



# An Ultra-low-cost Thermal Energy Storage System using Reverse Osmosis Concentrate

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### Mission Issue

Augment Water Supply by treating impaired waters and reduce the cost and environmental impact of treatment

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### Problem

The reject of the reverse osmosis water treatment process (aka brine, concentrate, ROC) is a mixture of salts that are dissolved in high salinity water. The ROC is classified as an industrial waste by the U.S. Environmental Protection Agency and can face regulatory limitations on disposal. All of the methods that are currently used in managing the ROC require releasing high concentrations of salt to the environment. There are currently no applications in industry for this high salinity stream or the resulting solid salt mixture after the water content is removed. According to the National Academies, developing ROC disposal alternatives is one of the major priorities for water desalination research.

### Solution

Thermal Energy Storage (TES) systems are used to store thermal energy in the form of the internal energy of a storage medium for future use. TES systems can be considered “Thermal Batteries” that store thermal energy instead of electricity. TES is an essential part of Concentrating Solar Power (CSP) to increase dispatchability and load shifting. Molten salt mixtures ( $\text{KNO}_3$  and  $\text{NaNO}_3$ ) are mostly used as the storage medium in conventional TES systems due to their low vapor pressure, high specific heat, and chemical stability. The elevated demand for nitrate salts has led to higher storage fluid costs and increased the cost of thermal energy storage. This study investigates the use of ROC as a TES medium.

***“One of the major challenges in the widespread use of renewable energy sources is the intermittency of most renewable energy sources, thus low-cost storage of this intermit is key to wider adoption of renewable energy.”***

Reza Baghaei Lakeh  
Associate Professor  
California State Polytechnic  
University - Pomona

### **More Information**

<https://www.usbr.gov/research/projects/detail.cfm?id=8133>

### **Application and Results**

Modeling, experimental verification of potential of ROC as a TES medium and a techno-economic assessment on the use of ROC as a TES medium have been completed. ROC is a viable medium to use as a TES medium. The normalized cost of TES (cost per unit volume of stored thermal energy) is estimated through a series of cost analyses. It was shown that the normalized cost of TES using ROC salt content is in the range of \$6.11 to \$8.73 per kilowatt-hours (kWh) depending on ROC processing methods. This meets the cost requirements of the U.S. Department of Energy of \$15/kWh for TES systems.



*Verification of solid to liquid phase change on ROC salt content. No phase change observed in the sample from Chino Desalter Authority (left). Solid to liquid phase change observed in the sample from Eastern Municipal Water District between 350-400 °C (right).*

### **Future Plans**

The methods developed in this work are currently being expanded with In the next steps of this effort, scaling up ROC-based indirect two-tank thermal energy storage systems will be investigated. In addition, the effect of using the ROC-based thermal energy storage on the levelized cost of energy (LCOE) of solar-thermal power will be investigated.