Desalination and Water Treatment
www.deswater.com
5 (2009) 183–191
May
1944-3994 / 1944-3986
doi: 10.5004/dwt.2009.574

Application of forward osmosis in pretreatment of seawater for small reverse osmosis desalination units

O.A. Bamaga[a,b], A. Yokochi[b]*, E.G. Beaudry[c]

[a]*Department of Agricultural Engineering, Faculty of Agriculture, Sana'a University, PO Box 13609, Sana'a, Yemen*
[b]*School of Chemical, Biological and Environmental Engineering, Oregon State University, 102 Gleeson Hall, Corvallis, OR, USA*
Tel. +1 541 737 9357; Fax. +1 541 737 4600; email: alexandre.yokochi@oregonstate.edu
[c]*Hydration Technologies, Inc., PO Box 1027, Albany, OR 97321, USA*

Received 27 September 2008; Accepted 10 March 2009

ABSTRACT

Recently, membrane pretreatment has been accepted as a technically and economically viable alternative to conventional pretreatment in SWRO processes. MF, UF and NF membranes were used in these pressure driven processes, with UF most commonly recommended. Amongst these, forward osmosis (FO) driven process has been used in different water treatment operations including membrane pretreatment of wastewater. In this study, the application of a FO driven membrane process in seawater pretreatment was evaluated. This application is particularly important for small autonomous RO desalination units as it eliminates the need for chemicals which are conventionally used in pretreatment steps, the concomitant need for disposal of the chemical laden waste resulting from the process, and the requirement of qualified expertise for unit operation. The performance of commercially available FO membrane cartridges (Hydration Technologies Inc.) in terms of water flux and salt flux was evaluated using tap water and seawater as feed. Refined sea salt was used for preparing highly concentrated osmotic draw solutions at three salinity levels up to 100,000 ppm. Profiles of water and salt fluxes versus osmotic draw solution concentrations were established and analyzed. A conceptual system design for an integrated desalination unit consisting of a closed FO and RO process was presented in which RO brine is used as the osmotic draw solution and thus the chemical energy stored in the RO brine is recovered and utilized by the FO membrane process. In addition, the energy contained in the excess RO brine pressure is used for brine circulation in the FO process loop. The main operating parameters and relationships of the conceptual FO-RO system are described.

Keywords: Forward osmosis; Seawater pretreatment; Membrane pretreatment; Autonomous RO desalination units

* Corresponding author.

Presented at EuroMed 2008, Desalination for Clean Water and Energy Cooperation among Mediterranean Countries of Europe and the MENA Region, 9–13 November 2008, King Hussein Bin Talal Convention Center, Dead Sea, Jordan.