Reduced Emission Completions
(Green Completions)

Lessons Learned from Natural Gas STAR

Producers Technology Transfer Workshop
Marathon Oil and EPA’s Natural Gas STAR Program
Houston, TX
October 26, 2005
Green Completions: Agenda

- Methane Losses
- Methane Recovery
- Is Recovery Profitable?
- Industry Experience
- Discussion Questions
Methane Losses
During Well Completions

★ It is necessary to clean out the well bore and formation surrounding perforations
  ◆ After new well completion
  ◆ After well workovers
★ 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
Methane Losses: Well Completions and Workovers

☆ An estimated 45.5 Bcf of natural gas lost annually due to well completions and workovers\(^1\)
  - 45,000 MMcf in losses from high pressure wells
  - 319 MMcf in losses from low pressure wells
  - 48 MMcf in losses from workovers

☆ An estimated total of 480,000 Bbl condensate lost annually due to venting and flaring

☆ This amounts to over $145 million lost due to well completions and workovers

Note:
- \(^1\)Percentage that is flared and vented unknown
- Value of natural gas at $3/Mcf
- Value of condensate at $22/bbl
Methane Recovery by Green Completions

- Green completions recover natural gas and condensate produced during well completions or workovers
- Use portable equipment to process gas and condensate suitable for sales
- Direct recovered gas through permanent dehydrator and meter to sales line, reducing venting and flaring
- An estimated 25.2 Bcf of natural gas can be recovered annually using Green Completions
  - 25,000 MMcf from high pressure wells
  - 181 MMcf from low pressure wells
  - 27 MMcf from workovers
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,
Source: BP

Reducing Emissions, Increasing Efficiency, Maximizing Profits
Green Completions: Preconditions

- Must have permanent equipment on site before cleanup
  - Piping from well-head to sales line
  - Dehydrator
  - Lease meter
  - Stock tank

- Sales line gas can be used for fuel and/or gas lift in low pressure wells
Green Completions: Low Pressure Wells

- Can use portable compressors to start-up the 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
Is Recovery Profitable?

- Partners report recovering 2% - 89% (average of 53%) of total gas produced during well completions and workovers.

- Estimate 7- 12,500 Mcf (average of 3,000 Mcf) of natural gas can be recovered from each cleanup.

- Estimate 1- 580 Bbl of condensate can be recovered from each cleanup.

Note: 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 state agencies and public neighbors
- Improved safety
- Reduced disposal costs
BP Experience

★ Capital investment ~ $1.4 million on portable three-phase separators, sand traps and tanks

★ Used Green Completions on 106 wells

★ Total natural gas recovered ~ 350 MMcf/year

★ Total condensate recovered ~ 6,700 Bbl/year
**BP Experience**

- Total value of natural gas and condensate recovered ~ $840,000 per year
- Investment recovered in 2+ years

Note:
- Value of natural gas at $1.99/Mcf
- Value of condensate at $22/bbl
Weatherford Durango Experience

✔ Successfully completed pilot project in the Fruitland coal formations in Durango, Colorado

◆ 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
◆ No. of wells: 3 well pilots

☆ Captured 2 MMcf of gas and sold by client
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 psig
  ◆ Booster compressor, three phase separator and sand trap

★ Estimate cleanup pressure of 300 to 400 psig at a well depth of 8000 feet

★ Suggest use in all kinds of completion and workover cleanup operations
Discussion Questions

- To what extent are you implementing this opportunity?
- Can you suggest other approaches for reducing well venting?
- How could these opportunities 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?