Improving Performance of Gas Lift Compressors in Liquids-Rich Gas Service

Will Nelle
Estis Compression

Bill Elmer, P.E.
Enclave Artificial Lift Technologies
Outline

- Financial Impact of Compressor Downtime
- Understanding Compression
  - Designed for Gas Sales from lean gas wells
  - Condensation issues with liquids-rich gas
- Impact of condensation to operations
- Methods to mitigate operating problems
- An Alternative: Prevention by design change
Financial Impact of 5% Downtime

- **Gas Sales: 750 MCFPD**
  - $3.00 MCF, 75% NRI: $3,420 per month

- **Gas Lift of 750 MCFPD**
  - Producing 250 BOPD, 500 BWPD, 250 MCFPD
  - $5.00 MCF, $50 Oil, $1 SWD, 75% NRI: $14,415
  - 4.6 times more impact to cash flow

- **Rental Rate Refund for 10% Downtime**
  - $6000 monthly rental fee x 5% = $300
Understanding Compression: The Phase Diagram
Temps kept above 120 F, no hydrocarbons condense
- Temps fall below 120 F, allowing hydrocarbon condensation
- Since gas is lean, not much will condense
Liquid Dropout for 30 F Ambient Gas Well Sales – water only

Stream Summary

Company: Ariel Corporation
Quote: 7.7.4.0
Case 1: 65 to 950

Customer: EOG
Inquiry: Project
BOSW Electric Driven

Gathering

Discharge

Cooler

65.00 psig
63.00 psig
80.00 F
179.98 psig
215.65 F

4993 MSCFD

60.00 F
4.993 MMSCFD
0.6502 SG

25 MSCFD

60.00 F
174.98 psig
4.967 MMSCFD
0.5506 SG

4 MSCFD

60.00 F
416.38 psig

2 MSCFD

4.964 MMSCFD
0.5506 SG

Feb. 11 - 14, 2019
2019 Artificial Lift Strategies for Unconventional Wells Workshop
Oklahoma City, OK
How does this change for richer gas?

100 F Ambient (0.76 Gravity Eagle Ford)

- Temps kept above 120 F, no hydrocarbons condense
- Temps fall below 120 F, allowing SIGNIFICANT hydrocarbon condensation since gas is richer
Liquid Dropout for 30 F Ambient
0.76 SG – 3.06% Hydrocarbons Condense

5105 MSCFPD

60 MSCFD

40 MSCFD

96 MSCFD

Feb. 11 - 14, 2019

2019 Artificial Lift Strategies for Unconventional Wells Workshop
Oklahoma City, OK
<table>
<thead>
<tr>
<th>Gas Type</th>
<th>Gas Gravity</th>
<th>Water Cond at 100 F Ambient</th>
<th>HC Cond at 100 F Ambient</th>
<th>Water Cond at 30 F Ambient</th>
<th>HC Cond at 30 F Ambient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas Well - Lean</td>
<td>0.65</td>
<td>0.46%</td>
<td>0</td>
<td>0.62%</td>
<td>0</td>
</tr>
<tr>
<td>Eagle Ford - Rich</td>
<td>0.76</td>
<td>0.59%</td>
<td>0</td>
<td>0.74%</td>
<td>3.06%</td>
</tr>
<tr>
<td>Permian – Rich</td>
<td>0.80</td>
<td>1.08%</td>
<td>0</td>
<td>1.27%</td>
<td>7.63%</td>
</tr>
<tr>
<td>Permian – Rich+</td>
<td>0.97</td>
<td>1.08%</td>
<td>12.38%</td>
<td>1.23%</td>
<td>23.72%</td>
</tr>
</tbody>
</table>

- Permian shows winter challenge of maintaining rich gas in vapor state
Impact of Liquid Dropout to Operations

- Frequent Interstage Scrubber Dumps a Given
  - Lines cool as light ends re-vaporize
  - Freezes from inside-out, plugging line
  - Heat tracing and insulation helps prevent high level shutdowns
Condensed liquids to tank?

- Can overwhelm TVRU capability
  - 5% of 5000 MCFPD is 250 MCFPD (45 HP)
  - Results in excessive flaring, less gas sales
- Plumb interstage scrubbers to low pressure separator, relieving TVRU
- Inlet and fuel scrubbers still dump to tanks
- Are your compressors pre-plumbed for this?
Impact of Liquid Dropout to Operations

- Compressor output reduced
  - Well performance suffers
  - Mitigate by oversizing compressor

- Safety Issues
  - Blowing down compressor sweeps liquids from horizontal piping onto location
    - Install slow rate auto blowdown into gas sales
  - Hydrates plug final cooler and discharge pipe
  - Methanol burns without flame, introduces $O_2$
Presence of Liquid at Wellsites

- Reduces gas measurement accuracy

- Gas lift valves may handle slug of liquid
  - If centralized compression, slugging an issue
  - Significant slug may cut orifice, or multipoint

- Last well on common line may receive 100% of condensation
Obvious Solution: Prevent by Elevating Gas Temperatures

- Even super-rich 0.97 gravity gas can remain vapor with 150 to 180 F temps
What if temps could be kept in 100% Vapor range to the wellhead?

- No increase in VRU load or flare emissions
- No need for methanol injection (oxygen)
- Warm corrosion chemicals work better
- No mess when blowing down compressor
- No need to oversize compressor
- Well performance improved
- Paraffin deposition prevented
Reality: Facility Engineers prefer old ways of centralized compression

- Pipelines may cool gas to earth temp ~ 70F

<table>
<thead>
<tr>
<th>Gas Type</th>
<th>Gas Gravity</th>
<th>Condensation %</th>
<th>BBL per MM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eagle Ford</td>
<td>0.76</td>
<td>3.85%</td>
<td>23.1</td>
</tr>
<tr>
<td>Permian - Rich</td>
<td>0.80</td>
<td>8.46%</td>
<td>52.4</td>
</tr>
<tr>
<td>Permian - Rich+</td>
<td>0.97</td>
<td>34.5%</td>
<td>216.6</td>
</tr>
</tbody>
</table>

- Some of this will re-vaporize as reaches downhole temps, but how much?

*Wellsite compression mitigates this problem*
Barriers to Maintaining High Temps

- Compressors designed for gas sales can not achieve high cooler outlet temps

- Cooler outlet temps not normally monitored, nor controlled
  - Pneumatic Kimray T-12 poor control answer
  - Several better methods available

- Compressor industry thinks it’s not their problem, but operator gas quality issue
Operators and compression companies need to address these problems jointly, perhaps in consortium environment.

Necessary to look at the entire picture and not compartmentalize:
  - Compressors impact entire facility operation

Collaborative environment will result in multiple options, and good results:
  - Improved safety, reliability, revenue, emissions
Suggested Changes

- Redesign compressor packages to prevent hydrocarbon condensation
  - Reduce cooler sizes / alternative coolers
  - Install automatic cooler bypasses
  - Install automatic louver control systems

- Install near wells to prevent temp loss
  - Design injection piping to maintain elevated temperatures to wellhead
Conclusions

- Predictable hydrocarbon condensation occurs when compressing liquids rich gas, causing gas lift operating problems.

- These problems can be solved by proper engineering design.

- Old habits of facility engineers and most compressor rental companies adversely impact well performance, wellbore integrity, and economics, while increasing product losses, flare emissions, and safety risks.
Acknowledgements

- Thanks to Branden Pronk and SM Energy for providing gas analyses and condensation data
- Thanks to Estis Compression for sharing videos and ideas on improving compressor design
- Thanks to Larry Harms and Jim Hacksma for collaborative work leading to this presentation
Rights to this presentation are owned by the company(ies) and/or author(s) listed on the title page. By submitting this presentation to the Artificial Lift Strategies for Unconventional Wells Workshop, they grant to the Workshop, the Artificial Lift Research and Development Council (ALRDC), and the Southwestern Petroleum Short Course (SWPSC), rights to:

- Display the presentation at the Workshop.
- Place it on the www.alrdc.com web site, with access to the site to be as directed by the Workshop Steering Committee.
- Place it on a CD for distribution and/or sale as directed by the Workshop Steering Committee.

Other use of this presentation is prohibited without the expressed written permission of the author(s). The owner company(ies) and/or author(s) may publish this material in other journals or magazines if they refer to the Artificial Lift Strategies for Unconventional Wells Workshop where it was first presented.
The following disclaimer shall be included as the last page of a Technical Presentation or Continuing Education Course. A similar disclaimer is included on the front page of the Artificial Lift Strategies for Unconventional Wells Web Site.

The Artificial Lift Research and Development Council and its officers and trustees, and the Artificial Lift Strategies for Unconventional Wells Steering Committee members, and their supporting organizations and companies (here-in-after referred to as the Sponsoring Organizations), and the author(s) of this Technical Presentation or Continuing Education Training Course and their company(ies), provide this presentation and/or training material at the Artificial Lift Strategies for Unconventional Wells Workshop "as is" without any warranty of any kind, express or implied, as to the accuracy of the information or the products or services referred to by any presenter (in so far as such warranties may be excluded under any relevant law) and these members and their companies will not be liable for unlawful actions and any losses or damage that may result from use of any presentation as a consequence of any inaccuracies in, or any omission from, the information which therein may be contained.

The views, opinions, and conclusions expressed in these presentations and/or training materials are those of the author and not necessarily those of the Sponsoring Organizations. The author is solely responsible for the content of the materials.

The Sponsoring Organizations cannot and do not warrant the accuracy of these documents beyond the source documents, although we do make every attempt to work from authoritative sources. The Sponsoring Organizations provide these presentations and/or training materials as a service. The Sponsoring Organizations make no representations or warranties, express or implied, with respect to the presentations and/or training materials, or any part thereof, including any warrantees of title, non-infringement of copyright or patent rights of others, merchantability, or fitness or suitability for any purpose.