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Osmosis-assisted cleaning of organic-fouled seawater RO membranes

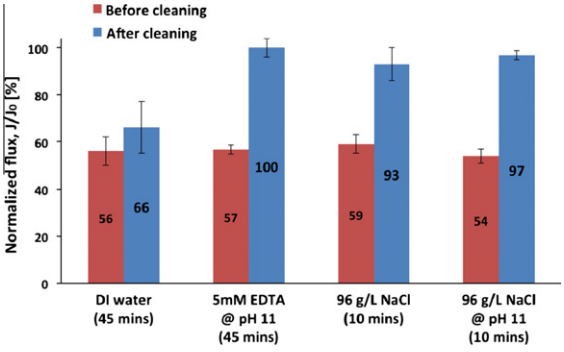
Guy Z. Ramon [1], The-Vinh Nguyen [2], Eric M.V. Hoek *

Department of Civil and Environmental Engineering, University of California, Los Angeles, CA, USA
California NanoSystems Institute, University of California, Los Angeles, CA, USA

HIGHLIGHTS

- Removal of Alginate with osmotic backwashing is comparable to chemical cleaning.
- Substantially higher cleaning efficiency achieved using a monovalent draw solution.
- Chemical 'loosening' of foulant layer is essential for backwashing effectiveness.
- Optimization of contact time, draw strength and chemical composition is required.

GRAPHICAL ABSTRACT



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ABSTRACT

Fouling of various kinds continues to limit membrane-based desalination and water treatment. Fouling is commonly countered through chemical cleaning of membrane elements, resulting in process downtime, membrane degradation and increased operation costs. Recent studies suggest that reversing permeate flux through RO membranes by dosing a slug of high salinity feedwater may offer an effective, chemical-free cleaning method. Herein, seawater RO membranes were fouled using alginic acid as a model seawater foulant and cleaned by osmotic backwashing with draw solutions of different salt concentration and chemistries. Flux recovery by osmotic backwashing was comparable with chemical cleaning (using caustic and a chelating agent); both recovered more flux than physical cleaning (rinsing with DI water). In particular, results illustrate the importance of combining chemical and physical mechanisms, the former contributing to 'loosening' of the foulant layer, and the latter facilitating its removal through fluid shear, enhanced by the presence of an osmotic backflow. Hence, osmotic backwashing may offer the potential for in-line, 'low-chemical' RO membrane cleaning, which would minimize discharge of cleaning chemicals to the environment and their impacts on RO membranes. Numerical simulations of the osmotic backwash cycle illustrate important time-scales and mass transfer limitations governing osmotic backwashing, through which operational insight may be obtained. The model offers a possible theoretical approach for optimization of RO membrane cleaning by osmotic backwashing.

1. Introduction

In reverse osmosis (RO) and nanofiltration (NF) membrane-based water purification systems, fouling of all kinds – colloidal deposition and organic adhesion, formation and growth of bacterial biofilms, and precipitation of sparingly soluble minerals – can limit plant performance, dominate operation and maintenance concerns and increase the cost of water produced. Even with

* Corresponding author at: Department of Civil and Environmental Engineering, University of California, Los Angeles, CA, USA. Tel.: +1 310 206 3735.
E-mail address: emvhoek@ucla.edu (E.M.V. Hoek).
[1] Present address: Department of Mechanical & Aerospace Engineering, Princeton University, Princeton, NJ, USA.
[2] Present address: Faculty of Environment, Vietnam National University-Hochiminh City, Hochiminh City, Viet Nam.

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