Gas Lift Well Severe Slugging Mitigation Plan for Unconventional Shale Play

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Agenda

• Shale well gas lift severe slugging
• Main causes
• OLGA for gas lift
  – Gas lift valve modeling
  – Automated solution
• Case study
• Value statement
Strokkur Geyser, Iceland

Picture Source: http://www.thousandwonders.net/Strokkur
Shale well gas lift severe slugging

- Long production downtime
- Low average production rate

Increased operational cost!!

Pipeline leaking
Affecting nearby wells
Separator flooding
Over gas injection
Damaging gas lift valves

SPE 158500

Stress on gas injection
Increase compressor horsepower demand

Impact of Horizontal Section Elevation
Liquid, Water, and Gas Production
Res Pres = 6000 psia, Toe-up

SPE 158500

Oct. 23 - 27, 2017
2017 Gas-Lift Workshop
Shale well gas lift severe slugging causes

- Undulated lateral section
- Multiphase flow with high GOR
- Undulated Wellbore

- Gas lift orifice under non-critical flow
- Insufficient gas injection rate
- Heading

- Low or near depleted reservoir inflow
- Reservoir inflow

- Bad gas lift design
- Unloading valve multi-pointing
- Gas lift valve

- 2017 Gas-Lift Workshop
OLGA for gas lift

- Complementary to steady state tools to examine the gas lift design
- Comprehensive gas lift valve modeling
- Robust heat transfer calculation in the annulus
- Wellbore transient events:
  - Liquid loading
  - Casing heading
  - Tubing heading
  - Multi-pointing
- System-wide transients:
  - GL delivery system
  - Backpressure from neighboring well
  - Fluctuating production line pressure

Transient multiphase flow simulator
OLGA for Well
Flow assurance study during transient event
OLGA gas lift valve modeling capabilities

<table>
<thead>
<tr>
<th>LEAK: Gas Lift Valve</th>
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<tr>
<td><strong>General</strong></td>
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<tr>
<td>LABEL: Gas Lift Valve</td>
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<tr>
<td>VALVETYPE: GASLIFTABLE</td>
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<td>TOPOSITION: &lt;None&gt;</td>
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<td>Leak Valve variables</td>
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<td>OLGAVALVE</td>
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Gas lift unloading valve curves

VPC Database

- **Venturi**
  - KLOSENTRY
  - KLOSEEXIT
  - INLETDIAMETER
  - THROATDIAMETER

- **Valve**
  - CD
  - DIAMETER

NOVA Venturi Valve

Orifice Valve

20/64"

16/64"

12/64"

Downstream Pressure - (psig)

Flowrate - (MScf/d)

Camco BK, 1" IPO VPC Performance Model Various Port Sizes No Choke

Camco BK with 12/64ths VPC Pd=904 Pc=920 Temp=150

Camco BK with 16/64ths VPC Pd=904 Pc=920 Temp=150

Camco BK with 20/64ths VPC Pd=904 Pc=920 Temp=150
Automated Gas lift workflow through Python Scripts

- User selected key parameters
- Multi-threading to run hundreds cases
- Auto-postprocessing through Analyzer script
Case study – gas lift well slugging

Well information:
- Hydraulic fractured shale well
- Gas was injected into tubing
- Produce through annulus
- Well was slugging under high gas injection rate

Investigated aspects:
- Reservoir PI
- Gas lift valve orifice size
- Gas lift valve depth
- Hydraulic flowing cross section
- Gas lift injection rate
- Unloading valves
Case study– gas lift well slugging

Graph showing gas injection, gross gas production, casing pressure, and tubing pressure over time from October 23 to January 21, 2017. The graph highlights fluctuations in gas flowrate, pressure, and injection rates.
Case study– gas lift well slugging

Multi-pointing!!

[Graph showing gas flow rate over time with data from OLGA simulation and real-time data, and highlighting unloading valves 5, 7, and 8.]
Case study – gas lift well slugging

Optimum gas injection rate = 1.9 mmScf/d

1.9 mmScf/d injection case

Cumulative Oil (bbl)
Cumulative Gas (scf)

1.9 mmScf/d injection case
2.7 mmScf/d injection case

Oil flowrate (bbl/d)
Gas flowrate (mmScf/d)
Water flowrate (bbl/d)
Value statements

**Short Term**

- Identify well production issues and opportunities using model-based approach.
- Efficient data- and model-based surveillance systems for better operational insights.
- Scalable to perform diagnostics and optimization for multiple wells in the field.

**Long Term**

- Digital transformation that significantly improves decision-making process, better productivity, reduced asset life cycle costs, improved efficiencies, safer operations and profit margins.
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