Plunger Lifts and Smart Automation

Lessons Learned from the
Natural Gas STAR Program

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

Producers Technology Transfer Workshop
Denver, Colorado
April 29, 2008

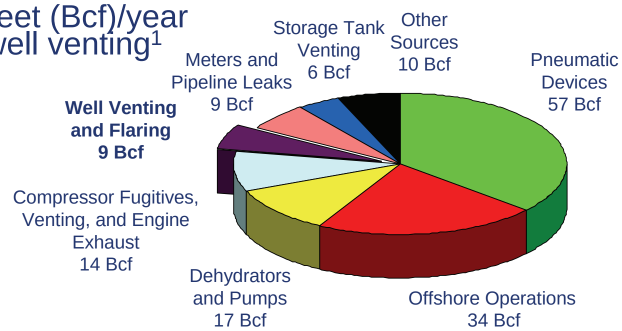
epa.gov/gasstar

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/year[2] to the atmosphere per well
- 9 billion cubic feet (Bcf)/year from onshore well venting[1]



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

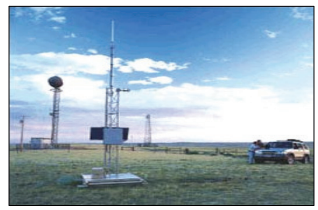
Liquid Unloading

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

Source: BP

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

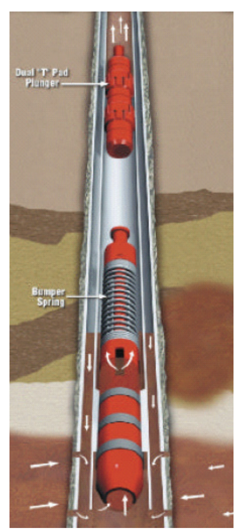


Source: BP

4

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

5

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

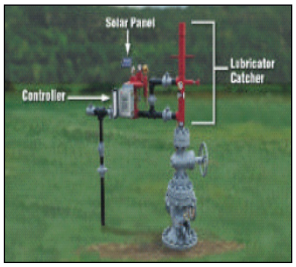
6

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

7

Automated Controllers



Source: Weatherford

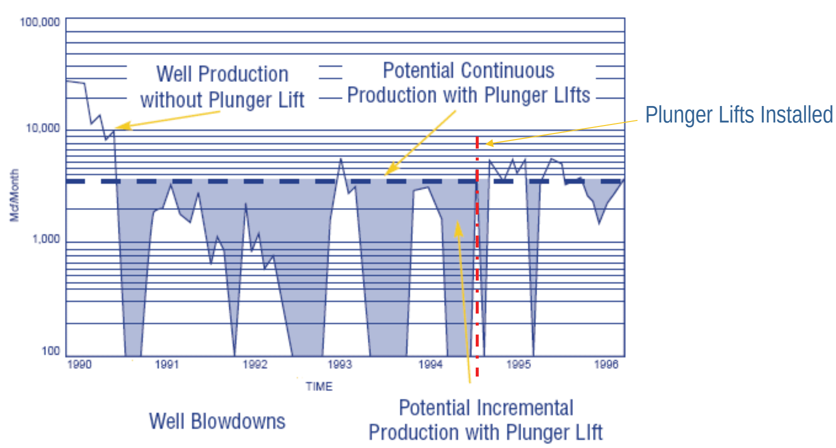
- Low-voltage; solar recharged battery power
- Monitor well parameters
- Adjust plunger cycling
- Remote well management
  - Continuous data logging
  - Remote data transmission
  - Receive remote instructions
  - Monitor other equipment

Source: Weatherford

8

Plunger Lift Cycle

Production Control Services
Spiro Formation Well 9N-27E



9

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

Source: BP

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

- Savings =

  (Mcf/year) x (10% increased production) x (gas price)
  + (Mcf/year) x (1% emissions savings) x (gas price)
  + (personnel hours/year) x (0.5) x (labor rate)

  $ savings per year

12

Economic Analysis

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

(50,000 Mcf/year) x (10% increased production) x ($7/Mcf)
+ (50,000 Mcf/year) x (1% emissions savings) x ($7/Mcf)
+ (500 personnel hours/year) x (0.5) x ($30/hr)
- ($11,000) cost

$35,000 savings in first year

3 month simple payback

13

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

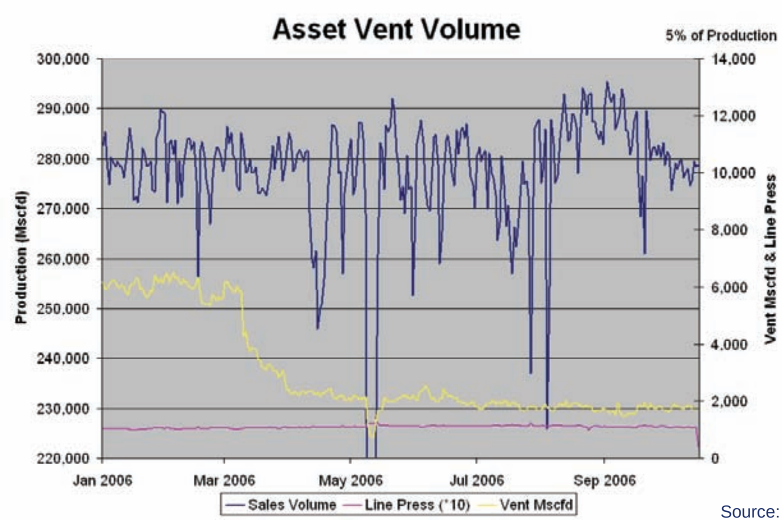
14

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

15

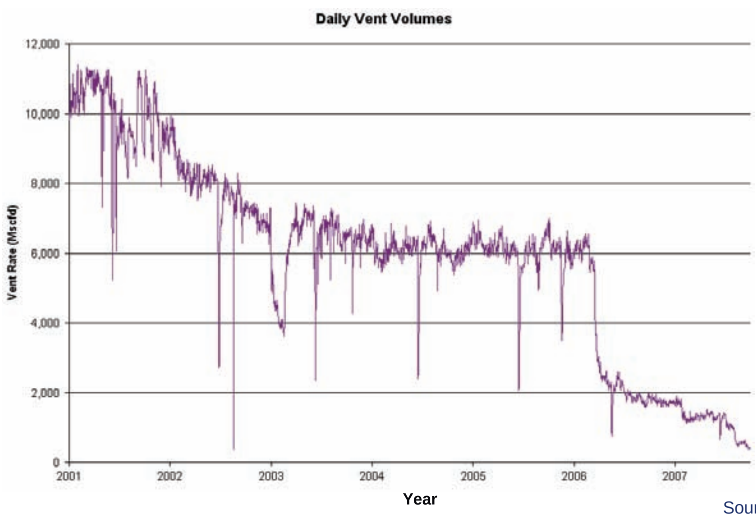
BP Experience



Source: BP

16

BP Experience



Source: BP

17

Discussion

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

18