Optimizing Fracturing Design by Applying Multicluster (TCP) in Horizontal Wells for Unconventional Development

SLAP 16-8

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- TCP Multi-cluster & Coiled Tubing - Objective
- Multi-cluster sequence – TCP Step by Step
- Case History: Well conditions
- Case History: Solution - TCP
- Case History: BHA design Coiled Tubing – Challenge
- Case History: Solution – Coiled Tubing
- Case History: Operational description & Outcomes
- Conclusion
INTRODUCTION

- Unconventional completions optimization is important for shale/tight field development to provide the industry with cost-effective solutions.
- Several technologies are available to create the toe perforations (1st stage perforations) required to enable using the pump-down technique.
- In Argentina, several unconventional completions methods are available, such as fracturing sleeves, sand jetting, tractor conveyed perforating, etc.
- However, complex geometry or collapsed wells requires a more reliable completion technic.
TCP Multi-cluster & Coiled Tubing

Objective

- A single tubing conveyed perforating (TCP) run can make a Toe Perforating possible, not only accomplishing cluster distribution to optimize the fracturing design but also allowing complex-geometry well completions for which coiled tubing (CT) is the only conveyance option.
  - Reduce Breakdown pressure of 1st stage.
  - Avoid pre-frac treatment.
  - Flexible perforating design for clean perforation tunnel.
  - Provide independent perforating of selected zones.
  - Leave the stage ready for hydraulic stimulation eliminating additional Pump Down run.
  - A safe and reliable system for Toe perforating
Multi-cluster sequence

TCP Step by Step

Press 6°
Gun Det
CT 6°
Gun Det
CT 6°
Gun Det
CT 6°
Gun Det
CT OUT

Firing Head | Gun 1 | Delay Fuse | Gun 2 | Delay Fuse | Gun 3 | Delay Fuse | Gun 4 | Coiled Tubing

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CASE HISTORY

Well conditions - Objective

- Operator requested to perform Toe perforation (1 gun)
- 2000 mts Horizontal well
- TVD 3100 mts
- MD 5000 mts
- No Initial Perforation to perform Pump Down.
- No tractor in country.
- Shale Formation (Vaca Muerta)
Solution - TCP

- **TCP Multi-cluster with 4 guns**
- 1 ft of effective perforating length, each gun
- 2-3/4" Gun System
- Deep penetration Charges
- 6 SPF, phase 60°, RDX
- BHA Length 11.4 m
- Distance between clusters ~ 20 mts

### Element | Description
--- | ---
Firing Head | Pressure actuated, including delay fuse of 6°.
Delay Fuse | Time delay element that gives 6° for gun positioning.

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CASE HISTORY

BHA design Coiled Tubing - Challenge

- Achieve well depth with a no flowing tool.
- LockUp following simulation results

<table>
<thead>
<tr>
<th>FC</th>
<th>Lock Up Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.30</td>
<td>4793 mts</td>
</tr>
<tr>
<td>0.29</td>
<td>4886 mts</td>
</tr>
<tr>
<td>0.28</td>
<td>No LockUp</td>
</tr>
</tbody>
</table>
Based on the simulations and experience, it is necessary to perform the job with a vibrating tool and a circulation port that allows pumping through.

- Pump friction reducer.
- Following these conditions, we can consider a FC of 0.28 in order to achieve the bottom of the well.

<table>
<thead>
<tr>
<th>Depth</th>
<th>4930 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td>Value</td>
</tr>
<tr>
<td>Max Weight RIH</td>
<td>24698</td>
</tr>
<tr>
<td>Max Weight POOH</td>
<td>41983</td>
</tr>
<tr>
<td>Lock Up</td>
<td>N/A</td>
</tr>
<tr>
<td>Max Pick Up at Depth</td>
<td>17124</td>
</tr>
<tr>
<td>Max Surface tension</td>
<td>90291</td>
</tr>
<tr>
<td>Max set down on end</td>
<td>-150</td>
</tr>
<tr>
<td>CT inner pressure</td>
<td>1486</td>
</tr>
<tr>
<td>Annular velocity</td>
<td>190(4.5&quot;)/65(7&quot;)</td>
</tr>
</tbody>
</table>
CASE HISTORY

Solution – Coiled Tubing

<table>
<thead>
<tr>
<th>BHA details</th>
<th>CT String</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ CT Connector</td>
<td>▪ Quality: QT-1000</td>
</tr>
<tr>
<td>▪ DFCV</td>
<td>▪ Wall Thickness</td>
</tr>
<tr>
<td>▪ Hydraulic Disconnect</td>
<td>▪ 0 – 1897 mts → 0.188”</td>
</tr>
<tr>
<td>▪ Circulating Sub + Rupture Disc</td>
<td>▪ 1897 – 4012 mts → 0.175”</td>
</tr>
<tr>
<td>▪ Vibrating Tool</td>
<td>▪ 4012 – 5300 mts → 0.156”</td>
</tr>
<tr>
<td>▪ Cross Over with circulating ports (2 of 1/4”)</td>
<td></td>
</tr>
<tr>
<td>▪ Perforating Guns</td>
<td></td>
</tr>
</tbody>
</table>

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Operational Description & Outcomes

- CT reaches Max Depth to correlate with Collar.
- Detonation sequence initiated by applying 5000 psi over Firing head (pressure actuated)
- Gun detonation not detected at surface.
- Guns positioning performed by monitoring time and delay sequence.
- Coiled Tubing POOH and Gun detonation confirmed at surface.

Hydraulic treatment executed avoiding the additional Wireline intervention for Pump-Down run.
CONCLUSION

- Cluster distribution (for Toe Perforating) executed according to the frac plan.
- Improved perforating design to reduce the need of pumping additional treatments.
  - Increase N° of shots/guns
  - Use of different shaped charges technology to improve tunnel clean up.
- Has been proven effective and safe for toe perforating.
  - This is a feasible option for complex-geometry well.
  - Early production of collapsed wells.
- Operator saving and additional Perforating run to complete the stage design.
- Execute the entire completion program replacing other perforating technics.
  - Plug & Perforating run deployed by Coiled Tubing.
QUESTIONS? THANK YOU!