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Probabilistic Assessment of Tight-Gas Sands Using a Data-Driven Modeling Approach

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ABSTRACT

Tight-gas sand reservoirs are considered to be one of the major unconventional resources. Due to the strong heterogeneity, very low permeability and advanced well designs with multiple hydraulic fractures; performance forecasting, characterization and optimum exploitation of these resources become challenging with conventional modeling approaches. In this study, it is aimed to develop data-driven predictive models for tight-gas sands and use them for probabilistic assessment of these resources. Data-driven models are based on artificial neural networks that can complement the physics-driven modeling approach, namely numerical flow-simulation models. Two different classes of data-driven models are trained and validated by using data from a numerical reservoir model for tight-gas sand reservoirs: 1) a forward model to predict the horizontal-well performance, once the initial conditions, operational parameters, reservoir/hydraulic-fracture characteristics are provided, 2) an inverse model to estimate reservoir/hydraulic-fracture characteristics once the initial conditions, operational parameters, observed horizontal-well performance characteristics are provided. The forward model is validated with blind cases by estimating the 10-year horizontal-well performance (i.e., cumulative gas recovery) with an average error of 3.7%. While the development of the inverse model was more challenging due to the inverse nature of the problem, reservoir and hydraulic-fracture characteristics are estimated with an average error below 20%, reducing the uncertainty associated with these parameters significantly. A graphical-user-interface application is developed that offers an opportunity to use the developed tools in a practical manner by visualizing estimated performance for a given reservoir or obtaining estimates of certain reservoir and hydraulic-fracture parameters, within a fraction of a second. Practicality of these models is also demonstrated with a case study for the Williams Fork Formation by assessing the performance of various well designs and by incorporating known uncertainties through Monte Carlo simulation. P10, P50 and P90 estimates of the horizontal-well performance and reservoir/hydraulic-fracture characteristics are quickly obtained within acceptable accuracy levels.