Case Study

DeGolyer and MacNaughton Workflow for Well Performance Analysis, Fracture Modeling and Completion Design

DeGolyer and MacNaughton
May 29, 2018
Dallas, Texas
Workflow

Multi-step process to assess well performance and completion design

- Optimal Completion Design
- Well Performance Diagnostics
- Rate-Transient Analysis
- Hydraulic Fracture Modeling
- Numerical Reservoir Simulation
Production Diagnostics

Deliverables of single well production diagnostics are metrics, flow regimes, etc.

Diagnostics Dashboard

- Oil Rate Pressure Drop Normalized vs Production Time
- Oil Rate Pressure Drop Normalized vs Oil Material Balance Time
- Pressure Drop Oil Rate Normalized vs Square Root of Time
- Total Fluid Rate Pressure Drop Normalized vs Production Time
- Total Fluid Rate Pressure Drop Normalized vs Total Fluid Material Balance Time
- Oil Rate vs Cumulative Oil Production
Production Diagnostics
Correlation of metrics from diagnostics yields potential drivers of productivity

Metrics from well performance diagnostics, completion parameters, and reservoir properties are compared in search of potential drivers of productivity.
**Rate Transient Analysis**

Production diagnostics provides insight into understanding flow regimes and relating to models.
Rate Transient Analysis

Results provide effective fracture surface area and permeability (to be used in reservoir simulation)

- **Skin**: 0.001
- **Well length, ft**: 5000
- **Number of fractures**: 100
- **Fracture half length, ft**: 75
- **Fracture height, ft**: 150
- **Permeability, md**: 5E-4

**Diagram:**
- **History Match Plots**
- **Diagnostic Plots**

**Graphs:**
- Gas Rate vs. Elapsed Time
- Pressure vs. Elapsed Time
- Inverse Pressure vs. Material Balance Time
- Normalized Gas Potential vs. Material Balance Time

This document is released for the purpose shown. It is not to be used for any other purposes.

Preliminary: Rely on report final results. This document of preliminary review on the used for any specific conditions and is released for the purpose date shown. It is not to be other purposes.
Rate Transient Analysis
Results are generally used to evaluate completion efficiency when multiple wells are analyzed

- **Tie to Well Completion — Comparison of RTA Results vs. Completions Design**
  - Example 1 illustrates a case study where increasing amount of fluid pumped (i.e., slick water jobs) yields higher total fracture surface area (through RTA).
  - Example 2 indicates that better completions (translated as higher effective fracture half-length in RTA) provide higher EUR values.

**Example 1 — Correlations of rate transient analysis results with completion design parameters**

**Example 2 — Cross plot of effective fracture half-length values from rate transient analysis**
Hydraulic Fracture Modeling

Fracture modeling provides fracture geometry through history matching treatment pressure data.

- Treatment pressures were calibrated to actual data.
- Fracture properties are the main output.
Hydraulic Fracture Modeling

Generated fracture geometry is incorporated into a reservoir model for modeling production.

Lateral View

Top View

Maximum hydraulic fracture height
Numerical Reservoir Simulation
Fracture geometry from modeling is simplified and then utilized in reservoir simulation

Reservoir Simulation Grid Overview

History Match

Gas Rate vs. Elapsed time
Completion Design Sensitivities

Sensitivities are performed to investigate impact of key completion parameters.

- **Stage Length**
- **Number of Clusters and Stages**
- **Fluid Type**
- **Proppant Type**
- **Proppant Load**
- **Pump Rate**

### Completion Design Sensitivities

**Pump Rate:** Base and -25%

<table>
<thead>
<tr>
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**Fluid Type:** Base (slick water) and WF160 (60 lb/mgal linear gel)

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### Diagram

- **Stage Length**
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Completion Design Sensitivities

Reservoir simulation is performed with fracture geometry based on design sensitivities.
Considerations for Evaluation and Development

Optimal evaluation and development involves an integrated approach.

### Completion Design and Efficiency
- Fracturing fluids
- Proppant types and amounts
- Number of stages/clusters
- Flowback/choke management
- Fracture properties…

### Production Performance and Diagnostics
- Plots: Flowback evaluation
- Plots: Choke management
- Plots: Flow regime identification

### Reservoir Characterization
- In-place volume
- Thermal maturity (PVT)
- Natural fractures
- In-situ stresses
- Lateral landing point
- Fracture dimensions
- Mineralogy/brittleness
- Reservoir pressure

### Calibration, Analysis and Forecasting
- Rate-transient analysis
- Evaluation of parameters
- Correlation of results
- Numerical reservoir simulation
- Well interference