Jet Lift: Bridge the Gap Between Various Forms of AL

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Agenda

► Challenge
► Solution
► Jet lift system design
► Results
Challenge

► Initial strategy was to commence post-flowback production from fractured wells with ESPs, and then transition to rod lift as rates declined over time

► However, as the wells approached the transition window between ESPs and rod pumps, high sand content and gas-to-liquids ratios caused frequent downtime for both types of lift, negatively impacting well performance
Solution

- Effectively bridge the application gap between high-rate ESPs in early well life and lower-rate rod pumps later in the lifecycle and accommodate the solids, wellbore deviation and GORs
  - Reduce the amount of well intervention to reduce downtime and capital expense
  - Maintain production rate

- Install a jet lift concentric string system
  - Allows gas to flow up the casing annulus similar to rod lift reducing the gas interference in the downhole jet pump
  - Jet pumps have the capabilities to handle solids and be set lower in the wellbore while still maintaining the production target
Jet lift system overview
Jet lift system overview
## Jet lift system overview

<table>
<thead>
<tr>
<th>Tubing Size</th>
<th>Jet Pump Size</th>
<th><em>Maximum Capacity</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>CT 1-1/4” or Larger</td>
<td>1-1/4” JP</td>
<td>~500 BPD</td>
</tr>
<tr>
<td>2-3/8”</td>
<td>1-1/2” &amp; 2” STD JP</td>
<td>~1500 BPD</td>
</tr>
<tr>
<td>2-3/8”</td>
<td>2” High Volume JP</td>
<td>~3000 BPD</td>
</tr>
<tr>
<td>2-7/8”</td>
<td>2-1/2” STD JP</td>
<td>~3000 BPD</td>
</tr>
<tr>
<td>2-7/8”</td>
<td>2-1/2” High Volume JP</td>
<td>~6000 BPD</td>
</tr>
<tr>
<td>3-1/2”</td>
<td>3-1/2” High Volume JP</td>
<td>~12000 BPD</td>
</tr>
</tbody>
</table>

*Casing sizes must be considered*
Jet lift system overview

<table>
<thead>
<tr>
<th>Category</th>
<th>Typical Range</th>
<th>Extreme Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth (TVD)</td>
<td>2,000’-15,000’</td>
<td>20,000’</td>
</tr>
<tr>
<td>Producing Rate</td>
<td>25-2,000 BPD</td>
<td>10,000 BPD</td>
</tr>
<tr>
<td>Producing BHP</td>
<td>25-200psi / 1,000’ of Lift</td>
<td>Near Pump Off</td>
</tr>
<tr>
<td>Temperature</td>
<td>250° F</td>
<td>450° F</td>
</tr>
<tr>
<td>Setting Deviation</td>
<td>40°-60°</td>
<td>90°</td>
</tr>
<tr>
<td>DLS</td>
<td>0-15° / 100’</td>
<td>20° / 100’</td>
</tr>
<tr>
<td>Gas Handling</td>
<td>100-1500:1 GLR</td>
<td>&gt;1500:1 GLR</td>
</tr>
<tr>
<td>Produced Solids</td>
<td>1-5 lbs. / Bbl.</td>
<td>&gt;25 lbs. / Bbl</td>
</tr>
<tr>
<td>Fluid Gravity</td>
<td>20° - 50° API</td>
<td>8° API</td>
</tr>
</tbody>
</table>
Concentric string completion (vertical)

**Advantages**
- Can be installed below the perforations and into the lateral
- Allows gas to flow up the casing annulus while keeping the pump submerged (Prod. Csg = 7”; Prod. Tbg = 2-7/8”; Inj. Tbg = 1-1/4”)
- Jet pump can still be pumped in and out

**Disadvantages**
- Limited to 500 BPD maximum production
Concentric design
Results (horizontal well configuration)

- Set pump at 70°, which allowed the system to maintain the same bottomhole pressure as the ESP system
  - Sub 450 psi producing BHP @ ~200 BPD
- Three wells produced from one surface pump
  - Spread maintenance and rental costs across three wells
- Three-year run time with no workover rig
  - Previous artificial lift systems had at least one pull per year
Results (horizontal well configuration)
Conclusion

► Jet lift system reduced downtime due to solids and gas interference
► Concentric installation allowed for gas ventilation
► Pump Intake at the base of the curve (~300’ deeper than previous lift system)
► Multiple wells ran from a singular surface pump
► Maintained previous ALS production with less downtime
Thanks and questions

► Acknowledgments
  ► Mauricio Monzon, Apache Production Engineer
  ► ChampionX Artificial Lift and the Prime Pump Solutions operations team
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