Plunger Lifts and Smart Automation
Lessons Learned from the Natural Gas STAR Program

Marathon Oil Company, and The Independent Petroleum Association of Mountain States

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epa.gov/gasstar

Plunger Lifts and Smart Automation: Agenda

- Methane Losses
- Methane Savings
- Is Recovery Profitable?
- Industry Experience
- Discussion
Methane Losses

- 395,000 natural gas and condensate wells (on and offshore) in the U.S.¹
- Blow-downs to unload fluids can vent 80 to 1,600 Mcf/year² to the atmosphere per well
- 9 billion cubic feet (Bcf)/year from onshore well venting¹

1 - Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990 - 2005
2 - Mobil Big Piney Case Study 1997

Liquid Unloading

- Accumulation of liquid hydrocarbons or water in the well bores reduces, and can halt, production
Conventional Plunger Lift Operations

- Manual, on-site adjustments tune plunger cycle time to well’s parameters
  - Not performed regularly
  - Do not account for gathering line pressure fluctuations, declining well performance, plunger wear
- Results in manual venting to atmosphere when plunger lift is overloaded

Source: BP

What is the Problem?

- Conventional plunger lift systems use gas pressure buildups to repeatedly lift columns of fluid out of well
- Fixed timer cycles may not match reservoir performance
  - Cycle too frequently (high plunger velocity)
    - Plunger not fully loaded
  - Cycle too late (low plunger velocity)
    - Shut-in pressure can’t lift fluid to top
    - May have to vent to atmosphere to lift plunger

Source: Weatherford
Smart Automation Well Venting

- Automation can enhance the performance of plunger lifts by monitoring wellhead parameters such as:
  - Tubing and casing pressure
  - Flow rate
  - Plunger travel time
- Using this information, the system is able to optimize plunger operations
  - To minimize well venting to atmosphere
  - Recover more gas
  - Further reduce methane emissions

Methane Recovery: How Smart Automation Reduces Methane Emissions

- Smart automation continuously varies plunger cycles to match key reservoir performance indicators
  - Well flow rate
    - Measuring pressure
  - Successful plunger cycle
    - Measuring plunger travel time
- Plunger lift automation allows producer to vent well to atmosphere less frequently
Automated Controllers

- Low-voltage; solar recharged battery power
- Monitor well parameters
- Adjust plunger cycling

Remote well management
- Continuous data logging
- Remote data transmission
- Receive remote instructions
- Monitor other equipment

Plunger Lift Cycle

Production Control Services
Spiro Formation Well 9N-27E

Well Blowdowns
Potential Incremental Production with Plunger Lift
Potential Continuous Production with Plunger Lift
Well Production without Plunger Lift
Plunger Lifts Installed
Methane Savings

- Methane emissions savings a secondary benefit
  - Optimized plunger cycling to remove liquids increases well production by 10 to 20%\(^1\)
  - Additional 10%\(^1\) production increase from avoided venting
- 500 Mcf/year methane emissions savings for average U.S. well

1 - Reported by Weatherford

Other Benefits

- Reduced manpower cost per well
- Continuously optimized production conditions
- Remotely identify potential unsafe operating conditions
- Monitor and log other well site equipment
  - Glycol dehydrator
  - Compressor
  - Stock Tank
  - Vapor Recovery Unit

Source: BP
Is Recovery Profitable?

- Smart automation controller installed cost: ~$11,000
- Conventional plunger lift timer: ~$5,000
- Personnel savings: double productivity
- Production increases: 10% to 20% increased production

\[
\text{Savings} = \\
\text{(Mcf/year)} \times (10\% \text{ increased production}) \times (\text{gas price}) \\
+ \text{(Mcf/year)} \times (1\% \text{ emissions savings}) \times (\text{gas price}) \\
+ \text{(personnel hours/year)} \times (0.5) \times (\text{labor rate}) \\
\text{$ savings per year}
\]

Economic Analysis

- Non-discounted savings for average U.S. Well =

\[
\text{(50,000 Mcf/year) \times (10\% \text{ increased production}) \times ($7/Mcf)} \\
+ \text{(50,000 Mcf/year) \times (1\% \text{ emissions savings}) \times ($7/Mcf)} \\
+ \text{(500 personnel hours/year) \times (0.5) \times ($30/hr)} \\
- \text{($11,000) cost}
\]

\text{$35,000 savings in first year}

3 month simple payback
BP Experience

☆ BP’s first automation project designed and funded in 2000

☆ Pilot installations and testing in 2000
  ● Installed plunger lifts with automated control systems on ~2,200 wells
  ● ~$15,000 per well Remote Terminal Unit (RTU) installment cost
  ● $50,000 - $750,000 host system installment cost
  ● Achieved roughly 50% reduction in venting from 2000 to 2004

BP Experience

☆ BP designed two pilot studies in 2006 to further improve well scientific control
  ● Interviewed control room staff and worked closely with the field automation team leader
  ● Established a new procedure based on plunger lift expertise and pilot well analysis
  ● In mid 2006, “smarter” automation was applied to wells
    ● 1,424 Mcf reported annual savings per well
BP Experience

Asset Vent Volume

5% of Production

Source: BP

BP Experience

Daily Vent Volumes

Source: BP
Discussion

- Industry experience applying these technologies and practices
- Limitations on application of these technologies and practices
- Actual costs and benefits