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Pilot Scale Test of a Produced Water-Treatment System for Initial Removal of Organic Compounds

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Abstract

A pilot-scale test to remove polar and non-polar organics from produced water was performed at a disposal facility in Farmington NM. We used surfactant-modified zeolite (SMZ) adsorbent beds and a membrane bioreactor (MBR) in combination to reduce the organic carbon content of produced water prior to reverse osmosis (RO). Reduction of total influent organic carbon (TOC) to 5 mg/L or less is desirable for efficient RO system operation.

Most water disposed at the facility is from coal-bed gas production, with oil production waters intermixed. Up to 20 gal/d of produced water was cycled through two SMZ adsorbent units to remove volatile organic compounds (BTEX, acetone) and semivolatile organic compounds (e.g., napthalene). Output water from the SMZ units was sent to the MBR for removal of the organic acid component of TOC. Removal of inorganic (Mn and Fe oxide) particulates by the SMZ system was observed. The SMZ columns removed up to 40% of the influent TOC (600 mg/L). BTEX concentrations were reduced from the initial input of 70 mg/L to 5 mg/L by the SMZ and to an average of 2 mg/L after the MBR.

Removal rates of acetate (input 120-170 mg/L) and TOC (input up to 45 mg/L) were up to 100% and 92%, respectively. The water pH rose from 8.5 to 8.8 following organic acid removal in the MBR; this relatively high pH was likely responsible for observed scaling of the MBR internal membrane. Additional laboratory studies showed the scaling can be reduced by metered addition of acid to reduce the pH. Significantly, organic removal in the MBR was accomplished with a very low biomass concentration of 1 g/L throughout the field trial.

An earlier engineering evaluation shows produced water treatment by the SMZ/MBR/RO system would cost from $0.13 to $0.20 per bbl at up to 40 gpm. Current estimated disposal costs for produced water are $1.75 to $4.91 per bbl when transportation costs are included, with even higher rates in some regions. Our results suggest that treatment by an SMZ/MBR/RO system may be a feasible alternative to current methods for produced water treatment and disposal.