SPE-219231-MS

Application of Machine Learning and Deep Learning to Predict Production Rate of Sucker Rod Pump Wells

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This paper was prepared for presentation at the GOTECH Conference held in Dubai, UAE, 7 - 9 May, 2024.

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Abstract

Sucker rod pump (SRP) systems must be designed, optimized, and operated with the aid of production data. This work seeks to create machine learning-driven models that can forecast fluid flow rate at the surface of SRP artificially lifted wells because traditional separators and multiphase flowmeters (MPFMs) may not be available in all wells. Nine machine learning models were developed using real data from 598 wells over three years, with 8,372 data points randomly split into 80% (6,697 data points) for training and 20% (1,675 data points) for testing. These models include Gradient Boosting, AdaBoost, Random Forest, Support Vector Machines (SVMs), Tree, K-Nearest Neighbor (KNN), Linear Regression, Neural Network, and Stochastic Gradient Descent (SGD). Each data set contained readings for the parameters that are easily accessible during any SRP well lifting process, including wellhead flowing pressure, casing pressure, inferred bottom hole fluid production rate, inferred bottom hole oil production rate, net liquid above pump, pump size, stroke length, pump running speed (SPM), pump depth, temperature at pump depth, oil gravity, water viscosity, and pump clearance. The performance of machine learning models is evaluated using two methods (K-fold cross-validation and repeated random sampling), and the results of the top five models (Gradient Boosting, Random Forest, AdaBoost, Linear Regression, Random Forest, and stochastic gradient descent) show that the mean absolute percent error (MAPE) between the predicted fluid rate at the surface and the actual measurements is 3.6, 3.4, 3.4, 4, and 4.4%, respectively. The correlation coefficients (R2) are also 0.937, 0.935, 0.934, 0.921, and 0.915, respectively. Additionally, an oil well in Egypt's Western Desert had its fluid flow rate at the surface predicted using machine learning models. The outcomes were contrasted with the data from the separator test itself. The actual fluid rate and the model's predictions were in perfect accord. Within a wide range of pumping circumstances and completion configurations, the machine learning models are helpful for forecasting the production rates of particular wells. This should make it possible to continuously monitor, optimize, and analyze the performance of SRP wells and to respond more quickly to operational problems. The application of the proposed machine learning models is easy, quick, and affordable when compared to conventional separators and multiphase flowmeters (MPFMs).

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