Properties of Saline Solutions for Process Design using Padé Approximants and Artificial Neural Networks

José Valderrama [C, S]
Dpto. de Ingeniería Mecánica, Univ. de La Serena, La Serena, Chile
joseovalderrama@gmail.com

Richard Campusano
Dpto. de Fisica, Univ. de La Serena, La Serena, Chile

Padé approximants are used to model physicochemical, transport and thermodynamic properties of seawater for industrial applications. Padé approximants are rational functions in which the numerator is a polynomial and the denominator is another polynomial, $Q_m(x)/ R_n(x)$. As known, water scarcity is one of the main challenging problems in industry and is of especial relevance in mineral processes in which water consumption is huge and also because mining operations are usually located where there is no water or water is extremely scarce. The main problem in using seawater in industry is the salt content certainly affects the properties of the water and the processes in which such water is used. Sophisticated mathematical models to calculate saline solution properties, such as high degree polynomials, potential functions or logarithmic expressions, have been presented in the literature for applications in which very high accuracy is needed. Models for estimating properties for industrial processes have received less attention. The properties studied are density, specific heat, osmotic coefficient, viscosity, thermal conductivity, surface tension, enthalpy, entropy, vapor pressure, latent heat of vaporization, and boiling temperature elevation. After analyzing the models available in the literature for the properties of seawater and observing the form of the curves at several temperatures and salinities, it seems that sophisticated mathematical models are not necessary for industrial applications. Padé-type model considering the variables temperature and salinity have been considered and analyzed in this paper. The general Padé model resulted to be accurate enough to represent all properties and give deviations similar to those provided by more sophisticated models presented in the literature and similar to Artificial Neural Networks also calculated by the authors. The advantages of these different models, sophisticated mathematical models, Artificial Neural Networks and Padé approximants, are also discussed. Computer codes and spreadsheet for determining seawater properties are provided.