Practical Application of Neural Networks in Assessing Completion Effectiveness in the Montney Unconventional Gas Play in Western Canada

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Abstract

Neural Networks have been applied to identify completion optimization potential in the development of a Montney Gas Asset based on a field-wide completion effectiveness analysis. Fracture initiation and propagation in the hydraulic fracturing process is very complex, with the response to hydraulic fracturing affected by multiple drivers, such as in-situ stress, geomechanical heterogeneity, presence of natural fractures and completion parameters. As a result, it is difficult to understand the primary drivers that affect completion effectiveness, and how resulting production could be enhanced by optimizing completion parameters. This paper attempts to show how we can obtain a better understanding of the relationship between the hydraulic fracturing and well performance from a field-wide view, and to point to methods we can apply to enhance well production.

An Artificial Neural Network (ANN) modeling technique, PCA-ANN, is employed to identify the drivers for well performance, to build a model evaluating completion effectiveness and predicting well performance (given by EUR), and to identify optimal completion parameters for new wells to enhance well production. Eight key variables were identified by the Principal Component Analysis (PCA) method: breakdown pressure, instantaneous shut-in pressure, cluster spacing, perforation number, proppant amount, sand concentration, fluid volume and pumping rate. Within these eight variables, through a sensitivity analysis to EUR, the dominant production drivers identified are cluster spacing (stage number) and proppant amount, which are related to the hydraulic fracturing process and are controllable. The uncontrollable parameters of reservoir geology, which in this variable-set are related to the breakdown pressure and the instantaneous shut-in pressure, occur in the second category in affecting well performance in the study area. Although important to well performance, once the well is drilled they fall into an uncontrollable category: the question then is, what can be done in terms of the variables that can be controlled, to enhance the well performance.

An ANN model for predicting EUR based on the eight variables was then applied to evaluate the existing producing wells and to guide the optimized completion designs. For most of the wells with lower EUR, we found that there would have been a better performance if their completion parameters had been optimized. Furthermore, the PCA-ANN technique indicates which parameters should be changed and by how much, for optimal results. For higher performing wells, the analysis shows that there is less potential to enhance well performance, although there was usually some improvement possible in most cases. Based on the predictive ANN model, a handbook of charts was created for selecting and evaluating different completion parameters in the new completion designs.