

Zero Liquid Discharge Desalination: Solution for Water Security and Brine Management

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Abstract

Saudi Aramco conducted comprehensive field-testing program of produced water desalination technologies targeted for produced water reuse as process/utility water with low TDS less than 1000 mg/l and generated brine utilized for mineral recovery. The main driver for the produced water re-use program was due to, firstly transition from linear model of economic growth, which is based on "take-make-dispose", which is not sustainable to Circular Economy (CE) model supporting "closing the loop" of recovering value from produced water and RO rejects considered waste streams and secondly the conservation of Kingdom's precious non-renewable ground water resources which are currently used for crude washing in desalting across Saudi Aramco. The program will reuse produced water in its oil operations, with potential ground water savings of billions of gallons annually post full implementation and also enable circularity sustainably in its oil operations.

The program started in 2011 included performance evaluation of several emerging and mature technology for produced water desalination and completed testing of two different produced water desalination commercially available technologies such as membrane and thermal evaporators up to date. The program recently won four international awards from 2020 to 2023. The objectives of the program were to evaluate the produced water/ RO brine desalination with minimum 70% recovery factor as performance for different configurations i.e. desalination of low TDS produced water (10,000-15,000 mg/l) and high TDS produced water (>100,000 mg/l) to understand the overall system integration impacts on recovery factor and to determine system sustainability to change in feed conditions with dissolved organics.

Produced water desalination testing was conducted at two different produced salinity streams on Arab light crude oil at two different sites with gravities of 36-41 API, to determine the desalination performance and challenges with pre-treatment. The performance of three field produced water desalination technologies was evaluated by determining the TDS and oil in water concentration at different operating conditions. The test program demonstrated that produced water desalination can meet the challenging of treating produced water with high TDS and dissolved organics over a wide range of operating conditions. The distillate water is of the ideal quality to use in Aramco's crude oil washing, well maintenance and drilling operations.

This presentation presents the key results of the produced water re-use program along with three field tests as well as the path forward to the deployment of these technologies to unlock the value of produced water as a resource in the circular economy. The implications of this program's success extend beyond Saudi Aramco. By increasing produced water reuse in oil and gas processing, more groundwater will be available for non-industrial applications in Saudi Arabia, which reduces reliance on seawater desalination.