Available online at www.sciencedirect.com

SciVerse ScienceDirect

Procedia Engineering 42 (2012) 106 – 112

Procedia Engineering

www.elsevier.com/locate/procedia

20th International Congress of Chemical and Process Engineering CHISA 2012
25 – 29 August 2012, Prague, Czech Republic

An optimized neural network model of desalination by vacuum membrane distillation using genetic algorithm

M. Tavakolmoghadam[a] a*, Mohammadali Safavi[a,b]

[a]*Research Institute of Petroleum industry, P.O. Box 14665-137, Tehran, Iran*
[b]*Chemical & Petroleum Engineering Department, Sharif University of Technology, Azadi Ave., Tehran, Iran*

Abstract

An experimental based ANN model is constructed to describe the performance of vacuum membrane distillation process for desalination in different operating conditions. The vacuum pressure, the feed inlet temperature, the concentration of the feed salt aqueous solution and the feed flow rate are the input variables of this process, whereas the response is the permeate flux. The neural network approach was found to be capable for modeling this membrane distillation configuration. The application of Genetic Algorithm (GA) to optimize the ANN model parameters was also investigated.

Keywords: Vacuum membrane distillation, Artificial neural network, Desalination, Optimization, Genetic Algorithm

1. Introduction

Mathematical models for prediction of membrane separation play an important role in optimization of membrane systems leading to efficient and economical design of separation processes. Artificial neural networks (ANN) modeling was applied in different areas of membrane science and technology such as in

* Corresponding author. Tel.: *+98-2-148253109*.
E-mail address: *tavakolm@ripi.ir*

1877-7058 © 2012 Published by Elsevier Ltd. Open access under CC BY-NC-ND license.
doi:10.1016/j.proeng.2012.07.400

the pressure-driven membrane processes, microfiltration, ultrafiltration, nanofiltration, and reverse osmosis, due to its potential to study the relationship between the input variables and the target(s) or output(s) of the process using a limited number of experimental runs [1].

The model developed by ANN could be considered as the fitness function for optimization by genetic algorithm (GA). Recently, ANN (combined with GA) has become a popular approach to solve optimization problems in many processes without theoretical or mechanistic dependence [2-4].

Among various membrane desalination processes, RO or membrane distillation (MD) is believed to have a great potential for the production of drinking water from seawater and brackish water [5]. MD differs from other membrane technologies in that the driving force for desalination is the difference in vapor pressure of water across the membrane, rather than total pressure. A variety of methods have been employed to impose the vapor pressure difference across the hydrophobic membranes. In every case, the water to be desalted directly contacts the hot side of the membrane. Generally, there are four different techniques and configurations of the MD processes: direct contact membrane distillation (DCMD), air gap membrane distillation (AGMD), sweeping gas membrane distillation (SGMD) and vacuum membrane distillation (VMD) [6].

In this study an experimental based ANN model is constructed to describe the performance of vacuum membrane distillation process for desalination in different operating conditions. The application of Genetic Algorithm (GA) to optimize the ANN model parameters was also investigated.

2. Experimental

The VMD experiments were carried out using the experimental set-up and procedure presented in references No. 6 and 7. Experiments were carried out using a flat sheet Polytetrafluoroethylene (PTFE) membrane from Membrana (Germany). A cross flow membrane module made from Teflon was used in the experiments. Membrane properties are reported in Table 1.

Table 1. Properties of the flat sheet PTFE membrane

Parameter	Amount
Pore size, μm	0.2
Porosity, %	80
Thickness, μm	60

3. Modeling and optimization

3.1. ANN Modeling

ANN is a non-linear processing system operating in parallel being composed of neurons and connections between them that can be used for mapping input and output data [8]. An artificial neuron is a single computational processor, which has two operators (1) summing junction and (2) transfer function [9]. The connections consist of weights and biases with neurons addressing information. Considering the model of a single neuron, any scalar input x_i is transmitted via a connection that multiplies its strength by