Optimizing Production from Liquid Loading Wells

Shona Neve

GWD 2013, Groningen, October 2013
Outline

- Introduction
- Field Issues
- 2013 Optimisation Activities
  - Well Cycling Optimisation
  - Batch Foam Optimisation
- Lessons Learned & Best Practices
The Field

- A large gas-condensate field located in the UKCS
- First gas was around 1998
- 65% of GIIP recovered to date
- Gas is trapped in Lower Cretaceous deepwater sands
- Reservoir strongly layered with multiple reservoir intervals separated by thick shales
- Low – Moderate permeability
- Developed using long, deviated wells with large tubing IDs
Low Rate Well Strategy

- 25% decline rate
- 18% decline rate due to Low Rate Well Strategy
2013 Production Challenge

Multiple elements contributing to a more robust production performance process:

1. Cycle Well Optimisation
2. Batch Foam Treatment Optimisation
3. Improving Measurement Techniques
4. Production Performance Reviews
Well Cycling & Batch Foamer Treatments

Liquid loading well - frequent low pressure routing necessary (cycling)

Liquid loading well post-batch foamer treatment - less frequent low pressure routing necessary
Well Cycling Optimisation Study

- 19 liquid loading wells
- Maximum of 3 wells through low pressure system at once
- Each well takes around 7-8 hours to unload & stabilise

**Cycle Well Uptime**

<table>
<thead>
<tr>
<th>Month</th>
<th>Cycle + MP Uptime</th>
<th>Target Cycle Uptime</th>
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</thead>
<tbody>
<tr>
<td>Jan</td>
<td></td>
<td></td>
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<tr>
<td>Dec</td>
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**Cycle Well Production**

- Green bars represent daily gas production for the cycle
- Yellow bars represent daily gas production for the low pressure system
Test points obtained by routing well through Platform Test Separator

Decline rate assumed through test points

Typical THT decline input & relationship assumed between THT & Q
Well Cycling Tool Workflow

Input duration of next cycle → Model calculates current Q for each well → Cum. gas predicted over next cycle → Cycle Advantage determined

Optimise Production vs. Uptime → Become more predictive → PE to QC results & perform well movement

Advantages ranked → PE to QC results & perform well movement
Foamer (surfactant) is batch-injected into low rate wells to decrease the critical gas rate and encourage de-liquification.

Foam decreases the density ($\rho_L$) and surface tension ($\mu_L$) of the liquid, in turn increasing the liquid unloading potential.

Used on this gas condensate field with original trials 5 years ago.

Effectiveness highly variable... why? Optimisation... how?
MSc Project Outline – Imperial College

1. Literature Review
   - External knowledge
   - Internal data

2. Foam Effectiveness
   - Well Completion
   - Geographic Position
   - Dynamic Effects

3. Foam Optimisation
   - Injection Volume
   - Foam Soak Time

4. Field Production Trials
   - Potential Benefit
Foam Optimisation – Volume?

A. Pressure Survey
B. Downhole Gauge
C. Acoustic Survey
Foam Optimisation – Volume!

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<tr>
<th>Section</th>
<th>MD [ft]</th>
<th>TVD [ft]</th>
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<td>0</td>
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<td>3.658&quot; Nipple</td>
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<td>4457</td>
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<td>- Gauge Data</td>
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<td>Mid Perf</td>
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<td>Bottom Perf</td>
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<tr>
<td>Total Depth</td>
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</table>

Liquid Level
- Echometer ≈ 17000 [ft] 12580 [ft]
- Gauge Data ≈ 17093 [ft] 12611 [ft]

E.g.
Wellbore liquid volume +/- < 1.5 barrels
Foam injection volume +/- < 0.05 barrels
Foam Optimisation – Time?

\[
\delta = \left( \frac{3\Gamma \mu_f}{\rho_A^2 g \sin \theta} \right)^{1/3} \quad V = \frac{\Gamma}{\rho_A \delta} = \frac{g \cos \theta \rho_A \delta^2}{3 \mu_f}
\]

(Adapted from Jackson 1955)

Well Details

Foamer Viscosity

Foamer Density

Gas Z-Function

Gas Density

Figure 13. Foam Viscosity
Figure 14. Foam Den
Figure 15. PVT-based Gas Non
Figure 16. PVT-based Gas Density

Ref. 6, 14, 24, 28
Ref. 8, 13, 19

Schinagl, Kelly, Model, Nafis
Foam Optimisation – Time!
Field Production Trials

Test Case:

- 1x of ≈ 6-8 regular cycle wells:

Result:

- Increased well up-time (+12 hrs/wk)
- MP utilisation reduced by ≈ 36 hrs/wk
- Extrapolated to one year this is worth over £2M (at £0.66 / therm)
The Future for the Field

- Low Rate Well Work Over Development
- Long Term Compression
- 2010 New Wells
- 2011 Capillary Strings
- Cycling
- Base
Best Practices & Lessons Learned

**Best Practices**

- Close offshore & onshore collaboration is crucial to project success
- Never assume a routine activity is fully optimised
- Challenging current processes by interpreting & gathering the correct data & streamlining the process can lead to significant benefits

**Lessons Learned**

- Production optimisation can be successful with minimal associated cost
- The combined effect of multiple small optimisation opportunities can have a big impact to total production
Questions?
References