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Fact-Based Modeling: Shale Production Optimization

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Abstract

Advanced Data-Driven Analytics provides much needed insight into hydraulic fracturing practices in Shale. Unlike traditional modeling, Advanced Data-Driven Analytics incorporates “Hard Data1” rather than “Soft Data2”. Using this technology synthetic geomechanical well logs can be generated, impact of reservoir quality can be meaningfully assessed and contribution of completion and hydraulic fracturing practices to production from shale can be modeled and optimized.

Advanced Data-Driven Analytics is a unique and innovative implementation of Artificial Intelligence, Machine Learning and Data Mining in the upstream E&P. Data-Driven predictive models are trained, calibrated and validated using “Hard Data” and are used to design optimum frac jobs in new wells, identify the best locations to place the next pads, design distance between laterals, and distance between stages and clusters of hydraulic fractures. Application of this technology is demonstrated using case studies in multiple Shale assets. Advanced Data-Driven Analytics technology includes three phases: *(a)* Pre-Modeling Data Mining, *(b)* Data-Driven Predictive Modeling, and *(c)* Post-Modeling Analysis & Optimization.

Pre-Modeling Data Mining: During this phase hidden patterns in data are discovered and displayed using Fuzzy Pattern Recognition technology as shown in Figure 1. In this Figure values of clean injected fluid (prior to introduction of proppant) is plotted against the “12 months cumulative gas production” (top-left graph) to show the seemingly chaotic behavior of data when visualized using simple graphs. Categorizing the wells into fuzzy groups (poor, average, good, very good, and excellent) starts to reveal the hidden trend in the data (three bar charts on the right). These bar charts show the trend as the granularity increases from three (top chart) to five (bottom chart) groups. The final graph (bottom-left) shows the complete trend (highest possible granularity of categorization) in this dataset.

Data-Driven Predictive Modeling: During data-driven predictive modeling hard data (and not soft data) is used to train, history match and validate a multi-variant predictive model without making any assumptions about the state of our understanding of the physics of the production process. Figure 2 shows the quality of the match that can be achieved using data-driven reservoir modeling. A full field model can be developed for a shale asset while history matching every single well in the asset.

Post-Modeling Analysis & Optimization: This phase include analysis of the predictive model that includes quantification of uncertainties associated with reservoir characteristics, production optimization by identifying the optimum combination of design parameters such as

completion details or hydraulic fracture recipe. Furthermore, the predictive model is used to identify the best location for the next pad, optimum distance between laterals and best distance between pads.

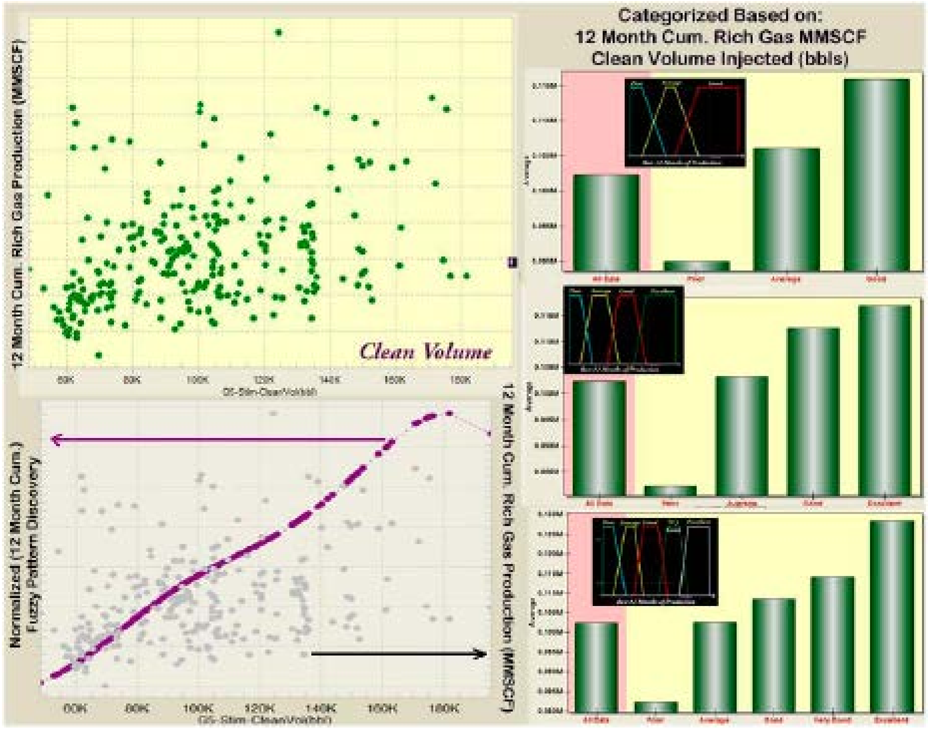

Figure 1. Fuzzy Pattern Recognition can discover hidden pattern in data with seemingly chaotic behavior.

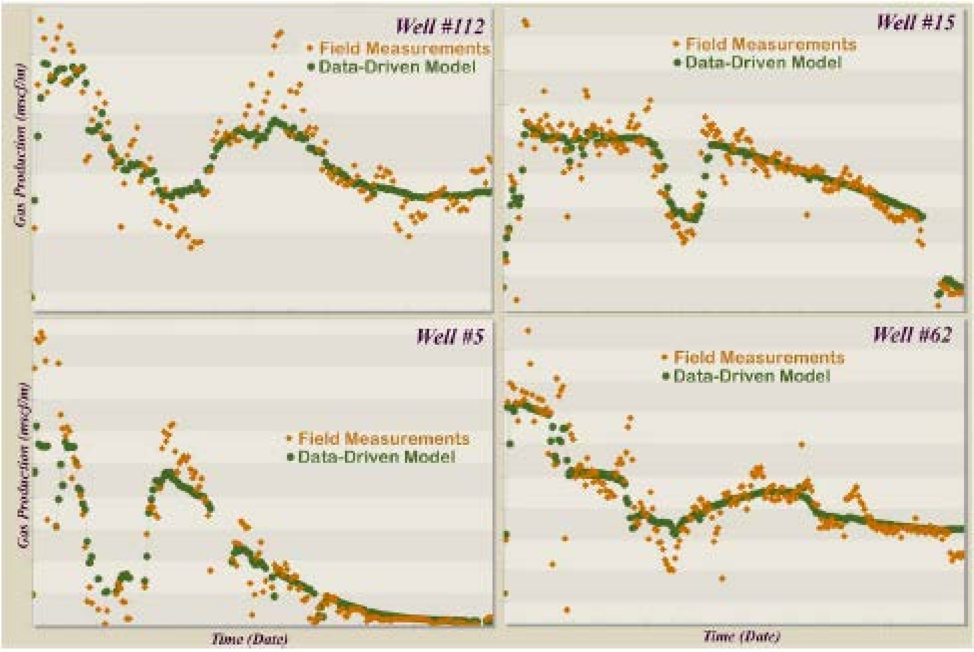

Figure 2. Modeling (history Matching) production conditioned to well construction data, reservoir characteristics and production constraints from a Shale asset using data-driven modeling technology.