Installing Plunger Lift in Gas Wells
Lessons Learned from Natural Gas STAR

Exploration & Production,
Gulf Coast Environmental Affairs Group,
American Petroleum Institute and
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Installing Plunger Lift in Gas Wells

- Methane Losses
- Methane Recovery
- Is Recovery Profitable?
- Industry Experience
- Discussion Questions
What is the Problem?

- There are approximately 316,000 condensate and natural gas wells (on and offshore) in the U.S.
- Accumulation of liquid hydrocarbons or water in the well bores of gas wells reduces and can halt production.
- Common practices to temporarily restore production vent significant quantities of methane.
Methane Emissions

- By venting, or “blowing” the well to the atmosphere, a high volume of gas entrains accumulated liquids to the surface.
- Methane is released to the atmosphere along with the gas.
- On average, 50 to 600 Mcf of methane per well may be emitted each year.
- To date, about 6 Bcf/yr of gas is being saved with plunger lift installations.
How Can Plunger Lifts Reduce Methane Emissions?

- Plunger lifts automatically produce liquids without blowing the well to the atmosphere.
- Gas pressure stored in the casing annulus periodically pushes the plunger and liquid load from the well bottom to surface vessels.
- Wells with the right combination of shut-in pressure, depth and liquid accumulation are kept productive without operator attention.
- Other wells can use injected gas lift more efficiently with a plunger lift system.
Plunger Lift Schematic

Source: Adapted from Production Services Control, Inc.
www.pscplungerlift.com/plungerlift.html
Overall Benefits

- Higher gas production
- Reduced methane emissions
- Lower capital cost
- Lower well maintenance cost
- Extends the life of wells
- Removes scale, salt, paraffin
Reducing Emissions, Increasing Efficiency, Maximizing Profits

Decision Process

Determine if a plunger lift is technically feasible for the well → Determine the cost of a plunger lift

Estimate the savings achieved by plunger lift installation:
- capital and operating costs
- increased production value
- gas savings
- avoided well treatment costs
- salvage value
- reduced workover/electricity costs

Compare overall costs and benefits of traditional remedial techniques vs. plunger lifts

Is a plunger lift cost-effective?
Plunger Lift Applications

- Plunger lifts are a long term solution
- Common plunger lift applications include
  - Wells with gas-to-liquid ratios of 400 scf/bbl per 1,000 feet of depth
  - Wells with shut-in pressure that is 1.5 times the sales line pressure
  - Gas wells with coiled tubing
  - Wells in need of paraffin and scale control
  - Oil wells with associated gas
- Using plunger lift when venting to the atmosphere
  - Wells with shut-in pressure that is 1.5 times atmospheric pressure
Plunger Lift Costs

- Two elements: facilities and set-up costs
- Total costs range from $1,500-$6,000
- Largest variability is in set-up costs
  - Tubing gage: check for obstructions/drift
  - Broach to assure free movement
  - Set/check depth of plunger stop bumper
  - Swab to allow plunger to surface reliably
Avoided Emissions

- Estimating gas vented to expel liquids
  - GRI studied more than 103,000 blowdown events
  - 41% of the 6387 wells analyzed required liquid unloading
    - Frequency ranged from once-per-year to once-per-day, averaging 40 times per year
    - Methane content was 78.8 mole %
  - ExxonMobil averaged savings of 640 Mcf/yr/well for 19 plunger lift installations in Big Piney, WY

- A conservative estimate is the well volume at shut-in pressure
  - \[0.37 \times 10^{-6} \times \text{ID}^2 \times \text{Depth} \times \text{Pressure} \times \text{Vents/yr} \text{ (Mcf/yr)}\]
  - 610 Mcf/yr for 8 inch, 10,000 ft well at 200 psig shut-in pressure with monthly venting
Increased Productivity

- Using a well production plot, assume plunger lift can maintain peak average production rate
Additional Benefits: Plunger Lift Replaces Beam Lift

- Avoided well treatment
  - Chemical treatments (solvents, hot fluids, dispersants, surfactants, etc.) = $10,000/yr
  - Microbial cleanups = $5,000/yr

- Avoided workover costs
  - Decreased need for remedial operations average = $12,000 to $30,000 three times in 10 yrs
## Economic Analysis

### Two Options for continuously unloading a well

<table>
<thead>
<tr>
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<th>Capital Costs</th>
<th>Annual Operating Costs</th>
<th>Remediation - Chemical</th>
<th>Electrical Costs</th>
<th>Production Increase</th>
<th>Emissions Savings</th>
<th>Payout</th>
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<td>Plunger Lift</td>
<td>$1,500 - $6,000</td>
<td>$500 - $1,000</td>
<td>$0</td>
<td>$0</td>
<td>3-300 MCFD</td>
<td>75-900 MCF/yr</td>
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<td>Beam Lift</td>
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<td>$3,000 - $40,000</td>
<td>$10,000 +</td>
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<td>3-300 MCFD</td>
<td>75-900 MCF/yr</td>
<td>14 months</td>
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</table>
Partner Reported Experience

- Partners report methane reduction of 10 - 1,650 Mcf/yr per well
- Past emission reduction estimates for 120,000 wells using plunger lifts is 6 Bcf/yr or $18 million/yr
- Future emission reduction potential estimated to be 1-5 Bcf/yr for 100,000 additional wells
Midland Farm Field, replacement of beam lift, rod pump well production equipment with plunger lifts

- Initial decision based on paraffin blockage
- Installation costs = $10,000 /well
- Avoided costs of electricity, workover, and paraffin control = $20,000 /well/year
- Increased production = $22,548 /well/year
- Due to success, 190 plunger lifts units have been installed at other locations
Plunger Lift Installation Program at Big Piney, Wyoming

- Between 1995 and 1998 installed 23 plunger lifts (19 during first 3 years)
- Total installation costs = $115,000
- Annual emissions reduction = 14,720 Mcf
- Average annual value = $44,160 (at $3/Mcf)
- Program continues installing plunger lifts
Annualized Reduction of Methane Emissions

*Total Annualized Reduction = 12,166 Mcf/yr (640 Mcf/yr/well)
Lessons Learned

- Most remedial actions (many of which can be replaced by plunger lifts) are costly, repetitive, and lead to excessive gas emissions.

- Plunger lift installations reduce the amount of remedial work needed throughout the lifetime of the well, and the amount of methane releases.
Lessons Learned

- An economic analysis of plunger lift installation should include incremental boost in productivity and associated extension of well life.
- Plunger lift installations can offer quick paybacks and high return on investments.
Discussion Questions

- To what extent are you implementing this technology?
- How can the Lessons Learned study be improved upon or altered for use in your operation(s)?
- What are the barriers (technological, economic, lack of information, regulatory, etc.) that are preventing you from implementing this technology?