Value Creation from an Implemented Sand Management Strategy – A Case Study

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1 Insight of the technical journey PETRONAS has achieved in sand management – changing culture

2 The method and approach with the support of in-house tool by PETRONAS

3 Case studies from different fields and the value creation
SUB-SURFACE INITIATIVE

SandPre: in-house tool for sand prediction

- Create MEM model based on exploration well
- Create SOP model for production well with the same reservoir
- Plot CDP for target zone & conduct sensitivity analysis
- Predict the save production envelope or sand control method
SUB-SURFACE INITIATIVE

Thru Tubing Ceramic Sand Screen
• Cater for high GOR well with sand production-higher erosion rate

Well Background:
• Well was completed in Apr-95 as single oil producer
• Well was worked-over in Jul-14 as horizontal dual oil producer, completed at RN reservoir for short string (SS) and RP & RS for long string (LS)

Well Status:
• SS:
  - Sand production started in Jun-15 & TTSS was installed in Jan-16
  - C/I on May-16 due to high sand production & pin hole leak

Job Proposed:
• Retrieve existing TTSS
• Drift run to 5,520ft MDTHF.
• Install 2x Ceramic TTSS hang from XN-Nipple @ 5,445ft MDTHF
• Produce the well as per bean-up procedure
SURFACE - THE JOURNEY

Pilot implementation - Field A (Oil)

Replication - Field B (Oil)

Replication - Field C (Gas)

Replication - Field D (Oil)

2015  2016  Q1 2017  Q2 2017  Q4 2017  2018

Barrels gain ~600 bopd

LoPC avoidance saving millions MYR

METHOD & APPROACH

- Worked Backwards – Export to wells, identifying limits for each line
- Created dynamic erosion model in conjunction with sampling data
- Installation of acoustics on test headers
- Targeted repeat failure with full individual investigation – ROOT cause

Use of Acoustic Monitoring & Sampling to:

- Observe the sand production trend of the well
- Calibrate the readings with manual sensor
- Establish the best practice for sand monitoring using acoustic sensor
- Perform an erosion mapping of key components in platform

Use of 3-D UT Measurement:

- To record the 3-D profile of current wall thickness
- To identify the bends currently at risk
THE PILOT – BREAKTHROUGH

ACOUSTIC MONITORING RESULT
• Well ranking best on severity of erosion rate and velocity
• Focus string for further monitoring

3D UT RESULT
• Avoided one LoPC at the main inlet of separator
• Severe erosion observed below MAWT ~50% loss
• Team fabricated new spool as precaution
THE LEARNING CURVE

From the pilot, PETRONAS established sand management strategy for other fields.

• Internal evaluation and gap identification based on field
• Establish sand management strategy for 3 years ahead
• Launch in-house tool for sand erosion and deposition prediction – SET (Sand Erosion & Transportation)

SET VALUE CREATION

- Sand erosion analysis for string level and platform level
- Sensitivity analysis based on production rate, sand rate & etc.
- Can be updated monthly based on well test data & sand count
- Categorize the wells based on severity

Cost saving : in-house analysis. Model for >40 platforms
Bean up opportunity (restricted well) : gain ~2000bopd (total since 2015)
Structure database for monitoring & surveillance plan
REPLICATION – FIELD B (2017)

Replicate the same concept as Pilot case:

- 23 strings are monitored using acoustic (obj: indication of sand production)
- 10 locations are inspected using 3D UT

Bean up opportunity for one well with no sanding issue
- Gain of ~100bopd
(whole campaign cost covered)

Severe erosion observed below MAWT ~60% loss at discharge line of COTP (reducer)
REPLICATION – FIELD D (2017)

- All wells in Field D are producing with high GOR
- Pre-work before the campaign: Well ranking based on priority (velocity & history)
- Acoustic as monitoring for wells with TCSS

- Establish MSFR
- Bean up opportunity for 2 wells with ~300 bopd
- Plan for thickness measurement for well with severe sand production

![Velocity (m/s) and Ranking](chart1)

<table>
<thead>
<tr>
<th>Velocity (m/s)</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>7</td>
<td>13</td>
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![Sand production severity](chart2)

<table>
<thead>
<tr>
<th>Sand production severity</th>
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<tbody>
<tr>
<td>No sanding</td>
</tr>
<tr>
<td>3</td>
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VALUE CREATION

By managing the sand on surface:

• Opened up more opportunity

• Proper surveillance and monitoring in place

• Risk management is addressed

• Standardization of process flow
Thank you
SANDPRE UTILIZATION

Original reservoir pressure

With 13% pressure depletion
SANDPRE UTILIZATION