Desalination and Water Treatment
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doi: 10/5004/dwt.2012.2505

Taylor & Francis
Taylor & Francis Group

42 (2012) 155–162
April

Flux dependency of particulate/colloidal fouling in seawater reverse osmosis systems

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Received 20 October 2010; Accepted 14 April 2011

ABSTRACT

Fouling is the main operational problem in seawater reverse osmosis systems (SWRO). Particulate fouling is traditionally measured through the silt density index (SDI) and through the modified fouling index (MFI). In recent years, ultrafiltration membranes were used successfully at constant flux – MFI-UF – to measure particulate/colloidal fouling potential and tested in sea water applications. Furthermore, constant flux operation allows predicting the rate of fouling in RO systems. The objectives of this study are: (1) to measure the flux effect in MFI-UF with different membranes (100, 30 and 10 kDa) for raw seawater and pre-treated water before reverse osmosis in three different locations; (2) to study the particulate and colloidal fouling potential of seawater in reverse osmosis systems; (3) to project the increase in pressure due to cake resistance in reverse osmosis systems. In this research, flat ultrafiltration membranes (100, 50, 30 and 10 kDa) are used in a constant flux filtration mode to test and compare real seawaters from various locations (North and Mediterranean Sea) and from various full scale facilities including different pre-treatments (i.e., ultrafiltration and coagulation + dual media filtration). The operated fluxes range from 350 down to values close to real RO operation, 15 l $(m^2\ h)^{-1}$. After each filtration test, the MFI-UF is calculated to assess the particulate fouling potential. The obtained results showed that: (1) the particulate and colloidal fouling potential is directly proportional to the applied flux during filtration. This proportionality is related to the compression of the cake deposit occurring at high flux values; (2) the higher the flux, the higher the required pressure, the less porous the cake and therefore the higher the specific cake resistance; (3) particulate and colloidal fouling potential of seawater is site specific and is influenced by pre-treatment.

Keywords: Particulate fouling; Seawater; MFI-UF; Constant flux; Reverse osmosis; Pre-treatment

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Membranes in Drinking and Industrial Water Treatment—MDIW 2010, June 27–30, 2010, Trondheim, Norway