Methane to Markets

Opportunities for Methane Emissions Reductions in Natural Gas Production

Technology Transfer Workshop

PEMEX &
Environmental Protection Agency, USA

April 25, 2006
Villahermosa, Mexico

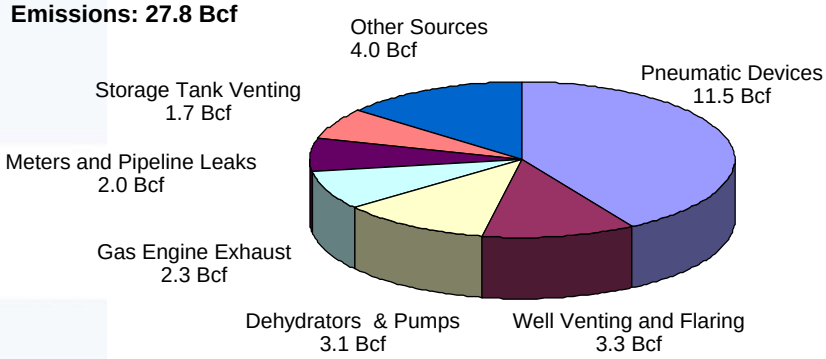
Methane to Markets

Agenda

- Reduced Emissions Completions
  - Methane Losses
  - Methane Recovery
  - Is Recovery Profitable?
  - Industry Experience
  - Discussion Questions
- Smart Automation Well Venting
  - Methane Losses
  - Methane Recovery
  - Is Recovery Profitable?
  - Industry Experience
  - Discussion Questions
- Project Summaries for Mexico

Mexico Production Sector Methane Emissions (2000)

Total Production Emissions: 27.8 Bcf



Sources: *US Natural Gas STAR program success points to global opportunities to cut methane emissions cost-effectively*, Oil and Gas Journal, July 12, 2004
Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2004

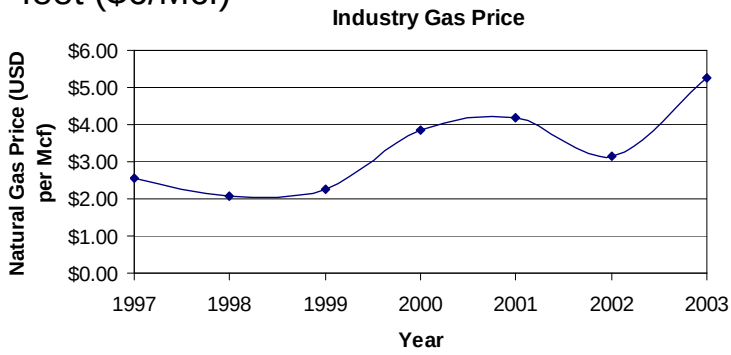
Bcf = billion cubic feet

Methane Losses During Well Completions

- It is necessary to clean out the well bore and formation surrounding perforations
  - After new well completion
    - Completion: installation of permanent wellhead equipment for production of oil and natural gas
  - After well workovers
    - Workover (or cleanup): operations to restore or increase well production
- Operators produce the well to an open pit or tankage to collect sand, cuttings, and reservoir fluids for disposal
- Vent or flare the natural gas produced
  - Venting may lead to dangerous gas buildup
  - Flaring is preferred where there is no fire hazard or nuisance

Wellhead Gas Prices

- Gas prices in Mexico have increased in recent years to over $6 per thousand cubic feet ($6/Mcf)



Source: EIA "Natural Gas Price for Industry" available at http://www.eia.doe.gov/emeu/international/gasprice.html

Methane Recovery: Reduced Emissions Completions (REC)

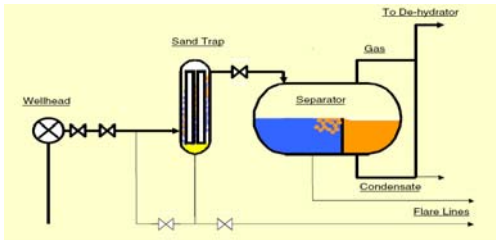
- REC or Green Completions recover natural gas and condensate produced during well completions or workovers
- Use portable equipment to process gas and condensate suitable for sales
- Send recovered gas through permanent dehydrator and meter to sales line, reducing venting and flaring
- An estimated 25.2 Bcf or $176 million of natural gas can be recovered annually using Green Completions in U.S.
  - 25,000 MMcf from high pressure wells
  - 181 MMcf from low pressure wells
  - 27 MMcf from workovers

MMcf = million cubic feet

Methane to Markets

Green Completions: Equipment

- Truck- or trailer- mounted equipment to capture produced gas during cleanup
  - Sand trap
  - Three-phase separator
- Use portable desiccant dehydrator for workovers requiring glycol dehydrator maintenance



Temporary, Mobile Surface Facilities Schematic
Source: BP

Methane to Markets

Green Completions: Requirements

- Must have permanent equipment on site before workover or cleanup
  - Piping connection to sales line
  - Dehydrator
  - Lease meter
  - Stock tank
- Sales line gas can be used for fuel and/ or for gas lift operations and techniques in low pressure wells

Methane to Markets

Green Completions: Low Pressure Wells

- Can use portable compressors to start up well when reservoir pressure is low
  - Artificial gas lift to clear fluids
  - Boost gas to sales line
- Higher cost to amortize investment in portable equipment

Portable Compressors, Separator and Other Equipment on a trailer

Source: Herald

Methane to Markets

Is Recovery Profitable?

- U.S. companies report recovering an average of 53% of total gas lost during well completions and workovers
- Estimate an average of 3,000 Mcf[1] of natural gas can be recovered from each green completion
- Estimate 1 to 580 barrels of condensate can be recovered from each green completion

[1]Values for high pressure wells

Green Completions: Benefits

- Reduced methane emissions during completions and workovers
- Sales revenue from recovered gas and condensate
- Improved relations with government agencies and public neighbors
- Improved safety
- Reduced disposal costs

Industry Experience: BP in U.S.

- Capital investment about $1.4 million on portable three-phase separators, sand traps, and tanks
- Used Green Completions on 106 wells
- Total natural gas recovered: about 350 MMcf per year
- Total condensate recovered: about 6,700 barrels per year

Industry Experience: BP in U.S.

- Total value of natural gas and condensate recovered: about $840,000[1,2] per year
- Investment recovered in just over 2 years

[1]Value of natural gas at $1.99 per thousand cubic feet

[2]Value of condensate at $22 per barrel

Three Phase Separator, Source: BP

Weatherford Durango Experience

- Successfully completed pilot project in the Fruitland coal formations in Durango, Colorado, U.S.
  - Well depth: 2,700 to 3,200 feet
  - Pore pressure: estimated at 80 pounds per square inch gauge (psig)
  - Well type: coal bed methane
  - Hole size: 5 ½ inches
  - Number of wells: 3 well pilots
- Captured 2 million cubic feet of gas which was sold by the operator

Weatherford Portable Equipment

Weatherford Green Completions

- Use pipeline gas with proprietary foaming agent as compressible fluid to initiate cleanout
- System includes
  - Wet screw compressor when well pressure is less than 80 pounds per square inch gauge (psig)
  - Booster compressor, three-phase separator and sand trap
- Estimate cleanup pressure of 300 to 400 psig at a well depth of 8,000 feet
- Suggest use in all kinds of completion and workover cleanup operations

Methane to Markets

Discussion Questions

- To what extent are you implementing this opportunity?
- Can you suggest other approaches for reducing well completion venting?
- How could this opportunity be improved upon or altered for use in your operation?
- What are the barriers (technological, economic, lack of information, regulatory, focus, manpower, etc.) that are preventing you from implementing this practice?

Methane to Markets

Methane Losses: Well Blowdowns

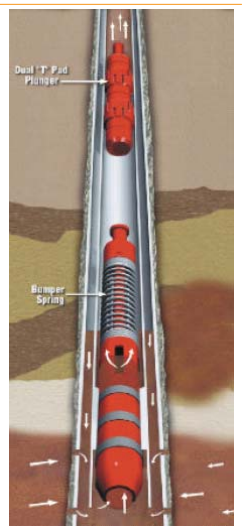
- Accumulation of liquid hydrocarbons or water in the well bores reduces, and can halt, production
- Common “blow down” practices to temporarily restore production can vent 80 to 1,600 Mcf per year[1] to the atmosphere per well

[1]Mobil Big Piney Case Study 1997

Methane to Markets

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 cannot lift fluid to top
    - May have to vent to atmosphere to lift plunger



Source: Weatherford

Methane to Markets

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
- Requires manual venting to atmosphere when plunger lift is overloaded

Smart Automation Well Venting

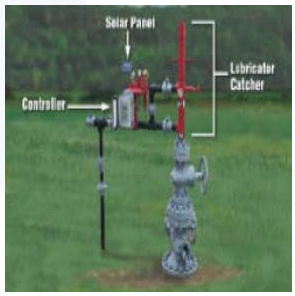
- Automation can enhance the performance of plunger lifts by monitoring wellhead parameters such as:
  - Tubing and casing pressure
  - Flow rate
  - Plunger travel time
- Using this information, the system is able to optimize plunger operations
  - To minimize well venting to atmosphere
  - Recover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

Methane to Markets

Automated Controllers



Source: Weatherford

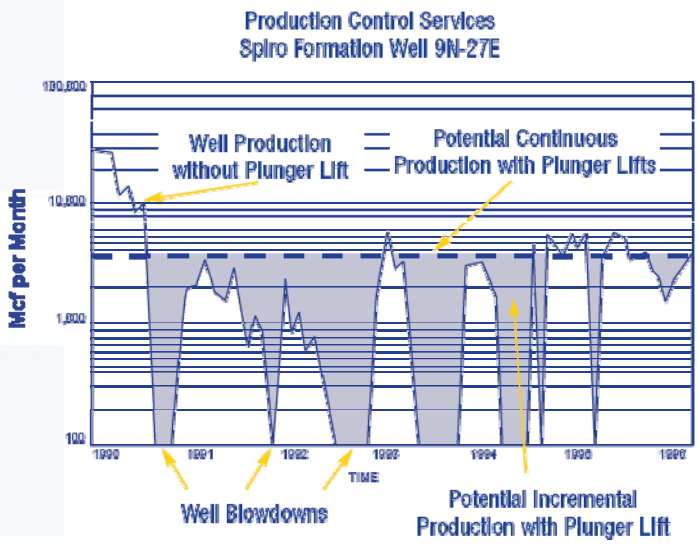
- Low-voltage; solar recharged battery power
- Monitor well parameters
- Adjust plunger cycling

Source: Weatherford

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

Methane to Markets

Plunger Lift Cycle



Methane to Markets

Methane Savings

- Methane emissions savings is 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 per year methane emissions savings for average U.S. well

[1]Reported by Weatherford

Methane to Markets

Other Benefits

- Reduced manpower cost per well
- Continuously optimized production conditions
- Remotely identify potentially unsafe operating conditions
- Monitor and log other well site equipment
  - Glycol dehydrator
  - Compressor
  - Stock tank
  - Vapor recovery unit

Methane to Markets

Is Recovery Profitable?

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

- Savings =

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

$ savings per year

Methane to Markets

Economic Analysis

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

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

$35,000 savings in first year

3 month simple payback

Methane to Markets

U.S. Industry Experience

- BP reported installing plunger lifts with automated control systems on about 2,200 wells
  - 900 Mcf reported annual savings per well
  - $12 million costs including equipment and labor
  - $6 million total annual savings
- Another company shut in mountaintop wells inaccessible during winter
  - Installed automated controls allowed continuous production throughout the year[1]

[1]Morrow, Stan and Stan Lusk, Ferguson Beauregard, Inc. Plunger-Lift: Automated Control Via Telemetry. 2000.

Methane to Markets

Project Summary for Mexico

- Reduced Emissions Completions

Project Description: Performing a reduced emissions completion on one high pressure well

Methane Saved:	3.3 MMcf per year per well (93.5 thousand cubic meters per well)
Sales Value:	$17,300 ($5.25 per Mcf gas)
Capital and Installation Cost[1]:	($770) per well per day (rental cost)
Operating and Maintenance Cost:	$10 per well per day
Payback Period:	17 months

Additional Carbon Market Value:	$40,000 ($30 per tonne of CO_2e)

[1]One well is completed in about 30 days

Project Summary for Mexico

- Smart Automation Well Venting

Project Description: Install one smart automated well controller on a well to increase production rate

Methane Saved:	500 Mcf per year (14 thousand cubic meters per year)
Sales Value:	$2,600 ($5.25 per Mcf gas)
Capital and Installation Cost:	($11,000)
Operating and Maintenance Cost:	($1,950) per well
Payback Period:	60 months

Additional Carbon Market Value:	$6,000 ($30 per tonne of CO_2e)

Discussion Questions

- To what extent are you implementing this opportunity?
- Can you suggest other approaches for reducing well venting?
- How could this opportunity be improved upon or altered for use in your operation?
- What are the barriers (technological, economic, lack of information, regulatory, manpower, etc.) that are preventing you from implementing this practice?

Reference: Unit Conversions

1 cubic foot =	0.02832 cubic meters
Degrees Fahrenheit =	(°F – 32) * 5/9 degrees Celsius
1 inch =	2.54 centimeters
1 mile =	1.6 kilometers
14.7 pounds per square foot =	1 atmosphere