Abstract

Relative permeability is an indispensable parameter that is involved in many sensitive tasks related to reservoir studies. Due to this fact, there is increasing interest about methods that can accurately capture the temperature effect on relative permeability. As the existing empirical methods suffer from inaccuracies and the experimental methods are expensive and time consuming, developing accurate, rapid, and inexpensive model is inevitable to determine temperature-dependent oil/water relative permeability. In this paper, we propose various intelligent approaches to predict the effect of temperature on relative permeability in the oil/water systems (Kro and Krw). These approaches are based on two machine-learning methods: least square support vector machine (LSSVM) and radial basis neural network (RBFNN), coupled with four metaheuristic algorithms including particle swarm optimization (PSO), genetic algorithm (GA), differential evolution (DE) and grey wolf optimization (GWO). A large database including 1223 experimental points collected from published literature and some Algerian fields is employed to establish and test the models with the following inputs: absolute permeability, water saturation, reservoir temperature, water viscosity, and oil viscosity. The obtained results revealed that the proposed models can predict the temperature-based oil/water relative permeability with very satisfactory accuracy. Furthermore, graphical and statistical error analyses illustrated that RBFNN-GWO model outperforms the existing correlations and the other established hybridization-based models in predicting both Kro and Krw, where RBFNN-GWO showed overall determination coefficients (R^2) of 0.9997 and 0.9996, average absolute relative deviations (AARDs%) of 3.4056 and 5.8663, and root mean squared errors (RMSEs) of 0.0073 and 0.0048 for Kroand Krw, respectively. Finally, outliers detection using the Leverage approach confirmed that the proposed RBFNN-GWO model is statistically valid, where only 1.69% and 1.39% of the Kroand Krw data points, respectively, may be regarded as doubtful data.