Predicting Pressure Behavior and Dynamic Shock Loads on Completion Hardware During Perforating

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- What if modeling could avoid disaster!
- Do you model your well?

Tacoma Narrows Bridge
Introduction

Shock-wave modeling software can:
1. Assist in the design of complex or unique jobs
2. Minimize NPT
3. Provide post-failure analysis.
Case History 1 - Camamu Basin

- **Considerations**
  - North of primary production
  - Formation test
    - Gas production rates
    - Sand and Water production
  - Logistics
  - Frac Boat Costs

- **Solution**
  - Perforate with Stim Gun propellant
  - Use software to
    - Design propellant fractures
    - Minimize NPT
Modeling Parameters

Reservoir:
- BHT: 225°F (107°C)
- Perm: 0.2md
- Porosity: .08
- Fluid: Gas

Mechanical:
- Casing: 7in 26#
- Interval: 115 ft (35 m)
- Top Shot Depth: 10,700 ft (3250m)
- Gun: 5 spf Deep Penetrating
- Fluid: 11 ppg
- Underbalance: 700psi

Energetic Materials:
- 42 feet of Stim gun
Job Execution

- Shock simulations completed
- Deployed equipment to location
- Detonated guns
- Formation test conducted
- POOH and .....

SLAP-15
Component Failure

Why was Failure **NOT** Predicted?

- Champ IV Packer
- Formation test string
- Pup Joint w/ Firing Heads
- 35m of guns

SLAP-15
Post Failure Analysis

Gauge Analysis
Reported perm = 0.2 md
Actual perm = 0.02 md

Changed perm and re-ran model

Model predicted failure at 3244m

Actual failure @ 3245m
Lessons Learned

- Reservoir parameters are critical!
- Uncertainty? Run sensitivity analysis
- Model is accurate if information is accurate!
- Model is accurate if an experienced engineer is running the models
Case History 2 - Santos Basin

**Considerations**
- Longer interval - 70 m
- Previous experience with large guns (7” 6 spf Deep Penetrating)
- Equipment Limitations
- Test lower Santonian sands

**Solution**
- Evaluate BHA to minimize NPT
Standard Configuration

Champ IV Packer

2 7/8 Tubing

2 7/8 BIT

2 7/8 Pup

70 m of 7” guns

Red – Movement
Blue – Packer Load
Cyan - Tubing Load
First Iteration

Champ IV Packer

3 ½ Drill Pipe

2 7/8 BiT

2 7/8 Tubing

2 7/8 Pup Joint

70 m of 7” guns

Red – Movement

Blue – Packer Load

Cyan - Tubing Load
Successful Solution

Job Successfully Deployed and Recovered

Red – Movement
Blue – Packer Load
Cyan - Tubing Load

Champ IV
Packer

3 ½ Drill Pipe

2 7/8 Bit

2 7/8 Tubing

2 7/8 Pup Joint

70m of 7” guns
Lessons Learned

- Evaluate “Standard Configuration”
- Failure to model and troubleshoot may lead to NPT
- Equipment limitations usually can be accommodated with simple rearrangement.
Summary

- Successful application can minimize NPT
- Can determine a root cause for problems
- Ideal for complex or unique jobs.
Conclusions

- Numerical modeling can predict perforating dynamic behaviors.
- Avoid high costs of non-productive time for operators
  - Personnel Safety
  - Environmental
- Tool to understand Root Cause for job problems.
- Job modeling is important for every well since all wellbores have different geometries and formation parameters.
Do you use modeling for your perforating? If not — Why not?