

## A Study of the Effect of Operating Conditions on Reverse Osmosis Membrane Performance with and without Air Sparging Technique

QUSAY F. ALSALHY, TALIB M. ALBYATI, AND  
MUMTAZ A. ZABLOUK

Chemical Engineering Department, University of Technology,  
Baghdad, Iraq

*The aim of this work is to enhance the permeation flux and rejection during the reverse osmosis (RO) filtration process of simulated seawater, using gas-liquid two-phase flow to reduce the concentration polarization layer by injecting air. The effect of various operating conditions (feed concentration, flow rate, temperature, operating pressure, and gas flow rate) on RO performance was evaluated and optimized. The central composite design (CCD) technique was used to find the optimal operating conditions. The objective function (Response) was the flux of permeate and salt rejection. The coefficients of the proposed model were found, and the significant and nonsignificant parameters for the proposed model were checked by the F-test method. In order to ensure a good model the test for significance of the regression model (F-test) was performed by applying the analysis of variance (ANOVA). It was found that the flux and the rejection of NaCl solution throughout the RO are dependent on the operating conditions in the following sequence: concentration > pressure > temperature > flow rate. In addition, the results showed that the experimental data have good agreement with the values predicted by the response model for permeation flux and salt rejection. The results showed a positive effect of constant gas-liquid two-phase flow on permeate flux and salt rejection. At low liquid flow rates, better improvement was achieved with a horizontally installed membrane. Using the gas-liquid two-phase flow technique with an injection factor of 0.878, slug flow pattern, superficial air velocity of 1.5923 m/s, and superficial liquid velocity of 0.221 m/s, the permeate flux increased from 3.406 to 5.676 kg/m<sup>2</sup>.h and salt rejection increased from 85% to 91%.*

**Keywords** Filtration; Membrane; Optimization; Permeability; Reverse osmosis; Two-phase flow

### Introduction

The driving force for membrane filtration in water treatment is the pressure gradient across the membrane. As a result of this driving force a convective transport of material from the bulk to the membrane surface is obtained. Solvent (water) permeates through the membrane and solutes (dissolved and particulate material) are partly

Address correspondence to Qusay Fadhel Alsalhy, Chemical Engineering Department, University of Technology, Alsinia St. 52, P.O. Box 35010, Baghdad, Iraq. E-mail: qusay\_alsalhy@yahoo.com