# Supercritical water desalination and Oxidation: A novel approach for produced water treatment

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## What is produced water?

- Produced water is the wastewater generated during oil and gas extraction.
- It typically contains hydrocarbons, organic chemicals, and inorganic salts.
- Total salt concentration can be up to 350,000 mg/L.

https://portacool.com/common-heat-stress-concerns-at-oil-rigs/

"In 2018, New Mexico generated 42 billion barrels of produced water."

- The current available desalination technologies for produced water are energy intensive, costly and cannot easily handle the organics.

### "Supercritical Water Desalination & Oxidation(SCWDO)"

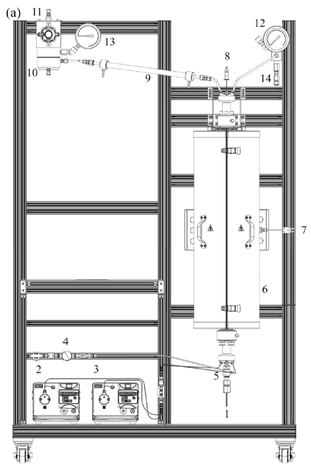


**Chart 1.** Experimental SCWDO setup

- At supercritical conditions (P >221 bar; T >374 °C), water behaves largely as a non-polar fluid:
  - The salt solubility in water drastically decreases.
  - Inorganic salts rapidly separate in the form of a highly concentrated brine,
- Supercritical condition also promotes highly effective wet oxidation of organic constituents.

## Testing of produced water samples treated with SCWDO

- Successfully treated produced water samples from:
  - **Permian Basin (New Mexico)** *(TDS: 170,000 mg/L)*
  - **Anadarko Basin (Oklahoma)** *(TDS: 284,000 mg/L)*
  - **Eagle Ford Basin (Texas)** *(TDS: 34,000 mg/L)*
  - **San Juan Basin synthetic sample** *(TDS: 16,000 mg/L)*
- Removed >99.9% of the salts
- Removed up to 100% of organics
- **Generated Drinking Quality Water (TDS <500 mg/L)**

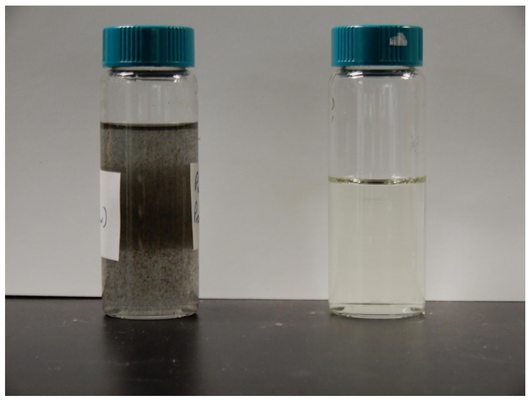

**Chart 2.** (Left) Permian Basin Produced Water sample. (Right) Treated Permian basin distillate of drinking water quality as per EPA standards.

**Composition of the treated Permian Basin produced water via SCWDO process**

| | Permian Basin (mg/ L) | Distillate(mg/L) | % Removed |
|---|---|---|---|
| TDS | 166900 | 499 | **99.7** |
| Li | 6.21 | 1.12 | 81.9 |
| Na | 63570 | 92.8 | 99.8 |
| Mg | 261 | 0.4 | 99.8 |
| K | 180 | 3.8 | 97.9 |
| Ca | 1229 | 0.5 | 99.9 |
| Sr | 262 | 0.01 | 99.9 |
| Cl | 96580 | 394 | 99.6 |
| Br | 2275 | 4.5 | 99.8 |
| NO3 | 2397 | 2.0 | 99.9 |
| SO4 | 0 | 0 | |
| TOC | 162.6 | 0.0 | **100** |

## Techno-Economic Analysis

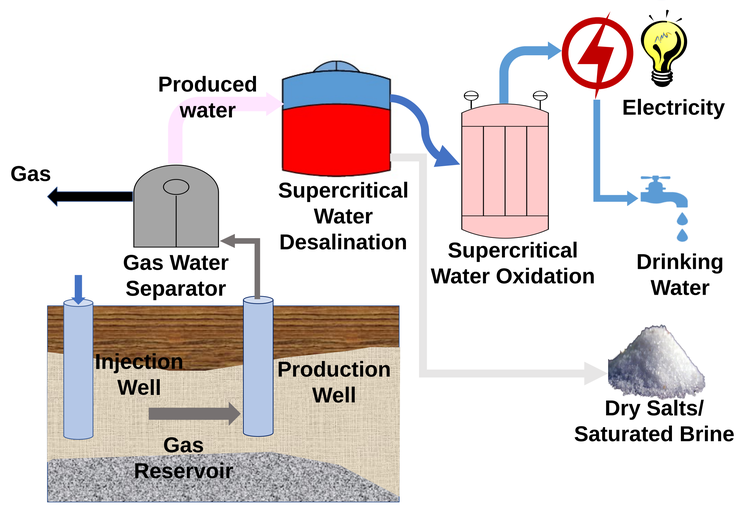


**Chart 3.** Schematic for produced water treatment using SCWDO process to generate ***drinking water***. Heat realized by organics oxidation can be used for ***electricity production***. The process is capable of generating ***saturated brine or dry salts***.

- SCWDO utilized the organics present in produced water as energy source. With only 1% organic content, the net energy required for SCWDO is zero.
- The SCWDO system performance is insensitive to salt concentration in the of produced water.
- **Treatment cost is constant at 3 $/m$^3$ or 50 ¢/barrel**
- SCWDO can be 50-70% cheaper compared to traditional processes

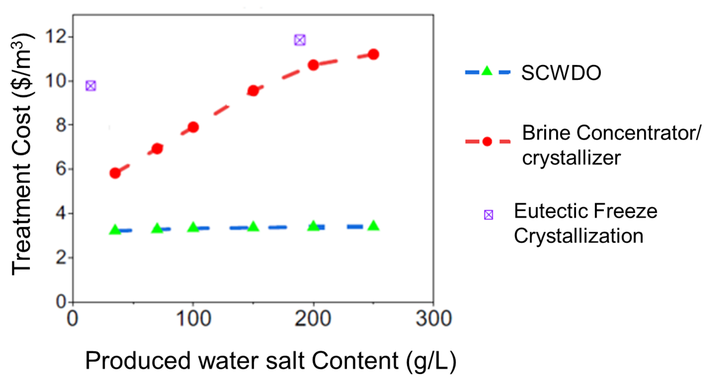


**Chart 4.** Comparison of produced water treatment cost for SCWDO process vs brine crystallizer and eutectic freeze crystallization.

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