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Please fill in your 5-digit IPTC manuscript number.	21IPTC-P-1644-IPTC IPTC-21337-Abstract	
Please fill in your manuscript title.	Modelling of Deep Polymer Gel Conformance Treatments Using Machine Learning	
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Abstract

Objectives/Scope

Polymer gel technologies have been widely employed in conformance-control applications to improve sweep and recovery from high permeability reservoirs. Modeling of polymer gel propagation, gelation time, and adsorption in the porous media requires a complex full-order computation of diffusivity equations, heat transfer and chemical reactions for components partitioning in oleic and aqueous phases. This paper presents a soft-computing alternative and data-driven approach of using machine learning to model deep polymer gel treatments in fractured reservoirs

Methods, Procedures, Process

Reference simulation models of various dual-permeability systems were used to generate the dataset for the machine learning model, an artificial neural network. A second-order reaction scheme for gel formulation was used to describe the chemical reaction between the polymer, polyacrylamide, and the cross-linker component, chromium acetate. Viscosities, adsorption properties and residual resistance factors of the polymer and produced gel were populated based on experimental data. Various conformance design factors and reservoir properties were parameterized for inclusion in the neural network, including temperature, injection rate, slug size, polymer's molecular weight, gel concentration, bottom-hole pressure, drainage radius, porosity, fracture spacing and permeability.

Results, Observations, Conclusions

Feature analysis of the input variables indicated that ten parameters are sufficient to train the model and predict the performance of the conformance treatment with indicators including the gelation time, the oil and water rate after applying the polymer gel treatment. The dataset was randomly divided into 80% training, 10% validation and 10% testing sets. Early stopping and monitoring of the validation and testing set's errors were used to generalize the solution and enhance the performance of the neural network. Hyperparameter tuning showed that using a multi-hidden layer network was more effective than increasing the neurons in a single hidden layer. The weights and biases of the model were adjusted using a mean squared error loss function and a gradient descent optimizer. A correlation of 90% was achieved for the test samples with a mean absolute deviation of less than 10% for all modeled variables. The developed neural network model was able to reduce the complexity of the full-order simulation model by accurately predicting the performance of polymer gel treatments in fractured reservoirs at 200 times faster

speed than commercial simulators with only ten input variables of polymer gel design and reservoir properties.

Novel/Additive Information

This work presents a unique surrogate modeling approach based on machine learning to describe complex polymer gel kinetics and flow dynamics in deep conformance applications. The presented neural network model can be used to robustly predict the oil recovery performance of polymer gel treatments in fractured reservoirs outperforming commercial simulators in terms of computational complexity and processing speed.