

# **Application of Machine Learning to Predict Estimated Ultimate Recovery for Multistage Hydraulically Fractured Wells in Shale Formation**

Ahmed Ibrahim

KFUPM

## **Abstract**

Multistage hydraulic fracturing has been commonly used to stimulate shale formation for a long time. The completion design including the cluster spacing injected proppant and slurry volumes have shown a great influence on the well production rates and estimate ultimate recovery (EUR). EUR estimation is a critical process to evaluate the well profitability. This study proposes the use of different machine learning techniques to predict the EUR as a function of the completion design. A data set of 200 well production data and completion designs were collected from oil production wells in the Niobrara shale formation. The completion design parameters include; the lateral length, the number of stages, the total injected proppant and slurry volumes, and the maximum treating pressure measured during the fracturing operations. The data set was randomly split into training and testing with a ratio of 75:25. Artificial neural network (ANN) and Random Forest (RF) techniques were implemented to predict EUR from the completion design. The results showed a low accuracy of direct prediction of the EUR from the completion design. Hence, an intermediate step of estimating the initial well production rate ( $Q_i$ ) from the completion data was carried out, then the  $Q_i$  and the completion design were used as input parameters to predict the EUR. The ANN and RF models accurately predicted the EUR from the completion design data and the estimated  $Q_i$ . The correlation coefficient (R) values between actual and predicted EUR from the ANN model were 0.96 and 0.95 compared to 0.99, and 0.95 from the RF model for training and testing, respectively. A new correlation was developed based on the weight and biases from the optimized ANN model with an R-value of 0.95. This study provides ML application with an empirical correlation to predict the EUR from the completion design parameters at an early time without the need for complex numerical simulation analysis. Unlike the available empirical DCA models that require several months of production to build a sound prediction of EUR, the main advantage of the developed models in this study is that it requires only initial flow rate along with the completion design to predict EUR with high certainty.