Why Gas-Lift is Taking Over, But Should be Approached “Unconventionally” in Unconventionals

Larry Harms
Jim Hacksma
Thought Experiment – “Wipe your mind clean”

- What are you thinking?
What do we want in AL Method for Unconventionals?

- Handles Sand
- Minimally affected by slugging
- Thrives on Increasing GOR
- Provides High/Low Flow rates in fairly small casing
- Flexible for rapid decline rate
- Works well in high angle/dogleg environment
- Easy to optimize
- Reliable
- Minimal well intervention and killing of the well
- Low cost
- Low risk

- Easy to design up front
- Simple
- Is potentially the only method of lift needed
- Easily switchable to other methods
- Gives low FBHP
- Lets FBHP be monitored easily
- Allows chemical treatment of any kind to the heel
- Can help avoid and deal with frac hits
- Easily adapts to changing conditions
- Ready access to bottom of well
- No temperature or depth limits
Gas Lift (Conventional)

Gas Lift (Conventional)

In summary

- 20% of total production from Oxy’s Unconventional assets is produced via gas lift (and that percentage is increasing)
- All new drills are completed with gas lift, if possible.
- Future of the Permian – Multilateral completions
  - Gas lift preferred method of artificial lift

Gas lift preferred method of artificial lift
What is “Conventional” Gas Lift (CGL)?

- Method of “lightening a fluid column” with gas to artificially lift oil wells
- Has packer – Lift gas injected in casing
- Injection gas pressure typically 900-1200 psig
- Utilizes multiple gas lift “valves”
- Dates from 1945 Invention by W. R. King of the “bellows” type gas lift valve
What types of wells/fields was CGL developed for?

- High perm water drive or pressure maintenance reservoirs
  - Increasing water cut
  - Decreasing GLR
  - Fairly constant liquid rate
- Low strength casing
- Large centralized facilities
  - Unitized fields
- Lean dry gas sent back to wells
- No “standard” compressors available for discharge pressures over 1300 psig.
CGL Fit perfectly with offshore production

- Same type reservoirs and facilities
- High rates (big casing)
- Surface Controlled Sub-Surface Safety Valve
- Limited rig work needed
If CGL was developed for such different applications why are people touting it for Unconventionals?
Bakken GOR

Shaleprofile.com
Eagle Ford GOR
Permian GOR

Gas/oil ratio

Months on production

Shaleprofile.com
CGL Fit with Ideal AL Method for Unconventionals?

- Handles Sand
- Minimally affected by slugging
- Handles Gas
- Thrives on Increasing GOR
- Provides High/Low Flow rates in fairly small casing
- Flexible for rapid decline rate
- Works well in high angle/dogleg environment
- Easy to optimize
- Reliable
- Minimal well intervention and killing of the well
- Low cost
- Low risk

- Easy to design up front
- Simple
- Is potentially the only method of lift needed
- Easily switchable to other methods
- Gives low FBHP
- FBHP monitored easily
- Allows chemical treatment of any kind to the heel
- Can help avoid and deal with frac hits
- Easily adapts to changing conditions
- Ready access to bottom of well
- No temperature or depth limits
If Experts are saying CGL should be the “default lift method for unconventionals” why are Jim and I saying we need an “unconventional” approach to gas lift
An Unconventional Approach using Single Point Gas Lift (SPGL) Can Improve All of These

- Provides High/Low Flow rates in fairly small casing
- Easy to optimize
- Low risk
- Easy to design up front
- Simple
- Is potentially the only method of lift needed
- Easily switchable to other methods
- Gives low FBHP
- FBHP monitored easily
- Allows chemical treatment of any kind to the heel
- Can help avoid frac hits
<table>
<thead>
<tr>
<th>Conventional GL</th>
<th>Single Point GL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method of “lightening a fluid column” with gas to artificially lift oil wells</td>
<td>Lightens column and ensures gas rate above critical rate</td>
</tr>
<tr>
<td>Has packer – Lift gas injected in casing</td>
<td>No Packer, Gas injected down Casing or Tubing (like “jetting” with coiled tubing)</td>
</tr>
<tr>
<td>Injection gas pressure typically 900-1200 psig</td>
<td>Injection gas pressure 200-6000+ psig as needed</td>
</tr>
<tr>
<td>Utilizes multiple gas lift “valves”</td>
<td>No valves, injection at one point, generally EOT(60+ degrees)</td>
</tr>
<tr>
<td>Dates from 1945 Invention by W. R. King of the “bellows” type gas lift valve</td>
<td>Dates from 1864 when air used in Pennsylvania oil wells</td>
</tr>
</tbody>
</table>
Early Day Limitations of SPGL no longer applicable

- High strength casing used to frac

- Readily available high pressure compressor cylinders up to 6000+ psig (7000 psig@10,000’)
  - HP Rental compressors now available

- High quality/cheap rate meters and surface controllers for injection gas

- Coiled Tubing/Nitrogen available to kick off
GL Valves Required at Different Surface Injection Pressures (Typical Eagle Ford Well Basis)

<table>
<thead>
<tr>
<th>Gas Lift Supply Pressure, psig</th>
<th>Gas Lift Valves Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>10</td>
</tr>
<tr>
<td>1200</td>
<td>6</td>
</tr>
<tr>
<td>1500</td>
<td>4</td>
</tr>
<tr>
<td>1700</td>
<td>3</td>
</tr>
<tr>
<td>2200</td>
<td>2</td>
</tr>
<tr>
<td>3700</td>
<td>Only Orifice</td>
</tr>
</tbody>
</table>
SPGL Can Improve All of These

- Provides High/Low Flow rates in fairly small casing
  - Easy to optimize
  - Low risk
- Easy to design up front
- Simple
- Is potentially the only method of lift needed
  - Easily switchable to other methods
- Gives low FBHP
  - FBHP monitored easily
  - Allows chemical treatment of any kind to the heel
  - Can help avoid frac hits
Nodal Analysis Assumed Conditions

- Depth = 10,000’
- FTP = 50 psig
- Gas gravity = 0.65
- 100% water
  - No oil or gas production
- Tubing = 2\(\frac{3}{8}\)”
- Casing = 5\(\frac{1}{2}\)” 20 #/ft
- Flow models = Ansari & Gray (modified)
“Optimum” FBHP

Diagram showing three lines representing different scenarios:
- Tubing
- Annulus
- Switched

The x-axis represents BLPD (barrels per day) ranging from 10 to 10,000.

The y-axis represents FBHP (pounds per square inch gauge) ranging from 100 to 10,000.
Optimum “Total” Gas (inj + prod)
Friction (injection pressure loss)

- **Tubing**
- **Annulus**
- **Switched**
Flowing Gradient (psi/ft)

- Tubing
- Annulus
- Switched
SPGL Can Improve All of These

- Provides High/Low Flow rates in fairly small casing
  - Easy to optimize
  - Low risk

- Easy to design up front
- Simple
- Is potentially the only method of lift needed
- Easily switchable to other methods
- Gives low FBHP

  - FBHP monitored easily
    - Allows chemical treatment of any kind to the heel
    - Can help avoid frac hits
• Surface injection pressure = PBHP @ EOT when gas head and friction corrected

• Just increase or decrease the injection rate to get the lowest injection pressure and that will be the highest rate
2 7/8” Tubing Flow Example – Rate

Total Liquid Rate (stb/ld) vs Gas Lift Rate (QG)
2 7/8” Tubing Flow Example – SPGL Rate Optimization with injection pressure

1900 psig @ Surface (Friction Negligible)

1800 psig @ Surface
SPGL Can Improve All of These

- Provides
  High/Low Flow rates in fairly small casing
- Easy to optimize
- Low risk
- Easy to design up front
- Simple
- Is potentially the only method of lift needed
- Easily switchable to other methods
- Gives low FBHP
- FBHP monitored easily
- Allows chemical treatment of any kind to the heel
- Can help avoid frac hits
SPGL Easily Switched to other lift methods

- Uses only a string of tubing
- Can convert directly to GAPL/PAGL with only the installation of a tubing stop/bumper
  - Annulus available
  - No potential of cut out valve leak points
  - No losses at mandrels
- Can easily pull tubing and run any kind of pump
SPGL Can Improve All of These

- Provides
- High/Low Flow rates in fairly small casing
  - Easy to optimize
  - Low risk

- Easy to design up front
- Simple
- Is potentially the only method of lift needed
- Easily switchable to other methods
- Gives low FBHP
- FBHP monitored easily

- Allows chemical treatment of any kind to the heel

- Can help avoid frac hits
SPGL Can Improve All of These

- Provides High/Low Flow rates in fairly small casing
- Easy to optimize
- Low risk

- Easy to design up front
- Simple
- Is potentially the only method of lift needed
- Easily switchable to other methods
- Gives low FBHP
- FBHP monitored easily
- Allows chemical treatment of any kind to the heel

- Can help avoid frac hits?
Single Point Gas Lift (SPGL) Can Improve All of These

- Provides High/Low Flow rates in fairly small casing
- Easy to optimize
- Low risk

- Easy to design up front
- Simple

- Is potentially the only method of lift needed
- Easily switchable to other methods
- Gives low FBHP
- FBHP monitored easily
- Allows chemical treatment of any kind to the heel
- Can help avoid frac hits
Easy to Design Up Front?

- Do not have to wait on well’s performance to make design choices

- Once tubing and casing size plus surface pressure are set, the following are determined:
  - Range of production rates possible
  - Range of lift gas rates required
  - Size of booster compressor needed
Simple Downhole

- No moving parts
- No need to do well interventions linked to AL
Single Point Gas Lift (SPGL) Can Improve All of These

- Provides High/Low Flow rates in fairly small casing
- Easy to optimize
- Low risk
- Easy to design up front
- Simple
- Is potentially the only method of lift needed
- Easily switchable to other methods
- Gives low FBHP
- FBHP monitored easily
- Allows chemical treatment of any kind to the heel
- Can help avoid frac hits
Low Risk

- No exposure to cutting out valves or multipointing

  - Reality of not installing a packer, mandrel, and orifice
    - Reduces installation costs
    - Reduces likelihood of future fishing jobs
    - Old PE Adage – “Never run anything below the master valve that is not absolutely necessary”

- No need for redesign based on well performance (or having to switch to another method in short period of time)
Where might SPGL fall short?

Wells with all the following characteristics

- GOR is low/does not increase
- EOT is not put into the bend because some tail pipes have gotten stuck
- High productivity, benefits from very low PBHP
  - 100 psig at pump intake
Coming Events in SPGL

- SPE-195180 “Single Point High Pressure Gas Lift Replaces ESP in Permian Basin Pilot Test” to be presented at OKC O&G Symposium
  - Successful pilot with over 5000 BFPD from Annular SPGL

- Third paper will be done comparing SPGL to other methods hopefully including cost

- COP has started SPGL pilot in Delaware Basin
Gas Lift is finally taking it’s place as the default artificial lift type for unconventional wells.

By approaching it unconventionally even the “drawbacks” of conventional gas lift can be removed.
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.