Installing Plunger Lift in Gas Wells

Lessons Learned

from Natural Gas STAR

Exploration & Production,

Gulf Coast Environmental Affairs Group,

American Petroleum Institute and

EPA's Natural Gas STAR Program

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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

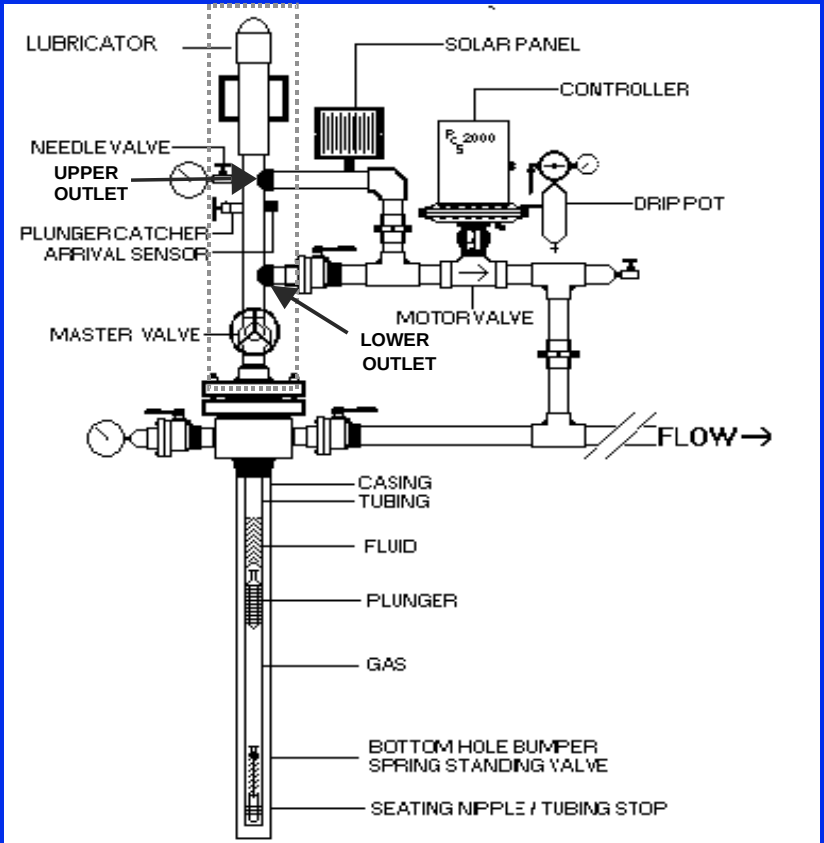
Methane Emissions

- 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

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

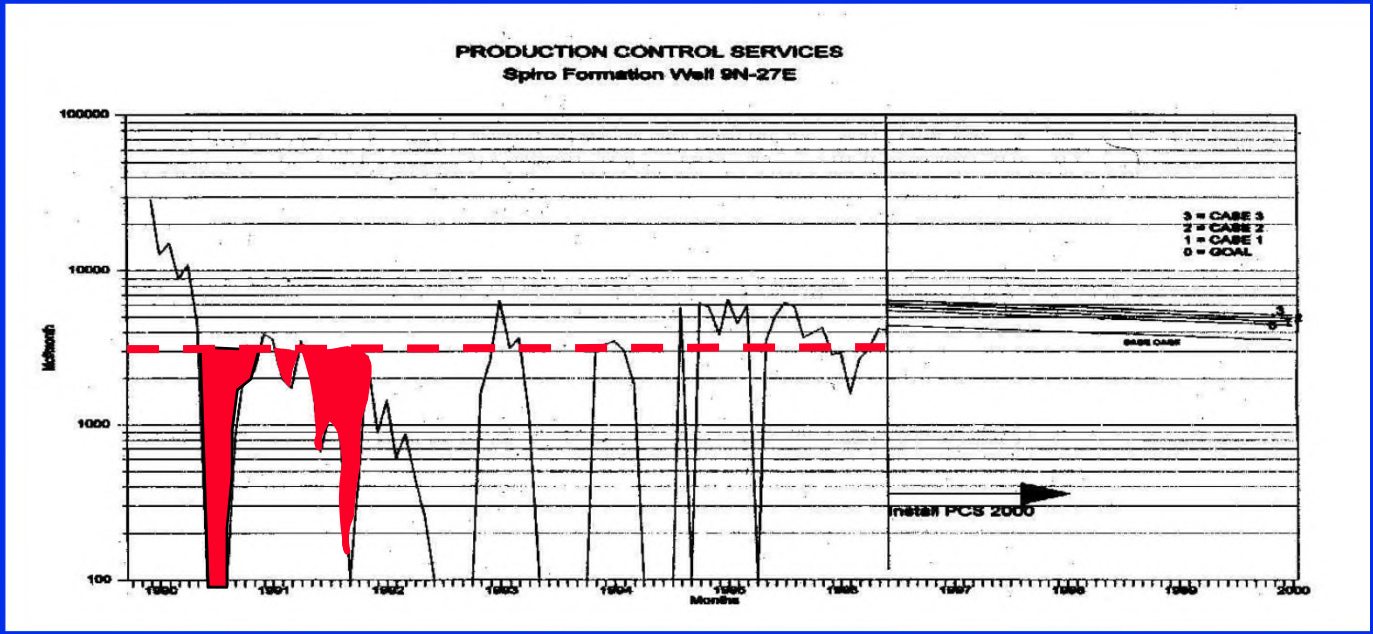
- Two elements: facilities and set-up costs
- Total costs range from $1,500-$6,000
- Largest variability is in set-up costs
  - Tubing gage: check for obstructions/drift
  - Broach to assure free movement
  - Set/check depth of plunger stop bumper
  - Swab to allow plunger to surface reliably

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
  - $0.37 \times 10^{-6} \times ID^2 \times Depth \times Pressure \times Vents/yr$ (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



Reducing Emissions, Increasing Efficiency, Maximizing Profits

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

	Capital Costs	Annual Operating Costs	Remediation - Chemical	Electrical Costs	Production Increase	Emissions Savings	Payout
Plunger Lift	$1,500-$6,000	$500 - $1,000	$0	$0	3-300 MCFD	75-900 MCF/yr	1 month
Beam Lift	$20,000 - $40,000	$3,000 - $40,000	$10,000 +	$1,000 - $7,300	3-300 MCFD	75-900 MCF/yr	14 months

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

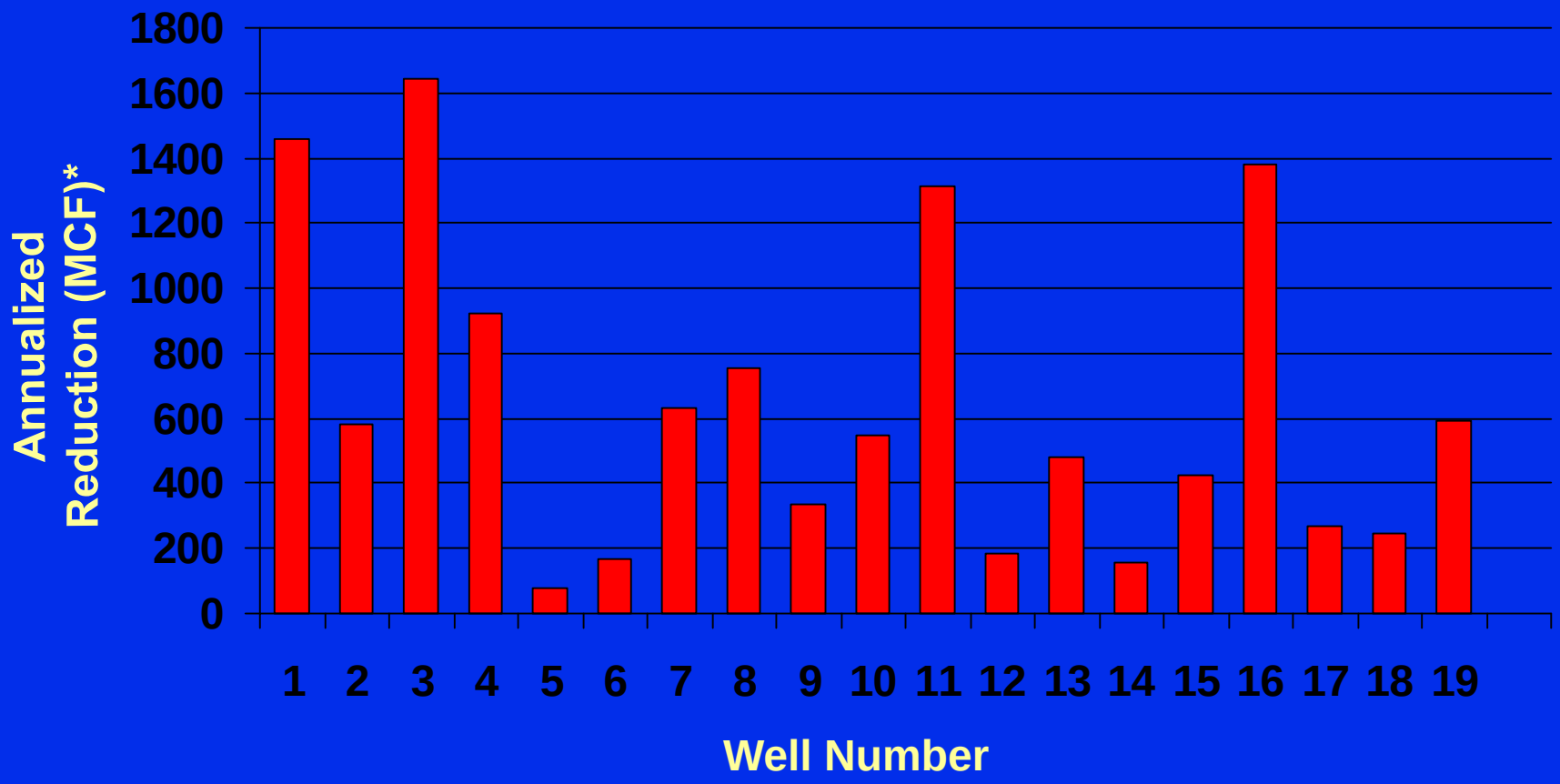
BP

- 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

ExxonMobil E&P U.S.

- 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)

NaturalGas
EPA POLLUTION PREVENTER

Reducing Emissions, Increasing Efficiency, Maximizing Profits

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?