Rock optimized shaped charges and Section IV testing

Presenter: Liam McNelis.
Co-Author: Christian Eitschberger.
Introduction & Outline

➔ Test configuration & sandstone targets

➔ Test results (TTP & flow ratio)

➔ Analysis of results

➔ Summary (way forward)
Section IV Test Configuration

- 4 x sandstone rock types
- 3 x charge designs

26g DP (Conventional)
26g Reactive Liner
26g Hard Rock Optimized

- Overburdon 6000 psi
- Pore-Pressure 2000 psi
- Wellbore 3000 psi

- Casing Thickness ½"
- Cement Thickness ¾"
- Cores Axially Flowed
Sandstone Targets (7” x 30”)

- **Sander Schilf**
  - UCS 6200psi
  - Porosity 19.4 – 20.6%
  - Perm. 120 – 150 mD

- **Carbon Tan**
  - UCS 8900psi
  - Porosity 14.9 – 15.6%
  - Perm. 25 – 30 mD

- **Main**
  - UCS 10150psi
  - Porosity 11.6 – 11.8%
  - Perm. 2 – 6 mD

- **Bunt**
  - UCS 11312psi
  - Porosity 12.4 – 13.6%
  - Perm. 40 – 50 mD
Depth of Penetration

- **Sander Schilf**
  - 26g HRO: 36.4” (concrete*)
  - 26g Reactive Liner: 10.5”
  - 26g DP Conventional: 16.5”

- **Carbon Tan**
  - 26g HRO: 36.4” (concrete*)
  - 26g Reactive Liner: 12.9”
  - 26g DP Conventional: 14.5”

- **Main**
  - 26g HRO: 32.1” (API 19b)
  - 26g Reactive Liner: 9.4”
  - 26g DP Conventional: 12.5”

- **Bunt**
  - 26g HRO: 36.4” (concrete*)
  - 26g Reactive Liner: 8.3”
  - 26g DP Conventional: 9.5”

*Note: Concrete depth penetration values are labeled as (concrete*) for reference.
26g Reactive Liner - 4 different rocks

Sander Schilf: 10.9"
Carbon Tan: 11.8"
Main: 8.1"
Bunt: 7.4"
Pre/Post Shot Permeability Ratio

<table>
<thead>
<tr>
<th>Rock Type</th>
<th>26g HRO</th>
<th>26g RL</th>
<th>26g DP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sander Schilf</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon Tan</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bunt</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PR (Axial Flow)
Main Sandstone – 3 different charges

<table>
<thead>
<tr>
<th>Reactive Liner</th>
<th>HRO</th>
<th>DP</th>
</tr>
</thead>
<tbody>
<tr>
<td>EHD: 0.37” – 0.41”</td>
<td>EHD: 0.35” – 0.38”</td>
<td>EHD: 0.28” – 0.30”</td>
</tr>
</tbody>
</table>

APPS-13-009
High Speed Recording (5 KHz) x 3 Main Sandstone

- All tests were shot under identical conditions.
- DUB 2500psi
- Dynamic Underbalance almost identical regardless of charge type & rock type.
- Pore Pressure Peak on HRO charge.

APP-13-009
Fluorescent Dye Radial Flow

Sander Schilf Sandstone: (UCS 6200psi), 26g DP HMX/St

Fluorescent dye indicates path of fluid flow
Main Sandstone: (UCS 10150psi), 26g Reactive Liner HMX/St

Fluorescent dye indicates path of fluid flow
Bunt Sandstone: (UCS 11300psi), 26g DP HMX/St

Fluorescent dye indicates path of fluid flow
Main Sandstone: UCS 10150psi, 26g DP HMX/St

Fluorescent dye indicates path of fluid flow
Summary

- Sufficient and good penetration is desirable but highest DoP, especially in concrete targets, does not automatically mean best downhole performance.

- Best performance can be achieved by developing a charge specifically for the rock type (not always feasible – time/cost/availability of rock).

- Reactive Liner charges appear to be more suited to harder tighter sandstone rocks.

- Results indicate that sandstone rocks with medium-high porosity are more susceptible to skin effect and crushed zone than the harder rocks, particularly with OB perforating.

- Need to repeat more tests with other test configurations to confirm the effect of Overbalance and DUB on the results.
Thank you for your attention.