Interference Testing to Advance Appraisal and Development Strategies

Hart Greenwood & Trevor Ingle
Devon Energy
Interference Testing Objective

Objective within DVN

- Quantify connectivity between infill wells
- In $k$ MFHWs, the connectivity is driven by fracture overlap (complex system)
- Leverage information to impact future development decisions
Several Interference testing options exist. Devon is primarily focusing on PTA approaches to capture high resolution data and characterize fracture overlap between infill wells in low perm systems.

### Production or Rate Transient Test

<table>
<thead>
<tr>
<th>Initial Infill Conditions</th>
<th>Source Well</th>
<th>Monitor Well</th>
<th>Data Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flowing Wells</td>
<td>Shut In</td>
<td><strong>Remain Flowing</strong></td>
<td>Rates + Pressures</td>
</tr>
</tbody>
</table>

- **Con:** Signal to noise, instantaneous liquid measurements
- **Pro:** Low cost, minimal planning, happens routinely

### Pressure Transient Test

<table>
<thead>
<tr>
<th>Initial Infill Conditions</th>
<th>Source Well</th>
<th>Monitor Well</th>
<th>Data Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shut-In</td>
<td>Sequence Online</td>
<td><strong>Remains Shut In</strong></td>
<td>Pressure Only</td>
</tr>
</tbody>
</table>

- **Con:** Recommend downhole gauge, increased planning
- **Pro:** High resolution, improved characterization of fracture overlap
Testing Design and Data Analysis

Additional Resources
- Chow Pressure Group: SPE 191407
- Pioneer/Kappa Publication

Approach
- Run downhole gauge in one or several wells
- Monitor falloff and obtain stable conditions
- Systematically put offset wells on production
- **Monitor deviation from stable conditions**

Benefits
- High quality data vs other approaches
- Can quantify level of well connectivity
- CPG ranges from 0 – 1 (index)

\[
CPG = \frac{\Delta P}{2 \times (\Delta P')}
\]
Testing Design and Data Analysis

Additional Resources

• Chow Pressure Group: SPE 191407
• Pioneer/Kappa Publication

Approach

• Run downhole gauge in one or several wells
• Monitor falloff and obtain stable conditions
• Systematically put offset wells on production
• Monitor deviation from stable conditions

Benefits

• High quality data vs other approaches
• Can quantify level of well connectivity
• CPG ranges from 0 – 1 (index)

\[
CPG = \frac{\Delta P}{2 \times (\Delta P')} 
\]

\[\text{MPI} = 0.57\]
**Case 1: Assessing Staggered Development**

- **LZ Status**
  - Successful Parent Wells
  - Vertical drainage?
  - Contacting OOIP from LZ below?

- **Gun Barrel Layout**

- **Value to Team**
  - Calibrate frac models
  - Refine expectations of contacted OOIP
  - Enhance characterization of appraisal zone sweet spots
  - Allows for considerations on completion fluid & volume
  - Develop it independently later?

---

<table>
<thead>
<tr>
<th>LZ Status</th>
<th>Gun Barrel Layout</th>
</tr>
</thead>
<tbody>
<tr>
<td>Successful Parent Wells</td>
<td></td>
</tr>
<tr>
<td>Vertical drainage?</td>
<td></td>
</tr>
<tr>
<td>Contacting OOIP from LZ below?</td>
<td></td>
</tr>
<tr>
<td>Known high quality targets</td>
<td></td>
</tr>
<tr>
<td>Successful co-development</td>
<td></td>
</tr>
<tr>
<td>Less certain lateral &amp; vertical drainage</td>
<td></td>
</tr>
</tbody>
</table>
Case 2: Understanding Fracture Degradation

Monitor Downhole Pressure (psi)

Completion & Drillout
Sequence on Offset Wells
Gauge Install
Monitor Interference
Test 1

Produce
Monitor Well

SI Wells
Obtain Stable PBU

Date

1/10/2020
2/9/2020
3/10/2020
4/9/2020

Produce Monitor Well

Monitor Interference
Test 2
~3 Months
Case 2: Understanding Fracture Degradation

-41% Degradation In Connectivity

Test 1 (Flowback)

Test 2 (SI & Build Up)
Strategy
Conducted Interference Tests on multiple units with varying development strategies

Notes & Takeaways
- ↑ MPI led to ↑ Unit Recovery
**Strategy**

Conducted Interference Tests on multiple units with varying development strategies

**Notes & Takeaways**

- ↑ MPI led to ↑ Unit Recovery
- Obtained Interference tests to assess impact to MPI at varying prop volume
Case 3: Completion Volume Optimization

Strategy
Conducted Interference Tests on multiple units with varying development strategies

Notes & Takeaways
• ↑ MPI led to ↑ Unit Recovery
• Obtained Interference tests to assess impact to MPI at varying prop volume
• ↑ Prop/Cluster provided ↑ MPI, at constant and light well spacing
• Dataset provided insights into diminishing returns of prop volume
Summary

• Short duration tests and data is cost effective to acquire

• Valuable technology for assessing connectivity throughout the producing lifecycle

• Interference tests can provide unique insights about conductive fracture overlap that adds value to appraisal and field development decisions
  • Vertical connectivity across various landing zones
  • Fracture degradation through wells lifecycle
  • Completion and well spacing optimization
Thank You

<table>
<thead>
<tr>
<th>Acknowledgments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mark Wilkins</td>
</tr>
<tr>
<td>Kyle Dahlgren</td>
</tr>
<tr>
<td>Kyle Haustveit</td>
</tr>
<tr>
<td>Austin Qualls</td>
</tr>
<tr>
<td>Chris Ketter</td>
</tr>
<tr>
<td>Jason Garrett</td>
</tr>
<tr>
<td>Brendan Elliot</td>
</tr>
<tr>
<td>Chris Cope</td>
</tr>
<tr>
<td>Scott Baker</td>
</tr>
<tr>
<td>Mouin Almasoodi</td>
</tr>
<tr>
<td>Travis Black</td>
</tr>
<tr>
<td>Brett Pribble</td>
</tr>
<tr>
<td>Jason Hildebrand</td>
</tr>
<tr>
<td>Aubrey Humbolt</td>
</tr>
</tbody>
</table>