Using a Perforation Flow Lab to select Shaped Charges and the Proper Underbalance Technique for Deepwater Subsea Wells, Offshore Africa.

Noma Osarumwense, Baker Hughes
Jim Gilliat, Baker Hughes
Content

- Introduction
- Perforation flow lab
- Design workflow
- Test configuration
- Results overview
- Conclusions
- Ongoing work
Introduction

- Offshore West Africa
- 1000 m – 1700 m water depth
- Sandstone reservoir
- Natural completion

Typical Well Data

- Reservoir depth: 3300 – 3600 mTVD
- Reservoir pressure: 6300 – 6412 psi
- Permeability: 200 – 600 md
- Porosity: 14 – 21%
- Temp: 200 – 230°F
Perforation Flow Laboratory – Section-IV Capabilities

Rock sample diameter: 7 in.

Rock sample length: 30 in.

Confining pressure: 15,000 psi

Wellbore pressure: 10,000 psi

Pore pressure: 10,000 psi

Temperature: 350° F

Data acquisition:
  Low speed – 100/sec
  High speed – 100,000/sec
Perforation Flow Lab Measurements

- Pre-shot porosity
- Pre/post perforation permeability
- Perforation tunnel diameter
- Perforation tunnel depth
- Detailed tunnel characterization using advanced CT scanning methods
- Dynamic pressure data
- Core flow efficiency and productivity ratio
- Evaluate perforation cleanup mechanisms
- Optimization of underbalance methods
Test Configuration

- Sandstone cores: 7-in. OD X 30-in.
- Type: Buff Berea
- Permeability: 150 - 350 md
- UCS: 3800 psi
- Porosity: 22%
- Confining pressure: 9,300 psi
- Pore pressure: 6,000 psi
## Test Configuration contd.

Two charge types (different designs);
- 39-gm steel case, HMX
- 39-gm zinc case, HMX

<table>
<thead>
<tr>
<th>Test Conditions</th>
<th>39 gm Steel Case Charge, HMX</th>
<th>39 gm Zinc Case Charge, HMX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static UB w/DUB</td>
<td>600</td>
<td>660</td>
</tr>
<tr>
<td>Static OB w/DUB</td>
<td>600</td>
<td>660</td>
</tr>
<tr>
<td>Static UB w/Standard *</td>
<td>585</td>
<td>360</td>
</tr>
</tbody>
</table>

Static UB = 500 psi
Static OB = 250.

*Standard conditions represent the natural dynamic pressure response of fully loaded guns without additional chambers.
Results Overview

Penetration vs. Perforating Option

- Core Penetration - Length of Perforation tunnel excluding casing, and cement
Results Overview

Dynamic Underbalance Achieved vs. Perforating Option

Duration vs. Perforating Option

- Duration – Time from Detonation to Pressure Equalization
Results Overview

Post-Shot Transient Pressure match: UB_ 39 gm DP Steel
Results Overview

Post-Shot Transient Pressure match: OB_ 39 gm DP Steel
Conclusions

- Dynamic underbalance achieved with 7-in. OD X 39-gm steel case charges under all conditions.

- Dynamic underbalance achieved with 7-in. OD X 39-gm zinc case charges under all conditions.

- Charge performance in core significantly less than predicted from models

- Tunnel geometry impacted by variation in core structure (examining additional factors).
Ongoing work

- Effects of fluid invasion on charge performance, perforation geometry, and productivity.
- Effects of higher magnitude of static underbalance on perforation clean up
- Effect of fluid loss control pill on productivity as used in shoot-and-pull applications
Publication Works in Progress

“Shaped Charge Selection and Underbalance Optimization Using the Perforation Flow Laboratory for Deepwater Subsea Wells in Offshore Africa”

- Accepted for the SPE Deepwater Drilling and Completions Conference 2014, Galveston, TX. 10-11 Sept
Thank You!