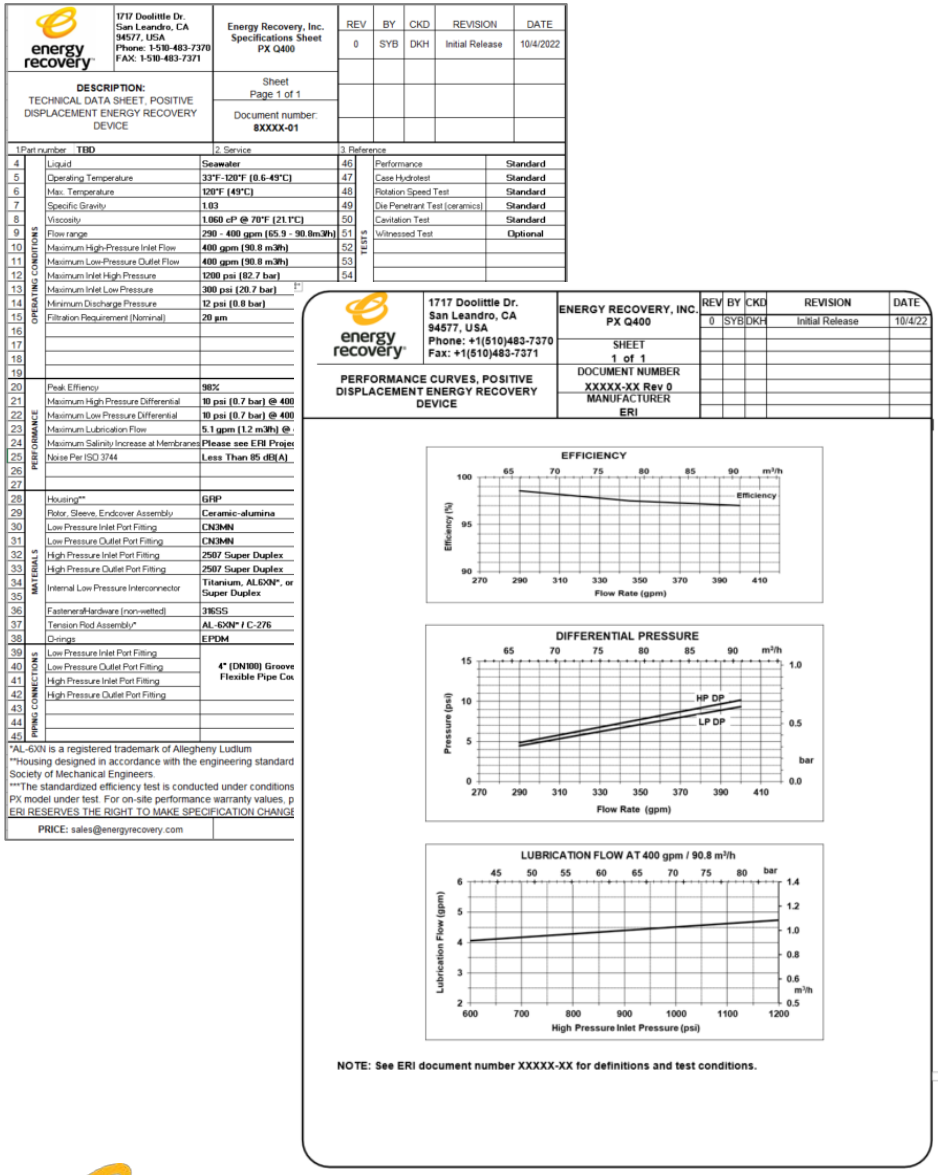
Features:

- Latest PX Q400 based on proven PX technology
- Flow capacity: 65.9 – 90.9 m^3/hr (290 - 400 gpm), max operating pressure of 1200 psi
- One moving component, no control
- Corrosion resistant ceramic core and FRP housing
- Optimized PX design for maximum performance

Benefits:

- Efficiency at max flow is 97.3%
- Volumetric mixing is <3% => Salinity Increase ~1.5%
- Improved performance provides >1% lower SEC compared to PX Q300
- 25% less Q300 modules
    - Smaller footprint
    - Provides saving from R&M
- Designed to recover up to 60% of otherwise wasted energy
- Industry leading reliability
- No scheduled maintenance, low OPEX and lifecycle cost
- Compact, modular and scalable
- Same manifold design as PX Q300

PX Q400: TECHNICAL DATA SHEET AND PERFORMANCE CURVE



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1717 Doolittle Dr.
San Leandro, CA
94577, USA
Phone: 1-510-483-7370
FAX: 1-510-483-7371

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Specifications Sheet
PX Q400

REV	BY	CKD	REVISION	DATE
0	SYB	DKH	Initial Release	10/4/2022

DESCRIPTION:
TECHNICAL DATA SHEET, POSITIVE DISPLACEMENT ENERGY RECOVERY DEVICE

Sheet
Page 1 of 1

Document number:
8XXXX-01

1.Part number: TBD | 2. Service | 3. Reference

OPERATING CONDITIONS	Liquid	Seawater	TESTS	Performance	Standard
	Operating Temperature	33°F-120°F (0.6-49°C)		Case Hydrotest	Standard
	Max. Temperature	120°F (49°C)		Rotation Speed Test	Standard
	Specific Gravity	1.03		Die Penetrant Test (ceramics)	Standard
	Viscosity	1.060 cP @ 70°F (21.1°C)		Cavitation Test	Standard
	Flow range	290 - 400 gpm (65.9 - 90.8m3/h)		Witnessed Test	Optional
	Maximum High-Pressure Inlet Flow	400 gpm (90.8 m3/h)			
	Maximum Low-Pressure Outlet Flow	400 gpm (90.8 m3/h)			
	Maximum Inlet High Pressure	1200 psi (82.7 bar)			
	Maximum Inlet Low Pressure	300 psi (20.7 bar)			
	Minimum Discharge Pressure	12 psi (0.8 bar)			
	Filtration Requirement (Nominal)	20 µm			
PERFORMANCE	Peak Efficiency	98%			
	Maximum High Pressure Differential	10 psi (0.7 bar) @ 400			
	Maximum Low Pressure Differential	10 psi (0.7 bar) @ 400			
	Maximum Lubrication Flow	5.1 gpm (1.2 m3/h) @			
	Maximum Salinity Increase at Membranes	Please see ERI Projec			
	Noise Per ISO 3744	Less Than 85 dB(A)			
MATERIALS	Housing**	GRP			
	Rotor, Sleeve, Endcover Assembly	Ceramic-alumina			
	Low Pressure Inlet Port Fitting	CN3MN			
	Low Pressure Outlet Port Fitting	CN3MN			
	High Pressure Inlet Port Fitting	2507 Super Duplex			
	High Pressure Outlet Port Fitting	2507 Super Duplex			
	Internal Low Pressure Interconnector	Titanium, AL6XN*, or Super Duplex			
	Fasteners/Hardware (non-wetted)	316SS			
	Tension Rod Assembly*	AL-6XN* / C-276			
	O-rings	EPDM			
PIPING CONNECTIONS	Low Pressure Inlet Port Fitting	4" (DN100) Groove			
	Low Pressure Outlet Port Fitting	Flexible Pipe Cou			
	High Pressure Inlet Port Fitting				
	High Pressure Outlet Port Fitting				

*AL-6XN is a registered trademark of Allegheny Ludlum
**Housing designed in accordance with the engineering standard Society of Mechanical Engineers.
***The standardized efficiency test is conducted under conditions PX model under test. For on-site performance warranty values, p
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PRICE: sales@energyrecovery.com

energy recovery

1717 Doolittle Dr.
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Fax: +1(510)483-7371

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PX Q400

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1 of 1

DOCUMENT NUMBER
XXXXX-XX Rev 0

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PERFORMANCE CURVES, POSITIVE DISPLACEMENT ENERGY RECOVERY DEVICE

NOTE: See ERI document number XXXXX-XX for definitions and test conditions.

	Specifications
ERD Technology	PX
Flow Range	290 – 400 gpm (65.9 – 90.9 m3/h)
Max Inlet High Pressure	1200 psi (82.7 bar)
Min Discharge Pressure	12 psi (0.8 bar)
Filtration Requirement	20 µm
Peak Efficiency	98%
Max Hi Press. Diff.	10 psi (0.7 bar)
Max Lo Press. Diff.	10 psi (0.7 bar)
Max Lube Flow	5.1 gpm (1.2 m^3/h)
All Ports	4" (DN100) Grooved-end Flexible Pipe Coupling
PV Size	9 inch ID

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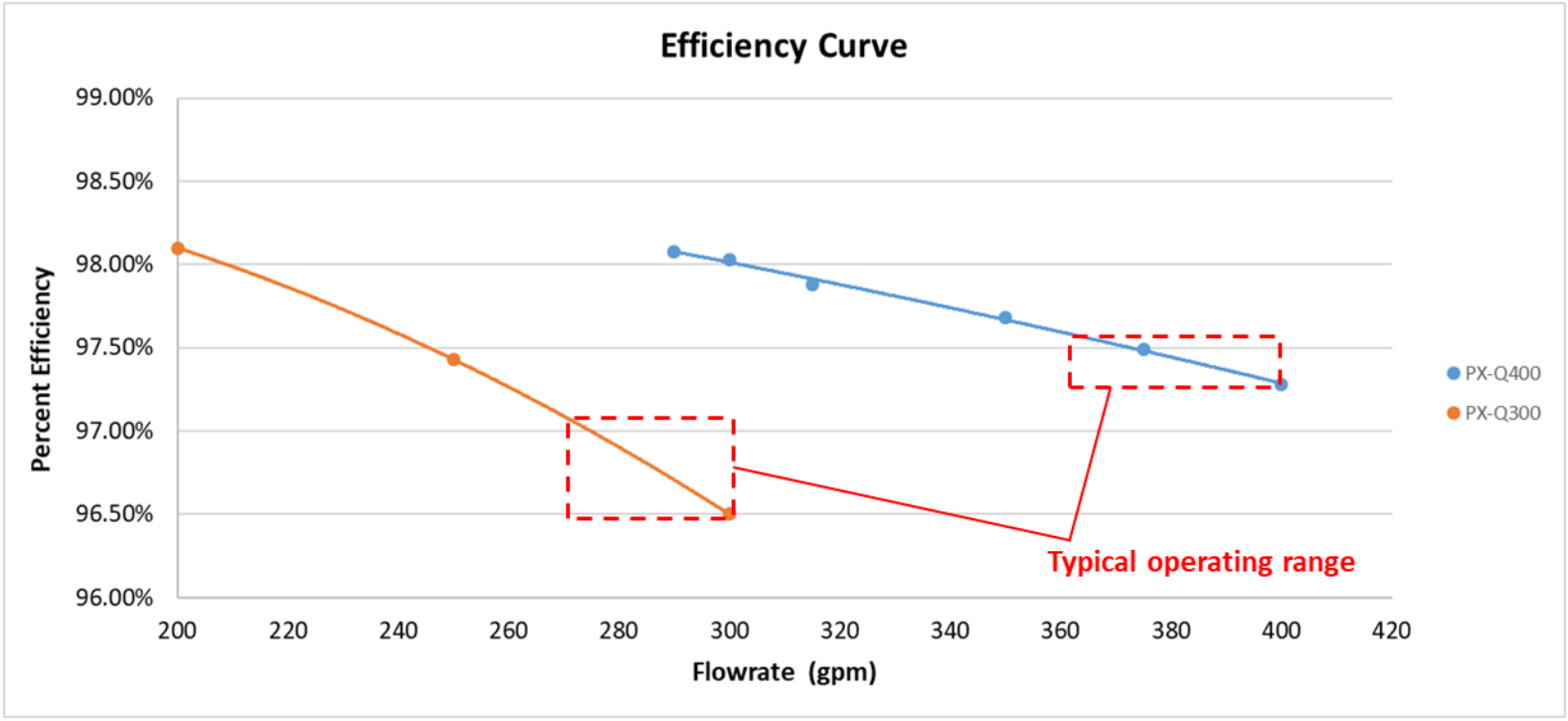
Performance Comparison

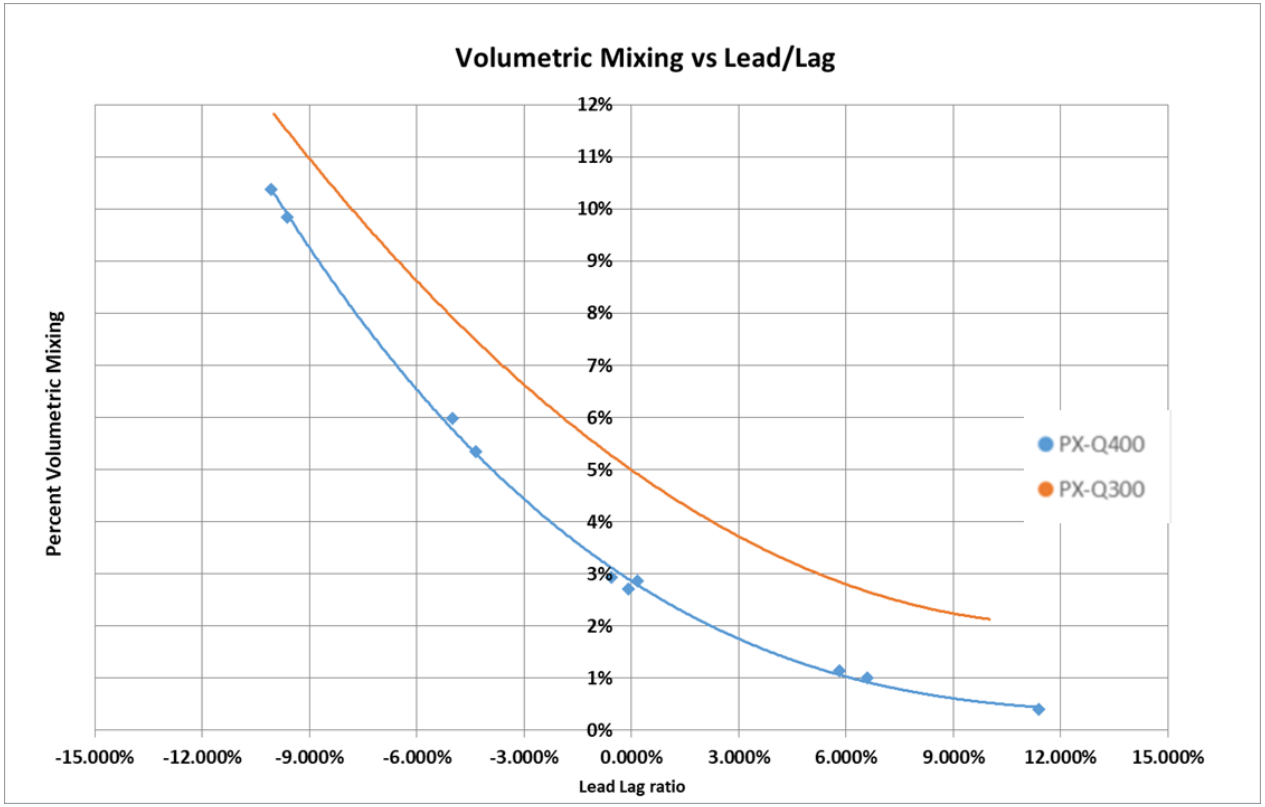
In-house testing

PX Q400: EFFICIENCY



- PX Q400 has the highest average efficiency throughout the flow range
- At maximum flow capacity, PX Q400 demonstrates higher efficiency than PX Q300 with a gain of 0.8% (97.3% vs 96.5%)

PX Q400: VOLUMETRIC MIXING



- PX Q400 demonstrates lower percent volumetric mixing than PX Q300
- At balance flow (0% Lead/Lag ratio), PX Q400 mixing is reduced down to 3%

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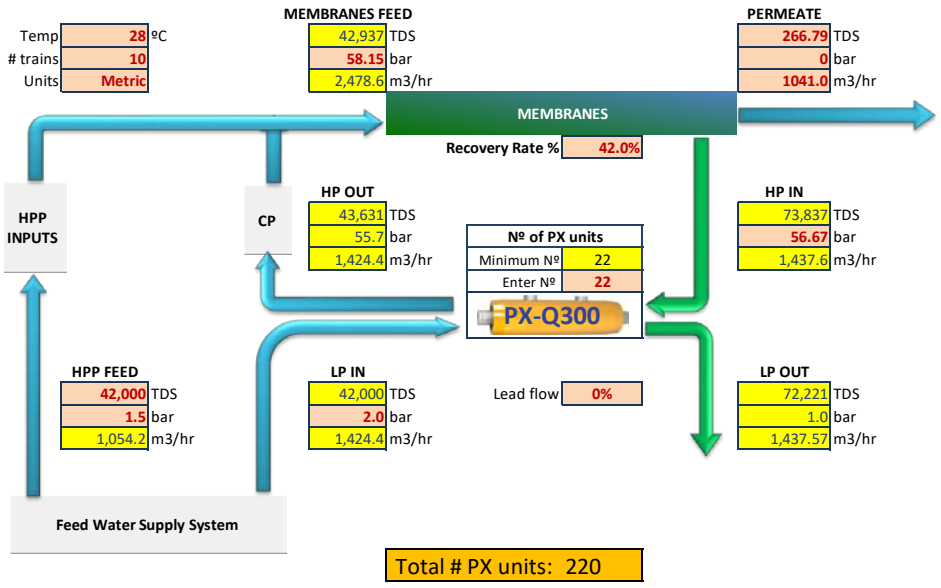
Economics:

Reducing Desal Plant OPEX further

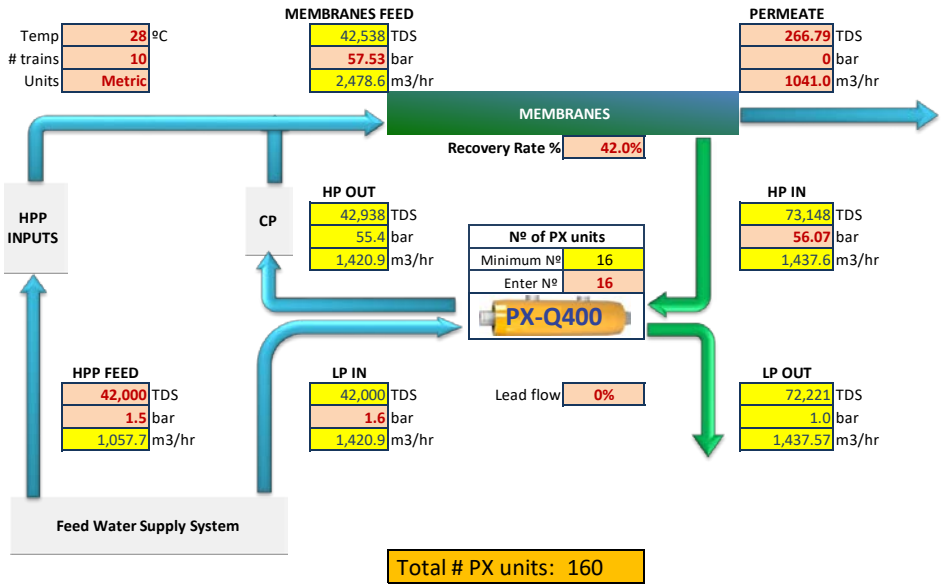
ECONOMIC BENEFITS FROM PX PERFORMANCE IMPROVEMENTS



Total # PX units: 220

PX Technology Performance		
PX unitary flow	65.3	m3/hr
Salinity Increase at membranes	2.2%	
Volumetric mixing VM	5.1%	1
Lubrication flow (LF) per PX array	13.2	m3/hr
LF as % of concentrate flow	0.9%	
HP DP	0.9	bar
LP DP	1.0	bar 3
RO Specific Energy **	2.072	kWh/m3
Brine Recovery Efficiency	97.429%	
Overall PX Efficiency	95.911%	2

** Does not Include Feedwater Supply Pump Energy consumption



Total # PX units: 160

PX Technology Performance		
PX unitary flow	89.8	m3/hr
Salinity Increase at membranes	1.3%	
Volumetric mixing VM	3.0%	1
Lubrication flow (LF) per PX array	16.7	m3/hr
LF as % of concentrate flow	1.2%	
HP DP	0.7	bar
LP DP	0.6	bar 3
RO Specific Energy **	2.044	kWh/m3
Brine Recovery Efficiency	97.631%	
Overall PX Efficiency	96.635%	2

** Does not Include Feedwater Supply Pump Energy consumption

1) Lower volumetric mixing → lower membrane feed salinity and pressure
2) Higher overall PX efficiency
3) Lower HP and LP DP's

ECONOMIC BENEFITS FROM PX PERFORMANCE IMPROVEMENTS (2)

Case Study:

- 250K CMD Plant
- 42% Recovery rate
- 10 SWRO trains

	Option #1: Feed Supply Energy Not Included	Option #2: Feed Supply Energy INCLUDED
Q300 Design (kWh/m3)	2.072	2.216
Q400 Design (kWh/m3)	2.044	2.169
Savings Q400 over Q300 (kWh/m3)	0.028	0.047
Total $$ Savings over 20 years (US $0.10/kWh)	$ 5,183,000	$ 8,522,750

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Field Testing

PX-Q400 BETA TEST: OVERVIEW

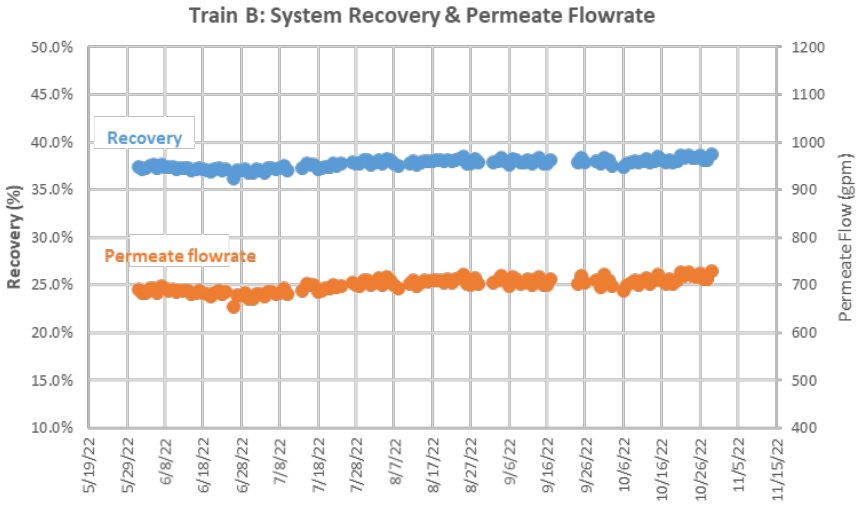
- SWRO Plant in the Caribbean
- Produces water primarily for drinking water, and sends remaining water to power plant for power generation
- RO Train Configuration: 3 Trains, 42 Pressure Vessels w/ (7) Filmtec SWRO, 850 psi membrane pressure, 38 - 40% recovery:
  - **Train B: 3,800 CMD capacity, with (4) PX-Q300 replaced with (3) PX-Q400**

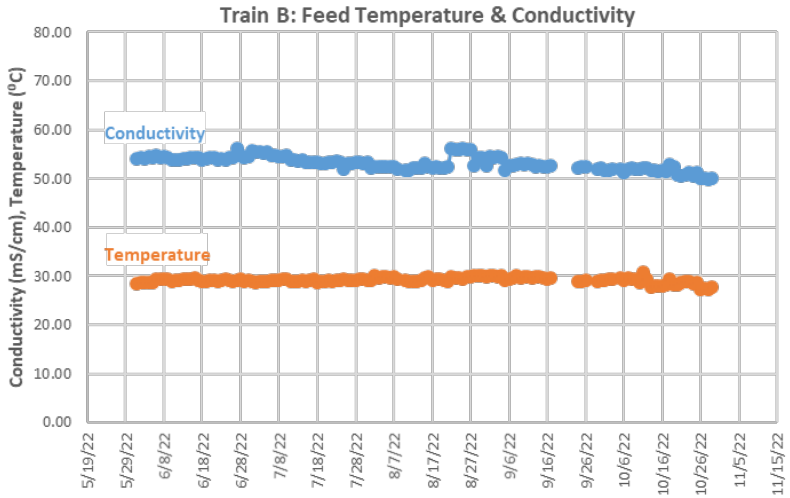
Before (PX-Q300)

After (PX-Q400)

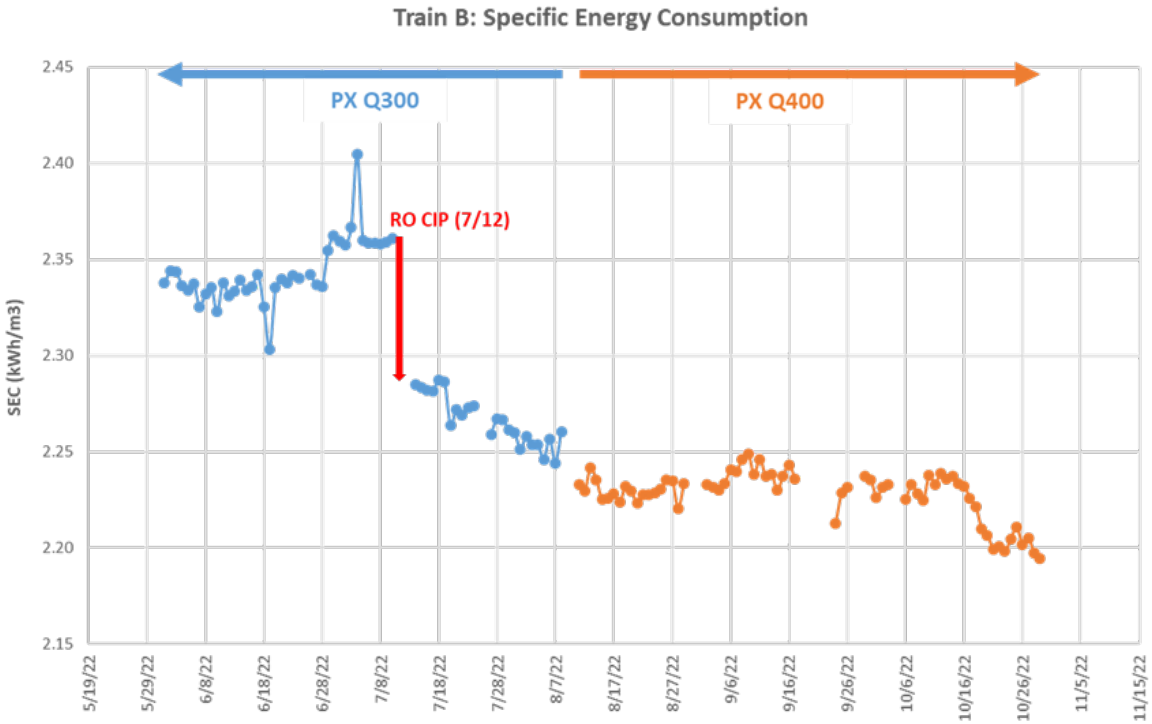
PX-Q400 BETA TEST: RESULTS

- PX replacement from PX Q300 to PX Q400 occurred on August 8th
- Stable feed water conditions and operating conditions before and after the PX replacement on Train B





PX-Q400 BETA TEST: RESULTS (2)



- HPP Pump pressure dropped by 0.5 bar after installing PX Q400
- PX Q400 shows lower SEC than PX Q300 (0.02 kWh/m3 ~ 1% reduction)
- SEC reduction represents an annual saving ~$13K in energy cost for Train B (@$0.4/kWh)
- Stable SEC since starting up PX Q400
- The SEC reduction is in agreement with the projection

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Literature & Resource

PX Q400 DOCUMENTATIONS

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PX Q400

Our most efficient, highest-capacity PX available for seawater reverse osmosis desalination facilities.

The next evolution in PX® Pressure Exchanger® Technology
Building upon Energy Recovery's reputation for best-in-class performance, the PX Q400 is our next evolution in the trusted, leading PX® Pressure Exchanger® technology. Delivering energy and cost savings, the PX Q400 offers the lowest life cycle cost of any energy recovery device (ERD) for seawater reverse osmosis (SWRO) desalination, and it's possible thanks to high performance and lower maintenance.

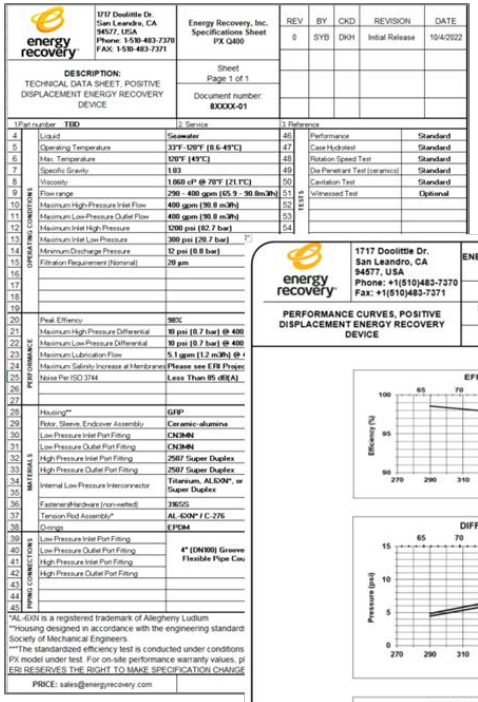
Reliable in even the harshest desalination environments
Constructed from corrosion-resistant ceramic and designed with only one moving part, the PX Q400 is easy to use, highly durable, and ideal for harsh desalination environments. These ceramic components are unique and machined in-house using our vertically integrated and highly specialized manufacturing processes, which create precision down to the micrometer level and a consistently high performing product. The PX Q400 supports a 25-year design life with no scheduled maintenance; leading to incredibly low design life costs and high uptime.

By The Numbers

- **25%** fewer devices needed to achieve the same output compared to the Q300*
- Capacity of **400 gpm** per module
- **<3% mixing**

PX Q400
BENEFITS

- **Highly efficient** – Highest efficiency at the highest flow compared to our other PX Pressure Exchanger technology products
- **Lower mixing** – <3% mixing resulting in higher system performance
- **Higher capacity** – At 400 gpm, it's our highest capacity PX yet, which results in 25% fewer devices compared to the Q300*
- **Ideal for harsh environments** – Industry-leading 25-year design life
- **Lowest life-cycle cost** – Offers the lowest life cycle cost of any ERD for seawater reverse osmosis (SWRO) desalination due to lower maintenance and operational expenditures



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	Fastener/Hardware (non-wetted)	316SS			
	Tension Rod Assembly*	AL-6XN* / C-276			
	O-rings	EPDM			
PIPING CONNECTIONS	Low Pressure Inlet Port Fitting	4" (DN100) Groove Flexible Pipe Cou			
	Low Pressure Outlet Port Fitting				
	High Pressure Inlet Port Fitting				
	High Pressure Outlet Port Fitting				

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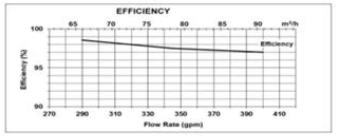

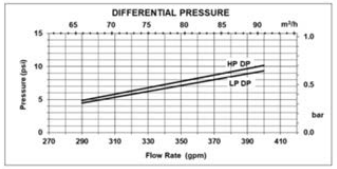

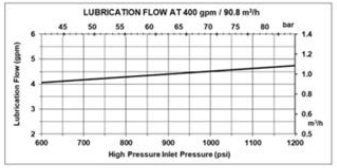

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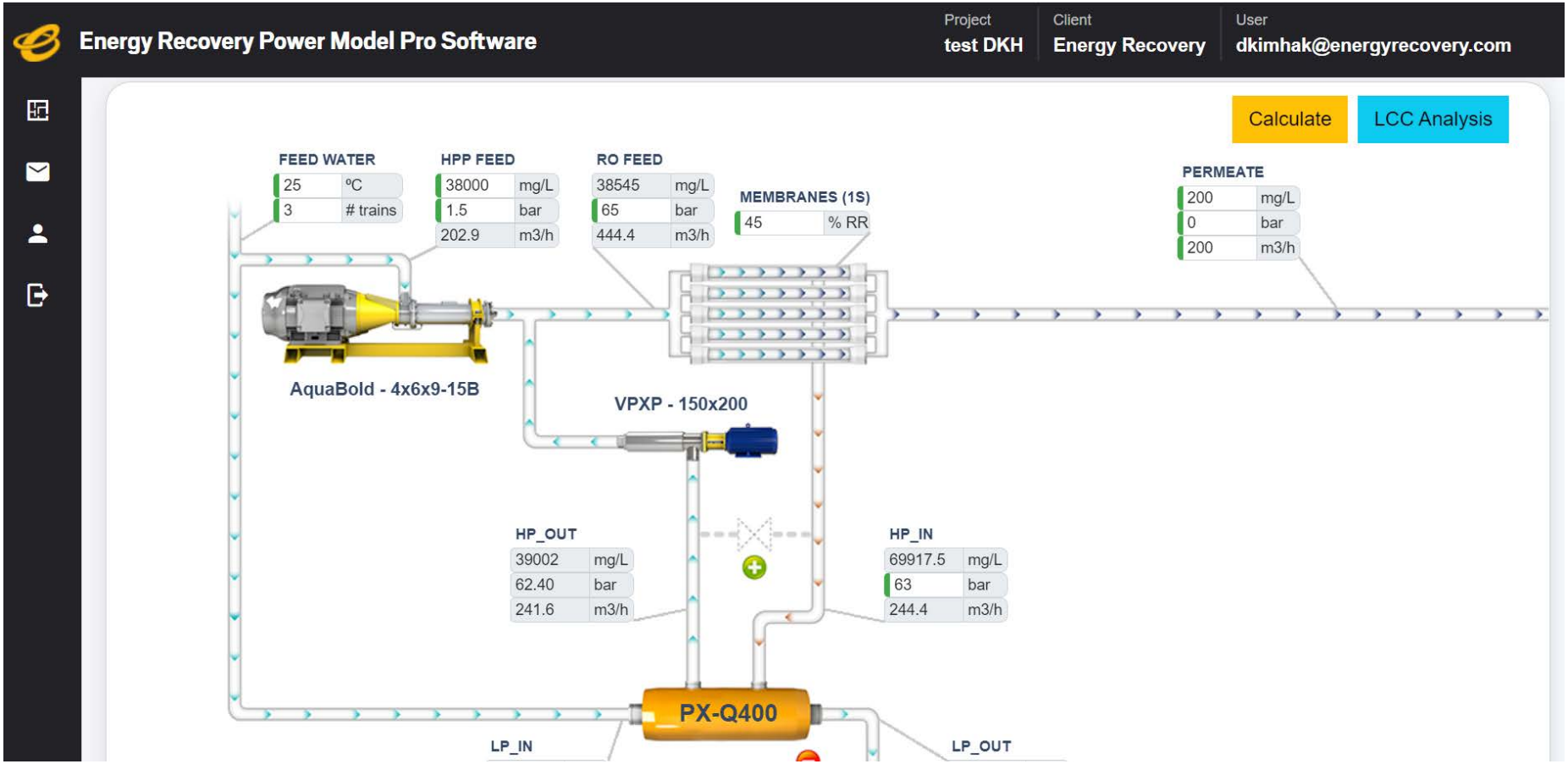
Energy Recovery Power Model Pro Software
Project
test DKH
Client
Energy Recovery
User
dkimhak@energyrecovery.com
Calculate
LCC Analysis
FEED WATER
25 °C
3 # trains
HPP FEED
38000 mg/L
1.5 bar
202.9 m3/h
RO FEED
38545 mg/L
65 bar
444.4 m3/h
MEMBRANES (1S)
45 % RR
PERMEATE
200 mg/L
0 bar
200 m3/h
AquaBold - 4x6x9-15B
VPXP - 150x200
HP_OUT
39002 mg/L
62.40 bar
241.6 m3/h
HP_IN
69917.5 mg/L
63 bar
244.4 m3/h
PX-Q400
LP_IN
LP_OUT

THANK YOU

Contacts:

Product Director: David Kim-Hak, dkimhak@energyrecovery.com

Global Sales Director: Castor Criado, ccriado@energyrecovery.com

Sr Water Vice President: rclemente@energyrecovery.com