Principles of Hydraulic Fracturing / GOHFER Training (5 Day)

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Day 1: AM

Introductions

***Polleverywhere* Class Survey**

Discussion - Fracturing: Objectives (G1)

Goals of Stimulation
How Do We Benchmark Well Performance?
Why don't wells perform as expected after frac?

GOHFER Software – Introduction

Software Overview
- Installation
- License Access
- Convert Existing Project to GOHFER 3D

Discussion - Input Data for Fracture Design Models (G3-4)

What Controls Created Fracture Geometry?
Modeling In-Situ Stress States
Effect of Pore Pressure on Stress
Effects of ductile (plastic) behavior
Other fracture containment mechanisms
Processing full-wave sonic (Dipole) logs
Deriving Synthetic Sonic Curves
Log QC

Day 1: PM

GOHFER Software – Vertical Well Class Example

Vertical Well Class Example – Actual Post Job
- LAS (Log Processing)
  - Input Data Requirements
  - Mechanical Property and Stress Profile Construction
- Geologic Section
  - Define wellbore segment(s) – treatment string / wellbore fluid
  - Define Grid Dimensions
- Treatment Design
  - Perforations
  - Actual Pump Schedule
- Engine Output Viewer
  - Output Grid Data

Day 2: AM

Discussion - Designing and Using Pre-Frac Injection Tests (G5-6)

Pre-Frac Injection/Falloff Tests
Pre-Frac Step-Rate Injection Test
Holistic pressure diagnostics
Fluid Efficiency and Leakoff Coefficient during Closure
Effects of Natural Fractures
After-closure analysis and reservoir characterization

GOHFER Software – Pressure Diagnostics

Pressure Diagnostics
Import Data / Analysis Input
Input File Preprocessor
Pre-Falloff / Closure / After Closure Analysis

GOHFER Software – Vertical Tight Gas Class Example History Match

Vertical Well Class Example – History Match
Pressure Matching Strategies
Matching Stresses (Pore pressure, Closure pressure, PZS) and leakoff
Matching Frictional Effects (Pipe / perf / near wellbore)

GOHFER Variable Sensitivity
Demonstration / discussion of individual input variables and their impact on the model

Day 2: PM

Discussion - Predicting Final Fracture Conductivity, Cleanup and Production (G9)

Traditional Conductivity Estimates
Polymer Concentration during Leakoff and Closure
Degradation and Half Life of Various Breakers
Proppant Crushing by Uneven Loading
Non-Darcy Flow Mechanisms
Relative permeability and Multiphase Flow
Combined Effects of Multi-phase and Non-Darcy Flow
Damage and Cleanup processes
Case History: Created versus effective frac length

GOHFER Software – Production

Vertical Well Class Example – Actual Post Job
Conductivity & Well Performance

Class Exercise - Economic Optimization
Design / Production / Economic Optimization

GOHFER Software – (GPA) GOHFER Production Analysis

GOHFER Production Analysis
Decline Analysis
Type Curve Analysis

Day 3 AM

Discussion - Unconventional Reservoirs and Horizontal Well Stimulation (G10 & G11)

Selection of stimulation designs
Transverse or Longitudinal fracs
Achieving diversion and placement
Treating pressures and breakdown efficiency

GOHFER Software - Horizontal Transverse Shale Model & Production Example

Treatment / Reference Wells
- 3D Surveys
- LAS (Shale / Carbonate Log Processing)

Treatment Stage
- Asymmetric modeling
- Longitudinal vs. Transverse Fractures
  - Building Geologic Structure
  - Offset Depletion
- Breakdown Pressure
- Fracture Orientation
  - Breakdown Gradient / Breakdown Angle

Day 3: PM

GOHFER Software - Horizontal Transverse Shale Model & Production Example (cont.)

Treatment Design
- Perforations
- Interference / Stress Shadowing
  - Single Transverse stage (multiple clusters)
  - Multiple Transverse stages (individual treatments)
- Stress Anisotropy
  - Ball Drop Transverse stages (single treatment / multiple stages)

Engine Output Viewer
- 3D Grid Output

Production
- Longitudinal / Transverse production parameters

Day 4: AM

GOHFER 3D Software – Multi-Well Fully 3D GeoModel

3D Example 1 – Multi-Well Model w/ Reference Logs only (No Geologic Model)

Site & Well Location Entry
Log Processing & Integration
Grid Setup & Map View

GOHFER 3D Software – Multi-Well Fully 3D GeoModel

3D Example 2 – Add 2D Surface Map to Previous Example

Grid Setup & Map View

Day 4: PM

GOHFER 3D Software – Multi-Well Fully 3D GeoModel

3D Example 3 – Add 3D Geologic Model to Previous Example

Create Core to Replace Reference LAS
LAS Mapping from Core (Full 3D Distribution vs. Reference LAS (Layer Cake)
Import Geologic Model / Requirements
Offset Depletion / Well Bashing
Zipper frac simulations

Day 5: AM

Discussion - Proppant Transport & Screenout Behavior (G8)

Factors Affecting Proppant Transport
Proppant Movement by Bulk Flow or "Convection"
Proppant Bridging and Screenouts
Proppant Holdup and Inefficient Transport
Effects of Overflushing Frac Jobs

Discussion - Fracturing Fluid Rheology and Leakoff (G7)

Fracturing Fluid Rheology
Effect of Sand Addition on Frac Fluid Rheology
Leakoff Modeling

GOHFER Software

GOHFER Databases
- Proppant Database
- Fluid Database
  - Review proppant / fluid database inputs and functions
  - How to add a fluid to the fluid database

Reports
- Report management/editing
- Adding images to reports

Microseismic Class Example (optional)
- Import Microseismic data into GOHFER

Real-Time Data Acquisition Demonstration (optional)

Day 5: PM

Discussion - Modeling Fracture Geometry (G2)

Types of fracture design models
Design models and their assumptions
Effects of elastic coupling and shear
Process zone mechanisms

GOHFER Software

Individual Multi-Well Fully 3D GeoModel Class Exercise

Wrap Up - Summary and Conclusions