



Recovery optimization of membrane processes for treatment of produced water with high silica content

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ABSTRACT

Disc tube (DT) and spiral wound (SW) configurations of nanofiltration (NF) and reverse osmosis (RO) processes were tested at pilot-scale using a two-pass configuration to treat produced water obtained from natural gas wells. First pass NF membranes were used to remove divalent cations from produced water. Permeate from the first pass NF membranes were used as feed to second pass RO membranes after increasing the pH to 10.0 to enhance silica solubility. To reduce the fouling potential on NF and RO membranes dissolved air floatation (DAF), ceramic ultrafiltration (UF), MYCELX cartridges, and organoclay filters were tested as pretreatment alternatives. Pretreatment processes were effective for turbidity and oil and grease removal but were not efficient in retaining organic matter, primarily protein-like and polysaccharide-like material, which eventually fouled the first pass NF membranes. The second pass RO membranes were scaled predominantly by silica. The overall feed water recovery of the two-pass NF-RO system was limited to less than 70%. Although the application of a two-pass configuration met the discharge limits for most of the contaminants in produced water, a more stringent pretreatment process for selective removal of organics and silica is essential to operate the membrane systems at recoveries greater than 85%. If treated appropriately, produced water can be employed as a true water resource to augment existing surface water streams and creeks.

Keywords: Ceramic membranes; Organic fouling; Biofouling; Silica polymerization; Two-pass configuration

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