Gas Lift for Long, Perforated Intervals

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Introduction

• More wells being drilled and completed with long perforated intervals – deep verticals and long horizontals with multiple zones.

• Insufficient velocities below the packer can cause liquid loading.

• New innovations in gas lift make it a viable option for long perforated intervals.
Typical GL System

- Fluid level in tubing and casing is at the surface
- No gas injected – no fluid produced
- All gas lift valves are open
- Pressure to open valves is provided by the weight of the fluid in the casing and tubing
Typical GL System

- Gas injection into casing
- Fluid U-tubes through all open valves
- Fluids produced from annulus only - pressure in the wellbore at perfs is greater than reservoir pressure
Typical GL System

- Fluid is unloaded to the top (#5) gas lift valve
- Fluid is aerated above this point in the tubing, decreasing flowing gradient
- Pressure is reduced at top valve, as well as all lower valves
- Unloading continues through lower valves
Typical GL System

- Fluid level now below valve #4 (second from top)
- Injection transfers to valve #4 and pressure is lowered
- Casing pressure drops and valve #5 closes
- Unloading continues through lower valves
Typical GL System

- Gas is injected through valve #4
- Lower valves remain open
- Reduced casing pressure causes upper valves to close in sequence
Typical GL System

- Gas is injected through valve #3
- Lower valves remain open
- Reduced casing pressure causes upper valves to close in sequence
Typical GL System

- Upper valves are closed

- Valve #2 = Point of Injection
  Ability of reservoir to produce fluid matches the tubing’s capacity to remove fluids

- Casing pressure dictated by operating valve set pressure

Valve #1 remains submerged unless operating conditions change in the reservoir (i.e. formation drawdown)
Gas Lift Advantages

- Flexible to meet changing conditions
- Cost-effective
- Unaffected by sand
- Effective in high GLR wells

**AND**

- Suitable for deviated and horizontal wells
- Suitable for wells with multiple production zones
- Suitable for multi-well pads
Below Packer Gas Lift

Extending the Range of Gas Lift Applications
Gas Lift Below the Packer

- The deepest point of injection is no longer limited by the packer
- Gas can be injected below the packer to the most efficient point of lift
- Liquid in the perforated zone is aerated, decreasing the flowing gradient
- Velocity of flow is increased by reducing the effective flow area
Gas Lift Below the Packer

Reduced bottom-hole pressure
+ Increased drawdown

Increased critical velocity, even below the packer
Below Packer Gas Lift Types

Common Below Packer Installations

• Annular Bypass Assembly (ABA)
• Dip Tube
• Enhanced Annular Velocity (EAV)
• Marathon AVE
Annular Bypass Assembly (ABA)

- Hybrid of a conventional gas lift system with packer and an open-ended, packerless system
- Utilizes tubing and gas lift valves above packer and a bypass assembly through the packer
- Production is normal up the tubing, and no adjustments are needed on the wellhead
- Ultimate point of lift can be the end of tubing, allowing for decreased flowing bottom hole pressure compared to a standard packer completion
- Most applicable where deviation of the wellbore limits how deep a packer can be set
ABA Advantages

• Prevents fluid loading above the packer during well shut-ins or offset frac activity
• Allows for lift around end of tubing in deviated or horizontal wells where a packer is desired at a shallower depth
• Inexpensive system using a gas-lift mandrel and check for flow cross-over
• Can be used with packer of choice
Below Packer Gas Lift
Horizontal Annular Bypass Assembly
Below Packer Gas Lift
Vertical Annular Bypass Assembly
Dip Tube

- Utilizes a crossover flow adapter and a unique mini well bore below the packer
- Lift gas travels down the casing annulus above the packer, through the crossover flow adapter and into the injection string below the packer
- Production flows up through the crossover flow adapter into the production tubing and to surface
- Deepest point of injection is achieved without applying back pressure on the formation
- Able to successfully lift large casing wellbores in perforations with lesser amounts of compression
Below Packer Gas Lift
Horizontal Dip Tube System
Enhanced Annular Velocity (EAV)

• Utilizes tubing and gas lift valves above packer, and an injection string with internally mounted gas lift valves below

• Lift gas travels through the casing annulus, through the crossover flow adapter and into the injection string below the packer

• Production flows up the annular area, through the crossover flow adapter and into the production tubing to surface
Below Packer Gas Lift
Horizontal EAV System
Marathon AVE

- Similar to EAV, but crossover flow adapter and all gas lift valves above and below packer are wireline retrievable
- Lift gas travels through the casing annulus, through the crossover flow adapter and into the injection string below the packer
- Production flows up the annular area, through the crossover flow adapter and into the production tubing to surface
- Patented Marathon system
Gas Rate Requirements

- **Dip Tube**: Example (2-7/8” x 1-1/4”) 400 MCFD total gas requirement*
- **EAV and Marathon AVE**: Example (2-7/8” or 3-1/2” x 5-1/2”) 800 - 1,000+ MCFD total gas requirement
- **ABA**: Example (2-3/8”) 400 MCFD total gas requirement

Liquid Production (highly variable)

- **Dip Tube**: lower liquids (average <500 Bbl/d)
- **ABA, EAV, Marathon AVE**: higher liquids (average >500 Bbl/d)

*Total gas requirement includes compressed gas plus produced gas
Other Considerations

• Production Philosophy
  – Marathon AVE: planning for inevitable future decline
  – Dip Tube, AVE, EAV: dealing with today’s production issues

• Other Variables to Consider
  – Geometry of the wellbore: Toe-Up, Toe-Down, Deviated or Vertical
  – Declining reservoir pressure
  – Producing well head pressure
  – Current flowing bottom hole pressure
Conclusion

- More wells are being drilled and completed with long perforated intervals
- Gas lift is cost-effective and flexible to meet changing conditions
- Recent gas lift innovations can now achieve deeper point of injection below the packer
- These systems create adequate velocity below the packer to recover fluids, reducing flowing bottom hole pressure and increasing drawdown
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