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The role of membrane distillation/crystallization technologies in the integrated membrane system for seawater desalination

Sulaiman Al Obaidani[a,b*], Efrem Curcio[b,c], Gianluca Di Profio[c], Enrico Drioli[b,c]

[a]*Department of Mechanical and Industrial Engineering, Sultan Qaboos University, P.O. Box 33, Al-Khod, P.C. 123, Sultanate of Oman Tel. +968 2414-2655; Fax +968 2414-1316; email: obeidani@squ.edu.om*
[b]*Department of Chemical Engineering and Materials, University of Calabria, Cubo 44/A,Via P. Bucci, 87030 Rende CS, Italy*
[c]*Institute for Membrane Technology ITM-CNR, Via P. Bucci, c/o University of Calabria, Cubo 17/C, 87030 Rende CS, Italy*

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ABSTRACT

Membrane desalination technology has emerged in recent years as the most viable solution to water shortage. However, despite the enormous improvement in membrane desalination technology, some critical developments are still necessary in order to accomplish possible improvements in the process efficiency (increase recovery), operational stability (reduce fouling and scaling problems), environmental impact (reduce brine disposal), water quality (remove harmful substances) and costs. In particular, cost effective and environmentally sensitive concentrate management is today recognized as a significant obstacle to extensive implementation of desalination technologies. As a result of the significant impact of desalination plants on the environment, the requirements for concentrate management tight up: brine disposal minimization and zero liquid discharge (ZLD) are the demanding targets for several applications. In this concept, conventional pressure-driven membranes such as MF, NF and RO were integrated with the innovative units of membrane contactors such as Membrane Distillation/Crystallization (MD/MC). The integration of different membrane units represents an interesting way for achieving the ZLD goal due to the possibility of overcoming the limits of the single units and, thus, to improve the performance of the overall operation. The present research study is focusing on the evaluation of the integrated membrane system which merges the membrane contactor technology with the conventional pressure-driven membrane operations for seawater desalination. Sensitivity studies were performed for several configurations of the integrated system to obtain the most sensitive parameter in the total water cost and the optimal design of the system. The results revealed that the pressure-driven membrane operations were very sensitive to the feed concentration and the cost of electricity consumption. On the other hand, MD processes were not sensitive to the variation on the feed concentration or the electricity costs. The most sensitive parameter in the total water cost of the MD plant was the cost of steam which contributed to values as high as high as 11.4% in the case of MD without heat recovery system. The best tolerance to the variation of these parameters was obtained when using the integrated membrane system of pressure-driven membranes and MC processes.

Keywords: Membrane distillation; Integrated membrane system; Sensitivity analysis

* Corresponding author.

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