Unique Applications - Section IV Testing

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APPS-13-004
Basics of Section IV
Visual reminder: Why are Section IV tests conducted? 
...we want to simulate downhole conditions!
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Perforation Flow Laboratory Schematic
The Original API Section IV Conditions

Net Effective Stress = Overburden – Pore Pressure

Overburden stress 4,500 psi
Wellbore pressure 1,000 psi
Formation Sample
Reservoir Storage

WellboreStorage
Inject
Flow

Pore pressure 1,500 psi
Net Effective Stress = Overburden – Pore Pressure
Beyond conventional Section IV testing...

Four unique applications:

1. Sanding and resin treatment
2. Complex tubular geometries
3. Kill fluid evaluations
4. Hydrojetting
1. Sanding and resin treatments

Testing rationale:
Implement sand control to avoid lost production

1. Perforate core
2. Flow until onset of tunnel collapse
3. Treat with resin to stabilize tunnel
4. Continue to flow and assess performance

Optical density image of entrained sand particles
Tunnel Geometry

- Perpendicular to bedding planes
- Parallel to bedding planes
Erosion of the Perforation
SPE120901

CT slice locations
Sanding Production

![Graph: Perpendicular Bedding Planes]

- Sand Production (g): 353
- Production Rate (b/d): 3703
- Differential (psi): 592

(apps-13-004)
Sanding Production

![Parallel Bedding Planes]

- Sand Production (g): 381
- Production Rate (b/d): 1440
- Differential (psi): 207

Pre Treatment
Matching downhole conditions is the goal.

- Wellbore deviation
- Absolute pressures and stresses
- High temperature
2. Complex Tubular Geometries

Testing rationale:
- Life extension for gravel pack well using small gun system for gas shutoff workover.
- Evaluate perforator and flow performance.

1. Perforate across multiple layers - extreme impedance mismatches
2. Balanced pressure conditions
Target Geometry – 7 layers

1. Tubing
2. Gel
3. Screen
4. Gel/Sand
5. Casing
6. Cement
7. Rock
### Results

<table>
<thead>
<tr>
<th>Test Shot</th>
<th>Tubing Exit Dia (in)</th>
<th>Base Pipe Exit Dia (in)</th>
<th>Casing Exit Dia (in)</th>
<th>Core Penetration (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.23</td>
<td>0.17</td>
<td>0.13</td>
<td>3.98</td>
</tr>
<tr>
<td>2</td>
<td>0.24</td>
<td>0.15</td>
<td>0.14</td>
<td>3.80</td>
</tr>
</tbody>
</table>

API 19B Section 1 penetration: 18.3 inches

Decision to perforate can only be made with confidence by conducting Section IV test.
3. Kill Fluid Evaluation

Testing rationale:

- Conventional permeability testing showed no difference between kill fluids
- Confirm using Section IV testing
- 200 psi overbalance
Kill Weight Selection – Return Permeability Analysis

Kill Weight Fluid Applied to Core

Inject Kill Weight Fluid (in separate fixture)
\[ \Delta P \text{ 500 psi} \]
360 °F
7 days

Wellbore

Overburden

Formation

Sample

Reservoir Storage

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Return Permeability Testing

Permeability ($S_{wi}$) - Pre and Post Kill
20 md Gas Sandstone

Potential Production Rate

KW Fluid 1	KW Fluid 2

Pre Kill	Post Kill

KW Fluid 1	KW Fluid 2

Production (mmscf/day)

-15%

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4. Hydrojetting

Testing rationale:

- Evaluate effects of hydrojet perforating using CT in a laboratory environment
Perforation Flow Laboratory Schematic

- Overburden stress: 4,000 psi
- Pore pressure: 1,000 psi
- Wellbore pressure: 2,000 psi

Wellbore Storage → Wellbore → Formation → Sample → Reservoir Storage

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The effects of Hydrojet Perforating on Coil
New Capabilities for Simulating Downhole Conditions

- Overburden to 50,000 psi
- Pore & Wellbore to 40,000 psi
- Temperature to 400F
- Deviations 0 to 90 deg
Thank You