Desalination and Water Treatment
www.deswater.com
doi: 10.5004/dwt.2021.27386

229 (2021) 17–30
July

Modeling, simulation, and optimization of the membrane performance of seawater reverse osmosis desalination plant using neural network and fuzzy based soft computing techniques

Rajesh Mahadeva[a], Mahendra Kumar[b], Gaurav Manik[a,*], Shashikant P. Patole[c]

[a]*Department of Polymer and Process Engineering, Indian Institute of Technology, 247667 Roorkee, Uttarakhand, India, Tel. +91-1322714340; email: gaurav.manik@pe.iitr.ac.in (G. Manik), Tel. +91-9909030497; email: rmahadeva@pe.iitr.ac.in (R. Mahadeva)*
[b]*Department of Electrical Engineering, Indian Institute of Technology, 247667 Roorkee, Uttarakhand, India, Tel. +91-7014798426; email: mkumar1@ee.iitr.ac.in (M. Kumar)*
[c]*Department of Physics, Khalifa University of Science and Technology, Abu Dhabi 127788, United Arab Emirates, Tel. +971-501335164; email: shashikant.patole@ku.ac.ae (S.P. Patole)*

Received 15 December 2020; Accepted 30 April 2021

ABSTRACT

One of the challenging tasks in desalination plants is to manage and optimize their real-time performance. In this direction, soft computing techniques have demonstrated superior efficiency compared to conventional techniques in overcoming this problem and predict optimal process conditions. In this paper, artificial neural network (ANN), particle swarm optimization assisted ANN (PSO-ANN), fuzzy inference system (FIS), and adaptive neuro-fuzzy inference system (ANFIS) models have been developed to predict the membrane performance of the seawater reverse osmosis (SWRO) desalination plants. All developed models consisted of four input parameters: feed temperature (5°C–30°C), feed pressure (45–65 kgf/cm^2), feed flow rate (~30 L/min), and feed total dissolved solids (TDS) (~32,000 ppm) with two output parameters: permeate flow rate (2.8–8.8 L/min) and permeate TDS (45–121.6 ppm). The models so obtained and trained produced a fairly good agreement between the experimental and predicted dataset. Amongst all models simulated, the PSO-ANN model provides superior performance for permeate flow rate and TDS (R^2 = 0.998, 0.997) with minimum errors (MSE = 0.007, 1.783) compared to other models (ANN, FIS, and ANFIS). Future results suggested that models may serve as perfect diagnostic tools for designing SWRO desalination plants to reduce the Capex, Opex, time, and energy.

Keywords: Artificial neural network; Fuzzy inference system; Particle swarm optimization assisted ANN; Seawater reverse osmosis; Adaptive neuro-fuzzy inference system

* Corresponding author.