A Fresh Approach to Gas Lift Design Verification

John Hall
Introduction

• Why gas lift is important to us
• What issues existed within our gas lift design process
• How we improved the process
• Key Issues from Examples
Talisman Sinopec Energy UK Asset Overview

- Claymore
- Saltire
- Tartan
- Montrose
- Arbuthnot
- Fulmer
- Clyde

Diagram showing connections between various assets:
- Gas Lift
- Nat Flow
- ESP
- Jet Pump
Talisman Sinopec Energy UK Gas Lift Issue

What Happened
• Gas Lift failed to operate on a high rate subsea well after 2 months of production
• The system had operated when the well was unloaded

Why It Happened
• Unloading valves were set up to operate only from a “cold” state
• A higher flowing temperature at the 1st unloading valve resulted in the valve not opening
• Gas lift could not be initiated from a “hot” start up
• Compressor delivery was overestimated

Actions Taken
• The well was “rocked” in order to restore production
• The gas lift design for the well was modified to place the orifice shallower
Gas Lift Investigation Findings

- No account taken of the full Pr and PI ranges
  - Relied on injection through unloading valves
  - Orifice positioned for late life low Pr and low PI conditions
  - Unloading valves set up assuming late life conditions

- Temperature effects not fully appreciated

- GLD Input Sheet – conveys basis of design, room for improvement

- Limited engineering assurance process in place
20 °F increase may require an additional 40 psig casing pressure
Asking the Right Questions

• Is well inflow complex?
  – Multiple layers, long horizontal, poorly connected fault block?

• When is gas lift required during well life?
  – will the injection depth vary with predicted well performance?

• Facilities Constraints

• Will unloading valves operate during re-starts?
  – has the annulus been unloaded down to orifice?
  – liquid backflow into annulus
  – lifting from an unloading valve by design
Think about the Input Data

<table>
<thead>
<tr>
<th>Well Test Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Survey Date: [ ] New Dril [ ] Flowing [ ] Gas Lift</td>
</tr>
<tr>
<td>Total Fluid Rate: [ ] bbl/d.</td>
</tr>
<tr>
<td>Water Rate: [ ] bbl/d.</td>
</tr>
<tr>
<td>Injected Gas Volume: [ ] mmscfd.</td>
</tr>
<tr>
<td>Total GLR: [ ] scf/bbl fluid.</td>
</tr>
<tr>
<td>FWHT: [ ] °F.</td>
</tr>
</tbody>
</table>

**What Rate?**

Replace this with questions:
Is this a subsea well?
Is annulus to be unloaded in an initial cold or hot state?
Check design for “hot” and cold” start up

**Wellbore**

<table>
<thead>
<tr>
<th>MD (ft)</th>
<th>Casing Nominal OD (in)</th>
<th>Casing Weight (#ft)</th>
<th>Tubing Nominal OD (in)</th>
<th>Tubing Weight (#ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ ]</td>
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</tbody>
</table>

**Existing Gas Lift Equipment**

<table>
<thead>
<tr>
<th>Station No.</th>
<th>Depth (ft)</th>
<th>Valve Series</th>
<th>Port Size (in)</th>
<th>TRO Pressure (psia)</th>
<th>Mandrel Size &amp; Type</th>
<th>Latch Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ ]</td>
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</tbody>
</table>

* Use Survey Data worksheet for detailed data.
Gas Lift Investigation Recommendations

• Improve and Implement Talisman Sinopec Energy UK’s Gas Lift Design Process

• Improve Talisman Sinopec Energy UK’s Gas Lift Design Knowledge

• Improve the understanding of Well Parameter Estimates
Perceptions of Available Resource

Gas Lift Service Provider

REALITY

Operator
Improve the Process – Key Steps

• Recognise the PT as the focal point for all gas lift designs

• Kick off meeting with GL Service Provider for all new gas lift designs
  – Follow up meetings to discuss gas lift design case outputs

• Formal review and acceptance of gas lift design
  – Gas Lift Design Report

• Health Check of the Gas Lift Design process
  – GLD Input Sheet through to valve setup and delivery

• Above underpinned with a Gas Lift Design Guideline
Interface between Organisations

- Meetings
- GLD Input Sheet
- GL Design Report

People

Operator

GL Service Provider

Process
Where the Process Lives

<table>
<thead>
<tr>
<th>Opportunity Identification and Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Initiation</td>
</tr>
<tr>
<td>Well Interventions</td>
</tr>
<tr>
<td>Option Selection</td>
</tr>
<tr>
<td>Cost Estimation</td>
</tr>
<tr>
<td>Justification and Approval</td>
</tr>
<tr>
<td>Risk Management</td>
</tr>
<tr>
<td><strong>Design</strong></td>
</tr>
<tr>
<td>Application and Notification</td>
</tr>
<tr>
<td>Procurement</td>
</tr>
<tr>
<td>Planning</td>
</tr>
<tr>
<td>Programmes</td>
</tr>
<tr>
<td>Preparation For Operations</td>
</tr>
<tr>
<td>Conduct of Operations</td>
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<tr>
<td>Handover</td>
</tr>
<tr>
<td>Reporting</td>
</tr>
<tr>
<td>Performance Monitoring</td>
</tr>
<tr>
<td><strong>Design</strong></td>
</tr>
<tr>
<td>Gas Lift Design</td>
</tr>
<tr>
<td>Well Design Summary</td>
</tr>
<tr>
<td><strong>Gas Lift Design</strong></td>
</tr>
<tr>
<td>Gas Lift Design Guidelines</td>
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<tr>
<td>Gas Lift Design Flowchart</td>
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<tr>
<td>Gas Lift Design RACI</td>
</tr>
<tr>
<td>Gas Lift Design Tracker</td>
</tr>
<tr>
<td>Gas Lift Design Report Template</td>
</tr>
</tbody>
</table>
Focus on Communication

- Ops Reservoir Engineer
- Production Technologist
- Gas Lift Design Engineer
- Projects/Facilities Engineer
- Gas Lift Design Engineer
- Ops Reservoir Engineer
Platform Well - Reluctant to Offload

Lift gas rate 0.8 to 1.6 MMscf/d
FTHP 100 to 650 psig
FTHT 110 to 120 Deg F
CHP 1680 to 1791 psig
GL Choke 71%

Set up assuming well will not lift from this station and Geothermal gradient as a straight line

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Pre Design</th>
<th>2009 Design</th>
<th>Post Design</th>
<th>2009 Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPM#1</td>
<td>Dummy</td>
<td>Dummy</td>
<td>Dummy</td>
<td></td>
</tr>
<tr>
<td>SPM#2</td>
<td>R-20, $\frac{3}{8}$&quot; 1580 psig TRO</td>
<td>R-20, $\frac{3}{8}$&quot; 1721 psig TRO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPM#3</td>
<td>Dummy</td>
<td>Dummy</td>
<td>Dummy</td>
<td></td>
</tr>
<tr>
<td>SPM#4</td>
<td>R-20, $\frac{3}{8}$&quot; 1775 psig TRO</td>
<td>Dummy</td>
<td></td>
<td></td>
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<tr>
<td>SPM#5</td>
<td>Dummy</td>
<td>Dummy</td>
<td>Dummy</td>
<td></td>
</tr>
<tr>
<td>SPM#6</td>
<td>RDO $\frac{3}{8}$&quot;</td>
<td>RDO $\frac{3}{8}$&quot;</td>
<td></td>
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</tr>
</tbody>
</table>
Platform Well – Start Up Instability

FTHT (Deg F)
GL Rate (Mscf/d)
CHP (psig)
GL Choke (%)
FTHP (psig)

Date and Time
24/08/2010 12:00 25/08/2010 00:00 25/08/2010 12:00 26/08/2010 00:00 26/08/2010 12:00 27/08/2010 00:00 27/08/2010 12:00

Talisman Sinopec Energy UK
GL line pressure constant. Lowering the unloading valve TRO results in the same initial instability.
If Injection is allowed at Station #4 then instability is removed.
Platform Well – 2012 Re-Design Results

GLV Change-out

CHP (psig)
FTHT (Deg F)
GL Choke (%)
FTHP (psig)
Subsea Well – Design Troubleshooting

• Original GLD based on Pr dropping quickly to 2185 psi. Pr stabilised at 3300 psi

• $P_{so}$ of GLV’s too close together. Lift gas cannot completely transfer down to SPM#3

• Not possible to reach orifice depth

• Optimum GL rate for well is 4 MMscf/d
Subsea Well – Re-Design Validation

GLV#1, 3/16” and TRO = 1886 psig
GLV#2, 5/16” and TRO = 1660 psig (this is required to keep valve open long enough to transfer down to orifice)
GLV#3 = 7/16” Orifice
Subsea Well – Dynamic Modelling Results

• Target Inj Pressure needs to be 1860 to 1870 psig to unload based on 74 to 99% watercut and FTHP = 420 psig.

• Compressor discharge limits max lift gas rate to 4 MMscf/d based on Dynamic simulations

• GLV#2 TRO needs to be selected carefully to allow transfer down to orifice depth
  – Dynamic simulation suggests TRO = 1660 psig, even if port size is increased to 5/16”.
Platform Well – Design Validation

Remember these are WHD

Lift gas transfers to GLVF3 at this tubing pressure

Remember these are WHD's
Summary

• Adhere to the Process

• Communicate across all disciplines, and between companies

• Key Technical Learning points
  – Consider temperature changes on unloading valves
  – Convey the right information to the GLD Eng
  – Understand facilities constraints
  – Communicate to allow a mutual understanding of design intent
  – Dynamic Simulation leads to a robust design
Acknowledgements

Talisman Sinopec Energy UK

– Roger Appleby
– Grant Ballantyne
Thank you...... any questions?