CASE STUDY

Surface Brackish Water Desalination and Brine Minimization

Advancing RO Membrane Performance in High-Recovery Brackish Water Treatment

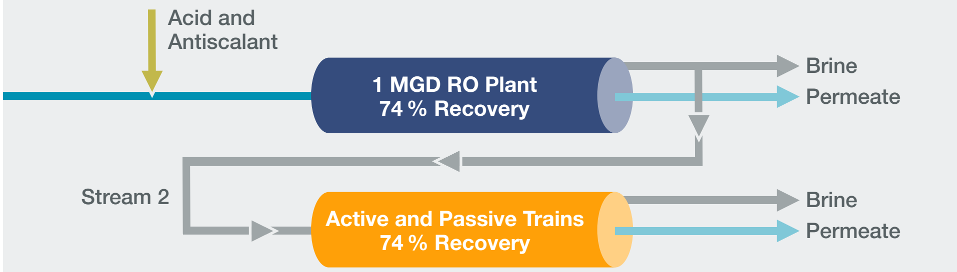
Overview

For a period of 9 months the U.S. Bureau of Reclamation's (USBR) Yuma Desalting Plant in Arizona provided the setting for an extensive project on brackish water desalination. The project evaluated Active Reverse Osmosis (RO) membranes in direct comparison with traditional Passive RO membranes to assess improvements in recovery rates, fouling resistance, and overall efficiency. The project involved two distinct water sources: surface brackish water from the Colorado River (source 1) and brackish water RO concentrate (source 2). Both streams presented significant scaling risks, with high concentrations of silica, gypsum, and lime, alongside organic fouling potential. The objective was to determine whether Active RO membranes could enhance system performance with minimal chemical pre-treatment.

Operational Setup

Source 1: Colorado River Surface Brackish Water

- TDS = 2,300 mg/L
- Hardness = 400 mg/L
- Supersaturated salts at >60% Recovery: Lime, Gypsum
- High Organic fouling potential



Source 2: Colorado Brackish Water RO Concentrate:

- TDS = 7,500 mg/L
- Supersaturated salts : Silica, Lime, Gypsum

Key Results

Higher Recovery Rates:
Active membranes achieved up to 84% recovery, compared to 74% for Passive membranes, increasing freshwater production with the same feedwater volume.

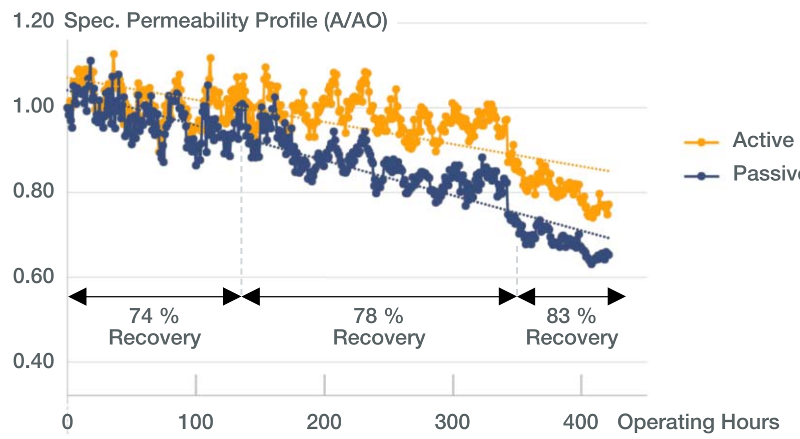
Extended Cleaning Cycles:
- Active membranes required only 3 cleanings, compared to 7 for Passive membranes.
- resulting in 57% performance and uptime improvement

Reduced Fouling and Scaling:
Permeability decline reduced by 18–70%, leading to more stable long-term operation.

Lower Energy and Chemical Demand:
- Active membranes maintained stable operation without the need for anti-scalant chemicals.
- Specific energy consumption (SEC) remained competitive despite higher recovery rates.

Techno-Economic Impact:
When compared to a 1 million gallons per day (MGD) brackish water RO desalination plant in Califonia, a cost savings of 27–65% can be achieved using existing infrastructure.
This impact is driven by higher recovery rates — reducing disposal costs — and eliminating chemical dosing, making desalination more cost-effective and sustainable.

Specific Permeability Profile (Skid)



Impact Example – 1 MGD Brackish Water RO Plant in CA

Feature/Parameter	Unit	Current Process	Active – Single Pass	Active – With Brine Minimization
Flow	m^3 per day	3,785	3,785	4,401
Plant Lifetime	Years	20	20	20
Chemical	-	Acid & Anti-Scalant	None	None
Fresh Water Recovery	%	75	80	92
SEC	kWh/m^3	0.70	0.90	0.94
Lifetime Membrane Replacement Event	Times	7	3	3
Lifecycle Chemicals Cost	$/m^3	0.34	-	-
Lifecycle Waste Disposal Cost	$/m^3	1.76	1.32	0.49
Life Cycle Power Cost	$/m^3	0.11	0.14	0.14
Life Cycle Membrane Cost	$/m^3	0.02	0.01	0.01
Life Cycle Operating Costs	$/m^3	2.23	1.47	0.64
Cost Savings	%	-	34	56
CO_2 Emissions Savings	%	-	7	10

Conclusion

The USBR project confirmed that Active Membranes set the new standard for RO technology. By significantly reducing cleaning frequency, minimizing chemical use, and enabling higher recovery rates, Active Membranes redefine the efficiency and economics of desalination plants.
In addition to cost savings, the reduced reliance on chemicals, fewer cleaning cycles, and lower waste volumes directly contribute to lower carbon emissions, supporting more sustainable and climate-resilient water treatment operations.

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