Optimization of Hydraulic Fracturing in A Tight Gas Reservoir

using Artificial Neural Network - A Case Study

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Abstract

Unconventional tight reservoirs are an important hydrocarbon resource. The successful recovery of hydrocarbons from such reservoirs involves the advanced horizontal drilling and multi-stage hydraulic fracturing techniques. An accurate design, execution and evaluation of the fracturing technique are required for better post frac performance and cost optimization. Although thousands of wells are drilled and completed using these technologies, there are relatively few modelling tools available designed specifically for these applications, leaving much of the optimization process to trial-and-error, experiences from past practices and analogous approaches. Such practices involve high risks in addition to being costly and time-consuming. Despite the industry’s optimization efforts, meeting the targeted post-frac production is still a major challenge. Therefore, it is of practical interest for engineers to develop a reliable and fast well performance analysis and prediction tool based on the knowledge extracted from the available and historical data. This will identify the current pattern in a specific field and translate the experiences (the trial and errors and past practices) into an accessible tool for engineers to support decisions about future process design. To achieve this, artificial neural networks (ANNs) were designed, trained, and applied to a tight gas field. In this work, three ANNs are developed, each serving a specific objective. The First ANN is used to predict some controllable hydraulic fracturing design parameters using different well and reservoir properties in addition to frac data. The Second ANN is used to predict several frac data outputs by means of inverse looking ANN using well and reservoir properties and actual frac design data to help optimize the primary hydraulic fracturing treatment design as well as to characterize the subject reservoir. As an add-on to the Second ANN, a third ANN is developed to predict expected productivity index resulting from a hydraulic fracturing treatment. All developed ANNs were also used to identify the most influencing parameters affecting the hydraulic fracture job using connection weight analysis. Results from this study show that the ANNs developed are able to estimate the unknowns of the problem within an error margin of 10.4%, 6.4% and 6.6%, respectively. Furthermore, the developed ANNs go hand in hand with the industry’s commonly used method for hydraulic fracturing jobs. This method has three main processes, design (First ANN), execution (Second ANN), and evaluation of the job (Third ANN). The developed networks were also converted to a graphical user interface (GUI), to make it more practical for users to access the different ANNs. A screening guide using ANN was developed to provide preliminary hydraulic fracturing design parameters. The understanding of hydraulic fracturing job was improved by identifying key influencing parameters. The developed process also can used to validate any proposed design resulting from current practices used by the industry.