

Switchable Solvent ZLD (Zero-Liquid Discharge) Process for Solving the Inland Desalination Brine Problem

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Challenge

There are vast reserves of brackish groundwater underlying much of the West that could theoretically be transformed into new fresh water supplies; however, attempts to use those reserves via desalination are almost always curtailed by the cost issues of treating the brine generated by the desalination process itself. Currently, when brine costs are fully included, the price ranges from \$1.30 to \$3.50 per cubic meter which equates to \$1,600 to \$4,250 per acre-foot ("AF"). Our goal is to demonstrate that the proposed novel Zero Liquid Discharge (ZLD) process can achieve 95%+ water recovery when treating a wide range of brine concentrations from multiple inland Brackish Water Reverse Osmosis (BWRO) and Electrodialysis (EDR) sites. Additionally, we intended to demonstrate full process 99% water recovery in a first stage BWRO or EDR system integrated with this new ZLD process, with a blended, levelized OPEX/CAPEX cost of under \$0.65 per cubic meter (\$800 per AF).

Research Approach

Global Water Innovations ("GWI") has teamed with Trevi Systems ("Trevi") to pilot the novel ZLD processes being developed by Trevi at 5 or more sites. We will validate the first viable breakthrough for brine treatment - by reducing the levelized cost of achieving ZLD with BWRO or EDR brines to what we calculate will initially be around \$4.50 to \$5.00 per cubic meter - over 80% less than current thermal ZLD costs of \$26 to \$36 per cubic meter. Of this, we believe \$3.00 or so will be OpEx costs, and the remainder will be 20-year amortized CapEx costs. Our goal with these pilots is to demonstrate that the proposed novel ZLD process can achieve 95%+ water recovery when treating a wide range of brine concentrations - 8,000 to 30,000 ppm with varied water chemistries - from multiple inland BWRO and EDR sites. We believe these pilots will be able to achieve final brine concentrations from 300,000 ppm to over 400,000 ppm - depending upon the incoming brine salinity. Our larger goal is to demonstrate full process 99% water recovery in a first stage BWRO or EDR system integrated with this new ZLD process, with a blended, levelized OPEX/CAPEX cost of under \$0.65 per cubic meter (\$800 per AF). This price point will allow the use of desalinated brackish groundwater for high value crops such as permanent crops, berries, tomatoes, etc. This cost breakthrough will also make inland desalination more affordable to cities that need additional water supply.

Impact

The successful demonstration of low cost, continuous brine softening with subsequent osmotically assisted Reverse Osmosis (RO) water recovery of around 95% from a range of RO and EDR brines at a levelized cost of under \$5 per cubic m3, will be a major breakthrough towards pipe parity. This ability will enable desalination including ZLD of the vast reserves of brackish groundwater across the West at a blended (first stage RO + ZLD) price point of \$800 per acre-foot. This price point will allow the use of desalinated brackish groundwater for high value crops such as permanent crops, berries, tomatoes, in addition to making inland desalination more affordable to cities that need additional water supply.

SSWS TECHNOLOGY EXPLAINED

SWITCHABLE SOLVENT WATER SOFTENING KEY TO ZERO LIQUID DISCHARGE

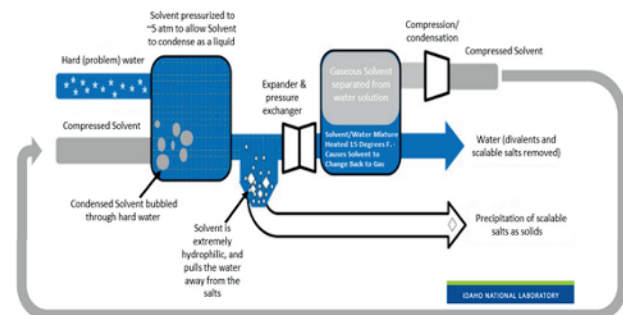


Figure 1. Trevi's Brine Softening Skid ("BSS") uses a novel switchable solvent extraction technology not previously deployed in commercial water treatment system Sparingly Soluble Salts – such as Calcium, Magnesium, and Sulphates – literally drop out of the brine like snowflakes within seconds of the solvent being bubbled through the water. The softened brine can then be squeezed up to 200,000 ppm or higher using Trevi's Pressurized Forward Osmosis (PFO) system. This is Trevi's proprietary version of an Osmotically Assisted RO system.

RESEARCH PARTNERS

Trevi Systems, Inc. : John Webley

REFERENCES

Foo, Zi Hao, et al. "Solvent-driven aqueous separations for hypersaline brine concentration and resource recovery." Trends in Chemistry 4.12 (2022): 1078-1093.