REUSE OF PRODUCED WATER USING NANOFILTRATION AND ULTRA-LOW PRESSURE REVERSE OSMOSIS TO MEET FUTURE WATER DEMANDS

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Chris Bellona is a graduate research fellow in the Environmental Science & Engineering Program at the Colorado School of Mines. He holds a BS degree in environmental science from Western Washington University. Dr. Jörg Drewes is Assistant Professor of Environmental Science and Engineering at Mines. His research interest is water reclamation and reuse with special focus on treatment technologies used for groundwater recharge including natural system and high-pressure membranes. Both authors are currently working on studies addressing rejection mechanism of micropollutants in high-pressure membrane applications and removal efficiencies of new nanofiltration and reverse osmosis membrane generations.

Abstract

Coal bed methane (CBM) production has become an increasingly important source of natural gas in the United States. The proposed increase in CBM drilling poses a risk to the environment because the process of CBM production produces substantial quantities of saline water. Therefore, proper treatment, disposal, and/or reuse of CBM produced water needs to be examined.

High-pressure membranes such as reverse osmosis (RO) can be used to remove high total dissolved solids (TDS) found in CBM produced water (mainly Na^+, Cl^-, and HCO_3^-). RO treatment is capable of providing a superb water quality meeting all drinking water standards while requiring a small footprint and the option for onsite operation. However, drawbacks are high pressure requirements and energy costs. More recently, new *tight* nanofiltration (NF) membranes and ultra-low pressure RO membranes (ULPRO) have become a viable option for produced water treatment because they can be as effective as RO in removing certain solutes from water while requiring considerably less feed pressure. However, it is unclear whether these emerging membranes can significantly remove the high TDS concentrations found in CBM produced water. In this study, we examined TDS rejection of model CBM waters (8,000 – 13,000 mg/L as TDS) by ULPRO and various NF membranes.

Of the membranes tested, the Filmtec XLE (ULPRO) and Koch TFC-S (NF) membranes achieved TDS rejections above 90%. Only the Filmtec XLE, however, reduced the TDS concentrations below the secondary drinking water standard (500 ppm). The Filmtec NF-90 achieved an 80% rejection of TDS, while providing a significantly higher recovery than the XLE and the TFC-S. Of the membranes tested, only the Koch TFC-SR2 showed a poor rejection of TDS. Preliminary testing has shown that CBM produced water with TDS concentrations of 10,000 ppm can be treated to meet the secondary drinking water standard for TDS with an ULPRO membrane. This high-quality water can be used for groundwater recharge to augment in part a drinking water supply. NF membranes with lower salt rejection could be used to treat water for surface discharge at considerably lower pressure requirements than RO treatment.