Batch Foaming Gas-lifted Oil and Liquid Loaded Gas wells in BSP

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Agenda

• Introduction
• Candidate Selection
• Foamer Agent Selection
• Results
• Conclusion and Way forward
Introduction

-East asset in BSP has several hundred producing wells. Mainly gas-lifted oil and gas wells

-Some oil wells have high water cut (> 70% BS&W). Here there is an opportunity to use batch foaming to provide short term production improvement and reduce Gas-lift (GL) consumption

-Some high rate gas wells have also gradually become liquid loaded and suffer kick off issues. Potential to use foamers to accelerate well kick off and reduce deferment
Candidate Selection

- 5 wells were selected for the foam trials (3 gas-lifted oil wells & 2 gas wells)

<table>
<thead>
<tr>
<th>Well</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluid</td>
<td>Oil</td>
<td>Oil</td>
<td>Oil</td>
<td>Gas</td>
<td>Gas</td>
</tr>
<tr>
<td>Type</td>
<td>Flowing (Gas-lifted)</td>
<td>Flowing (Gas-lifted)</td>
<td>Flowing (Gas-lifted)</td>
<td>Dead</td>
<td>Huff and Puff</td>
</tr>
</tbody>
</table>

- A, B & C – Partially loaded – Producing water
- D – Well with suspected inflow issue
- E – Flowing well with transient loading behaviour
Foamer Agent Selection

Water samples from Well A and B were tested with 3 foamers supplied by Champion Nalco

- V-505 (water-foaming foamer)
- IVDF-140 (water-foaming foamer)
- IVDF-130 (water-foaming foamer)

Foamer IVDF-140 and IVDF-130 performed better than V-505. **IVDF140 Selected**
DEPLOYMENT & APPLICATION METHOD

- The liquid foamer was batched into tubing via ½” NPT connection at the top of the wellhead shown below.

Anti-foam chemical was injected after flow back to minimize oil carry-over into gas line and avoid complication with level control in a separator or tank.

Foam Application Procedure

- An average of 120 liters of foamer (IVDF-140), followed by an average of 170 litres of overflush (KCL) was pumped into each well candidate.

- This was followed by a shut-in period of 18-24 hrs. Wells were flowed back to the test separator or main oil line (if a test separator was not available).
Results Overview

Overall the trial was successful with:

- **Well A (oil well)**
  - Initial flow back: Transient slugs
  - ~40% increase in gross (after two well tests 5 days apart). Some reduction in initial Gas-lift consumption. The was maintained for around 5 months

- **Well B (oil well)**
  - Initial flow back showed ~10% increase in gross rate maintained for around 3 months

- **Well C (oil well)**
  - Initial flow back showed no change in measured gross

- **Well D (gas well)**
  - 2 attempts at kicking off well. Well failed to respond
  - It was concluded that remediation must be performed to return well back to production

- **Well E (gas well)**
  - 3 attempts at kicking off well. Well kicked off strongly after 3rd foam injection attempt.
  - ~200ksm3/d gas production restored. Well is a gas-lift supplier supporting ~1000m3/d production
Results Detail – Well A- Gas-lifted Oil Well

Pre-foam liquid production rate (RED)

Pre-foam injection gas out (BLUE)

Pre-foam FTHP (BLACK)

Foam injection with CIITHP
Increase

Increase liquid production on the kick off

Fluctuating FTHP- Well unloading with Slugs

Decrease in gas out after kick off
Results Well E – High Gas Rate Well (Kick off)

Well ID-28 THP

Flowline Temperature (pre kick off after foam injection)
Tubing Pressure (BLUE)
Annuls Pressure (WHITE) pre kick off

SSSV control line pressure

Flowline Temperature (post kick off after foam injection)
Tubing Pressure (BLUE)
Annuls Pressure (WHITE) after kick off

11/11/2015 07:27:00
2988.3
3010.1
28.926
-13.132
1.0736
27384
27384
45359

10/11/2015 07:27:00
3177.8
3009.6
34.415
-13.663
90.625
10827
10745
44676
Lessons Learnt

- Aggressive well start-up for initial foam unloading
- Alignment of Injection period and flow back periods with availability of onshore support
- If a wells fails to respond, try successive treatments of batch foam chemical before discontinuing trial

Conclusions and Way forward

- Batch foam injection is a viable low cost method of providing short term production improvement by reducing fluid level in the wellbore under flowing conditions.
- Batch foaming may also provide an alternative “poor boy” stimulation method for oil and gas wells
- Current efforts within BSP to mature continuous foam injection via Gas-lift
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