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PUB Water Utility Increases Recovery Rate from 75% to more than 90% using novel Flow Reversal Reverse Osmosis (FR-RO) Technology for Reuse Purposes

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Agenda Topics



- AdEdge Introduction
- Flow Reversal Reverse Osmosis (FR-RO) Technology Overview
- PUB Case Study Industrial Reuse Application
- Exciting new Development for FR-RO First US Based Project Preliminary Update
- Q&A



Facts & Figures



- Approximately 900 system installations
- Unprecedented > 37% growth in 2018
- 99.9% of systems remain in operation
- Worker's Comp (Safety) index of 0.84...lowest in Water Industry
- Health & Safety Program Manager
- Multiple arsenic projects awarded in Latin America including one of the largest Adsorption projects in the world in 2017 & 2018
- No legal disputes, lawsuits or insurance claims in 17 year company history!
- Treatment solutions for > 20 different contaminants & extensive piloting program



AdEdge Treatment Matrix







AdEdge Innovation History



Bayoxide E33

Adsorption media for arsenic and heavy metals removal



MnO2 Catalytic Media

Arsenic, iron, manganese, and hydrogen sulfide removal media



Plug and play containerized treatment solution



Backwash recycle system with a 99.7% water recovery rate



Biological filtration for the removal of nitrate, perchlorate and other contaminants from groundwater

NǿMonia NoMonia™

Biological filtration for the removal of ammonia, arsenic, iron, and other contaminants from water



911box



Flow-Reversal RO Technology for higher recovery and lower wastewater volume



Remote programing trouble shooting for immediate response



Flow Reversal RO

A New Approach to Increasing System recoveries & Facilitating Concentrate management



Buzz words in the Water Industry







75% is Totally 70's



Site	Conventional RO RR	Flow-Reversal RO RR	% Increase (permeate)	% Decrease (concentrate)
Beverage company	65%	85%	20%	57%
Brewery	75%	92%	27%	68%
Fracking water	70%	89%	19%	63%
Cooling tower	71%	91%	20%	69%
SWRO 2 nd pass	90%	98%	8%	80%
Reuse	80%	90%	10%	50%





A conventional RO with a (patented)



Innovative, but not new





Voted "**The Most Valuable Technology**" Singapore International Water Week July 2018



Voted "**The Most Important Desal Technology**" TX Desal Sep 2018





AdEdge – Rotec Partnership



AdEdge was selected as the U.S. Partner of Rotec to introduce, establish, market, manufacture & sell this disruptive RO technology to North America.

Rotec owns the IP for the Flow-Reversal technology.

Why AdEdge?

- Experience with RO Membrane Technology
- Extensive water treatment capabilities
- Integration Capability with pre-treatment and Other Equipment
- Internal manufacturing Facility, U.S. made. US Operation
- Piloting, QA, and Service Departments





What can Flow-Reversal RO do?

- Maximize permeate flow by 20%
- Optimize feed water use by 20%
- Minimize concentrate flow by 60%
 - Concentrate management
- \$ ZLD

Two Ways to Save



80% RECOVERY (CONVENTIONAL RO)



92% RECOVERY (FR-RO)



Flow Reversal Prevents Scaling

Our solution:

Operate at higher recovery by reducing scaling potential.

Operational implications of scaling:

- Mineral Scaling leads to RO membrane plugging and...
- Decrease in flux >>Increase energy consumption
- Increased: CIP frequencies, Down time, Chemical consumption
- Overall increase in OPEX and decrease in profitability











Why Flow-Reversal RO is so Brilliant?



<u>Continuous process</u> works just like conventional RO



New & existing Retrofit



Before

After



<u>Low risk</u> 100% Fallback



<u>No proprietary equipment</u> Always adhere to manufacturers' specs



<u>Added value</u> Reduced biofouling & chemical use



No special operator training is needed

How does FR-RO Work?





The results: Scale prevention



Converting a Conventional RO to FR-RO is Simple



Conventional RO





New RO systems Existing RO systems Flow-reversal Concentrator

Flow-Reversal RO





Block Rotation

2

Block Rotation

3 Continuous

process



Flow Reversal adaptation to tapered flow array in a 2-Stage RO System



Impact of Flow-Reversal on Biofouling





- Sheering forces
- Changing water quality





Flow Reversal Products

1. New RO Systems (RNS)

2. Retrofit Existing RO Systems (RTF)

3. Concentrate Management System (FR-CONC)

Case study: Industrial Reuse application





- PUB is the most appreciated water utility in the world
- Innovation hub
- Large scale retrofit
- Perfect setting for a comparison study
- Municipal Reuse application for Industrial use
- Increased revenue & saving
- Led to a 25MGD new FR-RO system

Retrofit Case Study - PUB, Singapore







Flow Reversal & Block Rotation









Rotation of blocks - 1st and 3rd Stages







Municipal Reuse Retrofit Case Study (

Retrofit Results Summary

	Unit	Conventional RO	Flow Reversal RO	
Recovery Rate	%	75%	90%	
Array Configuration	N/A	49:24	45:25:10	
Feed Flow	GPM	1,955		
Permeate Flow	GPM	1,466	1,760	
Concentrate Flow	GPM	489	192	
Total Number of PVs	#	73	80	
Total Average Flux	gfd	10.4	11.4	
Feed Pressure Stage 1	PSI	100	111.7	
3 rd Stage Booster Pump	PSI	N/A	50.8	
Specific Energy*	kWh/m ³	0.32	0.33	
	kWh/ 1000 gal	1.21	1.25	

Water for All:Conserve, Value, Enjoy

CIP as a Function of Accumulated Product





The CIP was triggered by **a)** 10% increase PD or **b)** 10% drop in specific flux (Lp)

CIP was done when recovery on the FR train was increased in order to have the same starting baseline each time which explains why there is overall a larger total of CIP's in FR than in control.

Economic Comparison (95% utilization)



	% RR	Permeate Million m3/y	Permeate MG/y	Conc. Million m3/y	Conc. MG/y
Conventional RO	76	2.8	740	0.92	243
Flow Reversal RO	90	3.3	872	0.37	98
		(+) 0.5	(+) 132	(-) 0.55	(-) 145

\$1.22 USD/m3 Permeate	\$610,000 / Year
\$0.10 USD/m3 Concentrate removal	\$ 55,000 / Year
Total increased income / Year	\$ 665,000 / Year



First US Based FR-RO Project Preliminary Overview

Case Study: Native American Community in Arizona



Diversified Economy:

- Agriculture
- Casino
- Transportation
- Golf Club
- Entertainment complex

Improvements:

- New fire station •
- Water reclamation facility .
- Surface water treatment plant ۲



The Community is Facing a Water Supply Challenge



November 2019: Shut-down of the only source of water for potable use

The community needs to identify an alternative water source

Must install a new & cost-effective treatment solution in 6 months





Identify an alternative water source



The only readily available water source was groundwater from an idle well (800 gpm) that had never been used due to high concentrations of nitrate, uranium, iron, and total dissolved solids (TDS).











Install a new & cost-effective treatment solution



	Nitrate	Uranium 238	Iron	TDS
MCL	10 mg/L	30 μg/L	0.3 mg/L	<500 mg/L
AK Chin WQ	15 mg/L	30 μg/L	1.0 mg/L	1897 mg/L

Treatment approach & efficacy				
Biological - biottta	Yes	No	No	No
Biological - NoMonia	No	No	Yes	No
IX – NO ₃ , U	Yes *	Yes *	No	No
O/F	No	No	Yes	No
RO (High Recovery Flow-Reversal RO)	Yes	Yes	No	Yes

Hardness, alkalinity, silica

Pick one....



More water - 88% RR vs. 75% RR

1

Less concentrate by 50% compared to conventional RO





Also Good to Know...

- At the end of October 2019 when the canal is drained, FR-RO will be the primary water source for approximately 3 months
- Phase 1 goal is to get the treatment system online for this 3-month downtime period
- Phase 1 includes installation of the AD26, FR-RO, Chemical Feed Systems and a temporary shade structure
- During Phase 1 the community will use their existing WWTP to dispose of the concentrate. The WWTP is not sized for long term operation.
- This was one of the incentives for the higher recovery RO since it minimized the impact to the existing WWTP
- Once the Surface Water Treatment plants are back online the RO will go to reduced operation (4 hr. / day)
- Phase 2 includes the permanent building, evaporation ponds, etc.
- Once Phase 2 is completed, they will alternate usage between the Surface Water Treatment plant and the FR-RO system providing them full redundancy if one of the surface water plants goes down in the future











PROCESS FLOW SCHEMATIC AK CHIN COMMUNITIES FR-RO SYSTEM





"It simply doesn't make sense anymore to install conventional RO"

Questions?