Benefits of Phased Limited Penetration Perforating Systems for Well Abandonment

SKK MIGAS – Oil and Gas Technology Update

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Presenter Background

- Corelab – Owen Oil Tools Division
- Schlumberger – Data & Consulting Service
- Dahana – Oil/Gas Explosives
- Elnusa – E-Line - CH/OH/Perforation
- Schlumberger – E-Line - CH/OH/Perforation
Wells Decommissioning World Wide

- Gulf of Mexico: 5000 wells*
- UK Sector: 3000 wells*
- Norwegian Sector: 3000 wells*

*Estimates only
Well abandonment and zonal isolation have been previously limited to zero–phased perforating systems and/or section milling.

To meet a service company’s well decommissioning challenge, new phased limited penetration perforating systems were designed & developed.

Achieved flow area improvements of ~ 80% and over 85% reduction in rig operating cost.
Limited Penetration

Standard State

- Inner (Primary) Casing String
- Standard Perforator Jet
- Formation

Illustration
Challenge

• Use Existing Perforating System

• Perforate 9-5/8 in. 53.5# P-110 Inner Casing

• Minimal damage to 13-3/8 in. 72# L-80 Outer Casing
The following information had to be gathered before development could begin:

- 8.539 in. running restriction for the perforating zone
- 400°F (204°C) temperature requirements for the well
- 0.70 in. average entry hole at 18 SPF shot density for inner casing string
- Less than 0.10 in. damage to outer string
Single Charge Testing and Results

Limited Entry Perforator

0.75 in. Entry Hole Through 9.625 in.

0.07 in. Damage On 13.375 in.
Full System Test Setup

Centralized Test Setup

De-Centralized Test Setup
Both the centralized and de-centralized full system testing showed consistent entry holes in the 9-5/8 in. casing and minimal damage to the 13-3/8 in. casing.
Client Run

- The well was deviated less than 60°

- The client deployed the full system into the well using finned subs for centralization

- Area open to flow verified in retrieved 9−5/8 in. casing
The cement plug was successfully set and the well abandoned according to regulation.

Reduced abandonment time by 13 days valued at ~$7.8 million.

<table>
<thead>
<tr>
<th>Abandonment Method</th>
<th>Days to Abandon Well</th>
<th>Est. Rig Cost/ Day</th>
<th>Cost to Abandon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section Milling</td>
<td>15 Days</td>
<td>$600 K</td>
<td>$9 Million</td>
</tr>
<tr>
<td>Limited Penetration Perforating</td>
<td>2 Days</td>
<td>$600 K</td>
<td>$1.2 Million</td>
</tr>
</tbody>
</table>
Conclusions

- Phased limited penetration proved to be exponentially more time and cost effective than existing abandonment methods.

- This method could be used in a variety of applications regardless of geographic location and well orientation.

- Critical to develop/test in specific well scenario.
Questions?

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