THE VALUE OF PERFORATION PRESSURE RECORDING IN TCP OPERATIONS

MENAPS 16-19

AUTHORS: Ahmed Rashidi PDO, Hanaey Ibrahim PDO, Mohammed Taiwani Schlumberger

NOV 14TH, 2016
AGENDA/INTRODUCTION

- PDO TCP Operations Summary
- Case Scenarios
  - Well Fluid Displacement
  - Underbalance
  - Tubing Leak
  - Mis-Fire Investigation
- Recommendation & Way Forward
PDO TCP Operation Summary

Firing Head Selection

PDO TCP Activities Firing Head Type

- Mechanical: 78%
- Hydraulic: 8%
- Electronic/Mechanical: 11%
- Others: 3%
PDO TCP Operation Summary

Pressure Reading during Perforation Period

Pressure vs Time [Detonation Time]

Positive Firing indication of lower zone; noticeable hydrostatic drop after firing

Drop bar activates the second detonation creating additional underbalance.

Unset the packer

Pressure graphs transfers information...

Time [hrs]

Pressure [psia]

Formation Pressure Upper Zone [psia]
Case Scenario

Well Fluid Displacement Results

- Job designed to perforate with sayyala crude in the well to achieve underbalance on lower zone

![Planned Well Hydrostatic Pressure vs. Actual Pressure Recorded by Gauge](chart)

**Issue on circulation**
Case Scenario

Well Fluid Displacement Results *(Issue on Circulation)*

- Pressure gauge data shows that underbalance condition was not achieved prior perforation.
- Circulation operation quality was inadequate.

<table>
<thead>
<tr>
<th>Wells</th>
<th>Planned Hydrostatic @ Gauge Depth</th>
<th>Actual Hydrostatic reading @ Gauge after circulation</th>
<th>Difference in Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>KPA (psi)</td>
<td>KPA (psi)</td>
<td>KPA (psi)</td>
</tr>
<tr>
<td>Well 1</td>
<td>13,957 kPa <em>(2,024 psi)</em></td>
<td>16,547 kPa <em>(2,400 psi)</em></td>
<td>2,590 kPa <em>(376 psi)</em></td>
</tr>
<tr>
<td>Well 2</td>
<td>9,410 kPa <em>(1,365 psi)</em></td>
<td>13,307 kPa <em>(1,930 psi)</em></td>
<td>3,897 kPa <em>(565 psi)</em></td>
</tr>
<tr>
<td>Well 3</td>
<td>11,670 kPa <em>(1,692 psi)</em></td>
<td>14,024 kPa <em>(2,033 psi)</em></td>
<td>2,354 kPa <em>(341 psi)</em></td>
</tr>
<tr>
<td>Well 4</td>
<td>10,232 kPa <em>(1,484 psi)</em></td>
<td>11,488 kPa <em>(1,666 psi)</em></td>
<td>1,256 kPa <em>(182 psi)</em></td>
</tr>
<tr>
<td>Well 5</td>
<td>15,363 kPa <em>(2,228 psi)</em></td>
<td>16,096 kPa <em>(2,335 psi)</em></td>
<td>733 kPa <em>(107 psi)</em></td>
</tr>
<tr>
<td>Well 6</td>
<td>14,665 kPa <em>(2,126 psi)</em></td>
<td>15,024 kPa <em>(2,180 psi)</em></td>
<td>359 kPa <em>(54 psi)</em></td>
</tr>
<tr>
<td>Well 7</td>
<td>15,825 kPa <em>(2,295 psi)</em></td>
<td>17,428 kPa <em>(2,530 psi)</em></td>
<td>1,603 kPa <em>(235 psi)</em></td>
</tr>
<tr>
<td>Well 8</td>
<td>10,776 kPa <em>(1,563 psi)</em></td>
<td>11,735 kPa <em>(1,702 psi)</em></td>
<td>959 kPa <em>(139 psi)</em></td>
</tr>
<tr>
<td>Well 9</td>
<td>16,716 kPa <em>(2,424 psi)</em></td>
<td>17,251 kPa <em>(2,500 psi)</em></td>
<td>535 kPa <em>(76 psi)</em></td>
</tr>
</tbody>
</table>
Case Scenario

Underbalance

- Underbalance was still achieved and is clearly seen from the downloaded gauge data.
- TCP Blank Guns contributed on adding pressure drop introducing Underbalance to the design.

Chart showing drop in pressure after perforation

- Pressure drop after detonation
- Second detonation and pressure drop as planned for upper zone with string partially filled
- Lower Zone Formation Pressure [psia]
- Upper Zone Formation Pressure [psia]
Case Scenario

Underbalance

- Underbalance was still achieved even though we were in an Overbalance condition.

![Down Hole Chart]

- 580 psi Error due to circulation operation quality
- Planned Hydrostatic Pressure
- Underbalance still occurred after perforation.
Case Scenario

Tubing Leak

- Leak observed while waiting for guns to fire.
Case Scenario

Mis-Fire Investigation

• Electronic Firing Head could not detect the complete firing command as pressure went off range during activation signal operation.

• Surface Pressure Gauges were reading Zero while downhole actual pressure was at 107 psi (737 kPa).

• Unfortunately this could not be analyzed on spot hence job was completed with a mechanical firing head.

• Gauge data was analyzed after the job and the value of having downhole data lead to better guidance on how to proceed with the investigation and ensure proper learnings for similar future operations.
Case Scenario

Mis-Fire Investigation
Recommendation & Way Forward

- Displacing well with Sayyala Crude in TCP is no longer required in similar job designs. This will contribute to saving 6.5 MM$ for PDO on crude oil pump replacement at the station.

- PDO to revise the fluid circulation methods and update Well Engineering SOP.

- Tubing/Casing pressure test record is required for TCP operation with pressure activated firing.

- Ensure calibrated pressure gauges are in place for sensitive pressure operated tools.

- Continue utilizing Electronic Firing Head where applicable.
Recommendation & Way Forward

Summary of PDO Utilization of Downhole gauge in TCP operations

- PDO expands the use of Electronic Firing Head due to the value it brings from recording downhole pressure data, this have been significantly noticed during the last 3 years.

More details can be found at:
- MENAP-13-16
- IPS-16-31
QUESTIONS?
THANK YOU!