Orienting Perforations for Permanent Fiber Optics Deployment

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Background Information

Why Oriented Perforations?
• To Perforate away from Fiber Optic cable installed outside production casing in cased and perforated completions
Background – Fiber Optics Cable Specs

¼ or 1/8” standard control line used to deploy fiber, how do we locate it to orient the perforation guns?

• After cementation, the cable may cause a streak with no cement that can be detected by ultrasonic imaging tools (not warranted)

• Electromagnetic logging tools can detect the cable if magnetic properties enhanced

• If cable position known from surface, orientation can be done without the need for mapping
## Background - Available Options for Oriented Perforation

<table>
<thead>
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<th>Electric line convey</th>
<th>Tubing convey</th>
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<tbody>
<tr>
<td><strong>Principle</strong></td>
<td>Uses motor to locate and position guns based on high electromagnetic signal</td>
<td>Uses mechanical orientation tool to position guns based on pre-set casing profile</td>
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<td><strong>Applications</strong></td>
<td>Limited gun size</td>
<td>Carry bigger gun size</td>
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<td></td>
<td>Limited in length of perforation</td>
<td>Can perform long perforation interval in one go</td>
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<td>High risk in vertical wells due to tool sensitivity to centralization</td>
<td>Deviation is not necessary but high accuracy in cable positioning w.r.t. orientation profile is critical (rig operation)</td>
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Changes in Well Design

Changes to standard well design and perforation strategy:

• Surface casing ID increased to allow for larger production hole size (larger cement sheath expected)

• Production casing run with FO cable and cable locator profile (depth based on target perforation interval)

• Underbalance perforation not possible, however, dynamic underbalance considered after initial injectivity assessment

• Shot density reduced by half

• Shot angle limited to 90deg coverage

Risk: changes to injectivity/productivity and fluid velocity → Evaluate well performance
Job Execution (Deviated Well Application)

Outline program

• Scrapper run
• Jetting and dummy run of mechanical positioning tool
• Electromagnetic tool mapping and perforating (0deg phasing)
• Ultrasonic tool mapping and confirmation of 1st perforation
• Tubing convey perforation (0, +/-45deg)
• Temperature survey to confirm performance of perforation
Job Execution (Vertical Well Application)

Outline program

• Scraper run
• Jetting and dummy run of mechanical positioning tool
• Ultrasonic tool (detect cable position at casing profile location)
• Tubing convey perforation (0, +/- 30deg)
• Temperature survey to confirm performance of perforation

FO cable had not rotated w.r.t. casing profile
Manufacturing pattern on pipe
Job Execution (Gun Orientation and Space Out)

Run TCP guns with MPT and perforate.

Aligning Guns with Mech. Positioning Tool
Learning’s

• Use special rotatable scraper to avoid issues with casing profile
• Run with location tool as dummy run to clean & confirm casing profile clear from any debris or cement.
• Connect the guns together in perforation workshop and make scribe to avoid misalignment while running the guns in hole.
• Ensure drift ID of the X/O below CSLT more than fishing tool for drop bar.
• Displine sub should be within 10 deg orientation range to minimize misalignment between the guns & CSLT.
Well performance

✓ DAS and DTS show injection at the same depths as the PLT, injectivity index not affected
QUESTIONS?
THANK YOU!