

## CASE STUDY: Shale Gas

### At a Glance

**Industry:**  
Shale gas

**Wastewater:**  
Shale gas produced water with high TDS, hardness, and organics

**Treatment Requirements:**  
High quality freshwater for reuse in fracking, pond storage, and/or surface discharge and solids for low volume disposal

**Product:**  
SaltMaker

**Results:**  
Reliably treated produced water to produce freshwater and solids.

**Economics:**  
Total cost of ownership starting at \$2 to \$3/bbl (\$12.50 to \$19/m<sup>3</sup>)

### Challenge

Shale gas deposits have unlocked vast hydrocarbon reserves previously thought to be uneconomic. Developing these assets requires much larger volumes of water than conventional oil & gas. After initial hydraulic fracturing, a relatively constant low flow of natural formation “produced water” typically returns to the surface, lasting for years to a decade. This produced water can be highly saline, often exceeding 200,000 mg/L TDS and saturated in scaling compounds, thereby limiting the use of and reliability of conventional desalination technologies such as membrane or thermal concentration systems.

Sites with easy access to deep disposal wells and non-scaling waters may economically dispose of the produced water. However, sites with scaling waters can plug costly disposal wells, and sites distant from disposal wells, such as in the Marcellus formation, incur high transportation costs for disposal ranging from \$3 to \$22/bbl (\$18 to \$140/m<sup>3</sup>). Treating the produced water to freshwater quality could allow for beneficial water reuse in industrial operations or return to the ecosystem depending upon regulatory approvals. With the correct produced water treatment, shale assets can therefore be a net provider of water.

### Solution

Saltworks’ SaltMaker was used to treat hypersaline shale gas produced water from East Texas and Northwestern British Columbia to produce freshwater and solids. The SaltMaker is a low temperature crystallizer (<85°C) with an optimal treatment capacity of 700 to 2,500 bbl/day (100 to 400 m<sup>3</sup>/day). It operates remotely, self-starts/stops and self cleans. The SaltMaker can run off wellhead gas and uses 25% of the thermal energy of conventional evaporators due to its multiple effect heat recycling. These abilities make the SaltMaker ideal for treating produced water at the drilling pad or for treating small water volumes at centralized treatment facilities.

The SaltMaker is a robust, non-membrane, humidification-dehumidification (HDH) system incorporating automated self-cleaning and solids extraction. The SaltMaker was designed from the ground up to treat and produce solids from the toughest waters. Process components are largely gel coated fiberglass or PVC. There is no boiling on heat transfer surfaces, and automatic self cleaning prevents irreversible scaling. The SaltMaker’s modular design uses ISO shipping container blocks for low cost, rapid dispatch, and easy expansion.

### Results

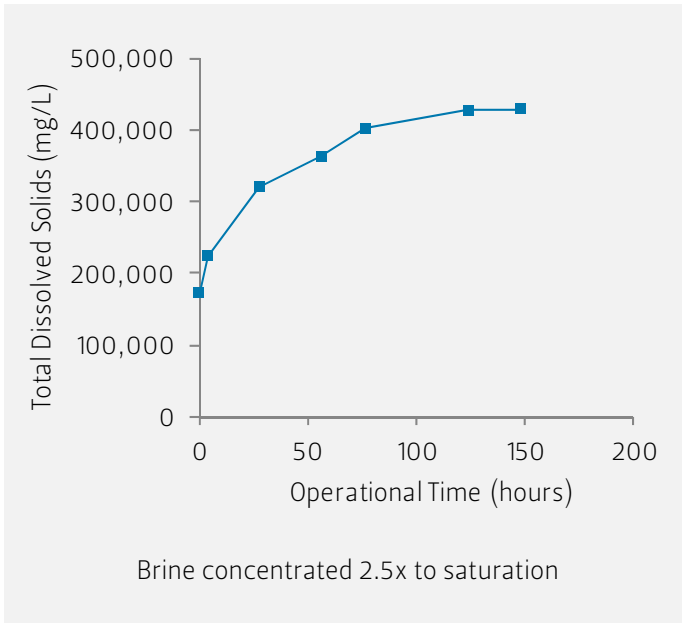
The pilot successfully and reliably produced high quality freshwater and solids. The project demonstrated that the SaltMaker can treat shale gas produced water to produce freshwater and solids for low volume disposal. Project results are as follows:

- High quality freshwater produced ~400 mg/L TDS
- Concentrated brine from 173,000 mg/L to 430,220 mg/L TDS (point of saturation and solids production)
- Solids (~15% moisture) produced and reliably extracted
- 99% recovery as freshwater produced
- Reliable operation with optimized automated self cleaning

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### Results (cont'd)

The solids produced require disposal (in a hazardous certified landfill) at only 20% the volume of the original flow, representing significantly less trucking. The SaltMaker can also produce a concentrated slurry of liquids and solids to allow for pumping and tanker transport.



Parameter (mg/L)	Freshwater produced	Untreated Texas shale gas produced water	Concentrated brine
pH	7.05	5.85	5.12
Total Dissolved Solids	400	169,540	408,000
Total Organic Carbon	31.9	374	528
Hardness (as CaCO <sub>3</sub> )	99	40376	237,000
Barium	0.41	7.21	27.6
Bicarbonate (as CaCO <sub>3</sub> )	31.4	70.6	<1
Boron	0.75	7.61	589
Calcium	35.1	14210	84500
Carbonate (as CaCO <sub>3</sub> )	<1	<1	402
Chloride	231	100,940	217,000
Iron	0.039	174	20
Lead	0.00238	0.0037	2
Magnesium	2.82	1186	6410
Manganese	0.011	3.53	6
Potassium	3.92	1,264	8,800
Sodium	102	49,294	37,800
Strontium	3.34	147	6800
Sulphate	1.08	638	202
Zinc	0.17	0.13	154



Shale gas produced water



Solids extraction system



Produced water solids

### Summary

The pilot project demonstrated that the SaltMaker can reliably produce freshwater and solids from East Texas shale gas produced water. The total cost of ownership (CAPEX and OPEX included) for a 2,500 bbl/day (100 m<sup>3</sup>/day) SaltMaker plant is \$2 to \$3/bbl (\$12.50 to \$19/m<sup>3</sup>) inlet. Saltworks has completed additional SaltMaker pilot projects to treat shale gas produced water from other oil & gas companies.

Saltworks would be pleased to complete a SaltMaker performance and economic assessment of your shale gas produced water treatment project. Please contact [projects@saltworkstech.com](mailto:projects@saltworkstech.com). Lease and pilot plants are available.