Wellhead Compression For Tight Gas Wells: A Selection and Evaluation Methodology

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Wellhead Compression for Tight Gas Wells

• A methodology to determine which wells will likely to benefit from wellhead compression

• Selection criteria

• Field examples
How does compression add value?

Return on Investment

Revenue
- Added recovery
- Increased Production
- Well operation stabilization

Cost
- Acquisition
- Installation
- Operation
- Maintenance
Background

- Lobo Lower Wilcox sands
- Depth 7000’ – 13000’ with net pay 15 -150 ft
- Depletion drive
- Tight gas play perm 0.02 – 1.00 md
- >5 TCF produced since development started
- Specific gravity: 0.58 - 0.75
- 0 - 50 bbls condensate per MMCF
- 0 - 40 bbls water per MMCF
- Average production 140 MCFD per well
Modeling Method

- Integrated production modeling approach:
  - Nodal analysis – well bore
  - Limitation – non-steady state – long transient period with tight gas
  - Approximate transient behavior by setting up critical flow rate flags
    - Material balance – tank model - reservoir
    - Surface production network – flow line, separators, compressors.
Modeling Results Well 1

IP = 3 mmcf/d; GIP = 1 bcf

Cumulative production

Production rate

P = 0 psig
P = 50 psig
P = 200 psig
P = 950 psig

Q (mmcf/d)
Cumulative Q (mmcf)
Actual Production History Well 1
Modeling Results Well 2

IP = 8 mmcf/d; GIP = 3 bcf

P = 950 psig
P = 200 psig
P = 50 psig
P = 0 psig
Actual Production History Well 2

Compression
Modeling Results Well 3

IP = 15 mmcf/d; GIP = 6 bcf

P=950 psig
P = 200 psig
P = 50 psig
P = 0 psig

Q (mmcf/d)

Cum Q (mmcf)
Actual Production History Well 3

Compression
### Expected Recovery for Different Pressure System (in mmcf)

<table>
<thead>
<tr>
<th>Well type (OGIP)</th>
<th>HP (950 psig)</th>
<th>IP (200 psig)</th>
<th>LP (50 psig)</th>
<th>Ultralow (0 psig)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 bcf</td>
<td>426 (52%)</td>
<td>215 (26%)</td>
<td>168 (20%)</td>
<td>17 (2%)</td>
</tr>
<tr>
<td>3 bcf</td>
<td>1683 (65%)</td>
<td>557 (22%)</td>
<td>291 (11%)</td>
<td>53 (2%)</td>
</tr>
<tr>
<td>6 bcf</td>
<td>385 (74%)</td>
<td>974 (18%)</td>
<td>385 (7%)</td>
<td>78 (1%)</td>
</tr>
</tbody>
</table>

Well moved to lower pressure system when it reaches critical rate.
Typical Wellhead Compression Cost

- Wellhead compressor capital
- Monthly full maintenance rental
- Monthly company labor cost
- Fuel Gas

<table>
<thead>
<tr>
<th>Well type (EUR)</th>
<th>Recovery</th>
<th>Project Economics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 bcf</td>
<td>17 mmcf (2%)</td>
<td>Negative</td>
</tr>
<tr>
<td>3 bcf</td>
<td>53 mmcf (2%)</td>
<td>Marginal</td>
</tr>
<tr>
<td>6 bcf</td>
<td>78 mmcf (1%)</td>
<td>Excellent</td>
</tr>
</tbody>
</table>
Selection criteria

- Cumulative production of more than 3 BCF Minimum
- Current production rate below unloading rate
- Unloading rate at 0 psig
- Expected water production rate less than 30 bbls/day
- Downstream Compression Capacity Availability
- Average FTP, psig
- Tubing Size, inches
- SIWHP, psig
- Mechanically Plunger Candidate
- Other Mechanical Concerns
- Is Annular Flow Possible
- Sensitivity to pressure
- Past Success w/ wellhead compressor
- History of unloading temporarily
- Proximity to other candidates
- Tubing condition
Wellhead Compressor Installation
Example 2

4 BCF, 2 3/8” Tubing

Volume (mcf)
Pressure (psi)
30 per. Mov. Avg. (Volume (mcf))
Wellhead Compressor Installation

Example 3

6 BCF, 2 3/8” Tubing
Wellhead Compressor Installation
Example 4

11 BCF, 2 3/8” Tubing

Volume (mcf)

Pressure (psi)

30 per. Mov. Avg. (Volume (mcf))
• Well head compression is a useful tool on better wells adding to recovery and maintaining rate on the decline curve

• Wells that meet multiple criteria are the most attractive candidates for wellhead compression
This study was the work of a large multi-functional team, especially the following individuals (in alphabetical order):

- Joe Becnel
- Robert Coffman
- David Cruz
- Tony Dotson
- Sandi Richardson
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