Project Number
WRF-03-013
USBR AGREEMENT: #00-FC-81-0248
AwwaRF Project Number: 3012

Rejection of contaminants of concern by nanofiltration and ultra-low pressure reverse osmosis membranes for treating water of impaired quality

Principal Investigator:
Jörg Drewes, *Colorado School of Mines*

Cash Contributors (in addition to the Bureau of Reclamation):
Awwa Research Foundation

Document name: Comparing Nanofiltration and Reverse Osmosis for Treating Recycled Water

(This summary was copied from the AwwaRF website)

Objectives:
This purpose of this study was to explore whether nanofiltration (NF) and ultra-low pressure reverse osmosis (ULPRO) membranes can consistently meet potable water quality requirements with respect to total organic carbon (TOC), total nitrogen, and regulated and unregulated trace organic compounds. The goals were also to determine whether or not operating characteristics of NF and ULPRO membranes (such as flux, fouling/scaling, and cleaning frequencies) are comparable to conventional thin-film composite RO membranes and operating feed pressure requirements are significantly lower than conventional RO.

Highlights:
The selection of NF and ULPRO membranes for pilot-scale testing became an exercise in balancing the benefits of lower pressure and energy requirements with constituent rejection and permeate quality. Rejection of trace organics, however, improved with membrane fouling, which is especially important for NF membranes, because initial (organic) fouling will always occur where membranes are employed to treat surface water or secondary and tertiary treated effluents. The transport of hydrophilic ionic organic contaminants was especially hindered in NF membranes as a result of improved electrostatic exclusion, pore clogging, and an increased adsorption capacity of fouled polyamide membranes.

Results/Findings:
Membranes tested during this study using the membrane testing protocol displayed a wide range of operating characteristics including fouling tendency, permeate productivity, and feed pressure while displaying a wide range of rejection behavior in terms of TOC, ammonium, nitrate, and select trace organic contaminant removal. The TMG10 (Toray America) and NF-90 (Dow/Filmtec) membranes were selected as candidate membranes for pilot-scale testing based upon high specific fluxes after a period of fouling as compared to the benchmark RO membrane (TFC-HR, Koch Membrane Systems) and efficient rejection of TOC (<0.5 mg/L), nitrogen species (<10 mg-N/L), and organic trace contaminants. Although the membrane NF-4040 (Dow/Filmtec) did not meet the nitrogen and TOC water quality criteria, this membrane was also selected for pilot-scale testing due to moderate flux decline, efficient trace organic rejection (usually greater than 90 percent), and a significantly higher specific flux than the benchmark TFC-HR membrane. Rejection of regulated organics was found to be similar to the benchmark TFC-HR membrane with a poor to moderate rejection of chloroform and N-nitrosodimethylamine (NDMA). All three candidate membranes were highly efficient in rejecting unregulated organics with non-detectable concentrations or only traces of the target compounds in the permeates.