Reducing Methane Emissions from Production Wells: Reduced Emission Completions

Lessons Learned from the
Natural Gas STAR Program

IOGCC
Marcellus Shale Basin Producers
Technology Transfer Workshop

Penn State, Pennsylvania
November 18, 2009

epa.gov/gasstar

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Agenda

- **Reduced Emissions Completions**
  - Methane Losses
  - Methane Recovery
  - Is Recovery Profitable?
  - Partner Experience
- **Discussion**

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Methane Losses During Gas Well Completions

- Gas wells in tight formations and coal beds require hydraulic fracture
- It is necessary to clean out the well bore and formation
  - After new completion
  - After well refracturing workovers
- Operators produce to an open pit or tank to collect sand, cuttings, and fluids for disposal
- Vent or flare the natural gas produced
- 67 Bcf[1] of gas is vented or flared from completions and workovers in the U.S. resulting in 27 Bcf of methane emissions

Williams E&P, Glenwood Springs, CO

1 – EPA estimate.

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Methane Recovery by Reduced Emission Completions

- Recover natural gas and condensate produced during flow-back following hydraulic fracture
- Portable equipment separates sand and water, processes gas and condensate for sales
- Route recovered gas through dehydrator and meter to sales line, reducing venting and flaring

Portable REC Equipment

Source: Weatherford

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Reduced Emission Completions: Preconditions

- Permanent equipment required on site before cleanup
  - Piping from well head to sales line
  - Dehydrator
  - Lease meter
  - Stock tanks for wells producing significant amounts of condensate
- Sales line gas can be used for compressor fuel and/ or gas lift in low pressure wells

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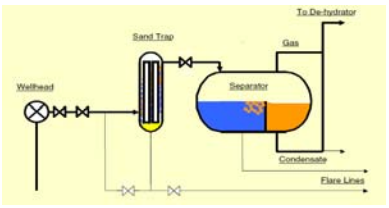
Reduced Emission Completions: Equipment

- Skid or trailer mounted portable 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

Source: Williams

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Reduced Emission Completions: Low Pressure Wells

- Partners and vendors are perfecting the use of portable compressors when pressure in reservoir is too low to enter sales line
  - Artificial gas lift to clear fluids
  - Boost gas to sales line
  - Manage slug flow
  - Adds cost to project

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Reduced Emission Completions: Benefits

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

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Is Recovery Profitable?

- Partners report recovering 2% - 89% (average of 53%) of total gas produced during well completions and workovers
- Estimate 7,000 – 12,500 Mcf of natural gas can be recovered from each cleanup
  - $50,000 to $85,000 savings at $7/Mcf
- Estimate 1 – 580 barrels of condensate can be recovered from each cleanup
  - Up to $30,000 additional revenue at $50/barrel
- Incremental contracted cost of typical REC is $700 to $6,500/day for 3 to 10 days of well cleanup
- Purchase of REC equipment costs $500,000
  - Payback in 3 to 5 months for 25 well/year drilling program
  - Assuming gas prices of $7, $5 and $3/Mcf, respectively

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REC Partner Experience: BP

- Capital investment of about $500,000 per skid on portable three-phase separators, sand traps, and tanks in the Rocky Mountain Region
- Used Green Completions on 106 wells
- Total natural gas recovered about 350 MMcf/year
  - 3.3 MMcf per well average
    - Conservative net value of gas saved is $20,000 per well[1]
- 6,700 barrels/year condensate recovered
- 1.5 year payback based on British Petroleum's prices for natural gas and condensate

[1] Natural gas valued by company to be $7/Mcf

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REC Partner Experience: BP

- Through the end of 2005 British Petroleum reports
  - 4.1 Bcf of gas and
  - 53,000 barrels of condensate recovered

Portable Three Phase Separator, Source: BP

[1] Combination of activities in Montana and Wyoming, U.S.

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REC Partner Experience: Williams

- Williams Fork Formation (Piceance Basin) – low permeability, tight, lenticular sandstone (10% porosity, permeability range of 1 to 10 microdarcies.
- Wells drilled to depths of 6,500 ft to 9,000 ft
- Flow pressures range from 1,500 to 2,500 psi
- Fracture stimulation needed to make wells economical
- Frac about 5 to 6 stages per well
- Breco Flowback skids used to separate sand, water and gas during initial flowback
- Breco Flowback skid resides on typical 4 well pad for 32 days

[1] Natural gas valued by company to be $7/Mcf

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REC Partner Experience: Williams

How Breco Works?

- Sand Vessel separates sand from backflow fluids
- Gas Vessel separates gas from water used for hydraulic fracturing
  - Gas routed to sales line
- Sand is dumped to reserve pit manually
- Water dumps to holding tanks automatically
  - Water is filtered and reused for future frac jobs
- Flowback skid operates at 20 to 40 psi greater than gas gathering line pressure which is about 260 to 320 psi in Piceance Basin

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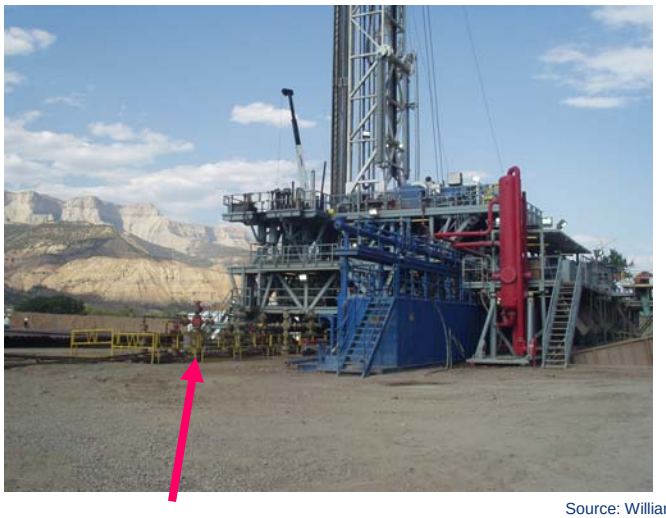
REC Partner Experience: Williams



Source: Williams

Two rows of four wells closely spaced.

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REC Partner Experience: Williams

Source: Williams

Two pair of sand and gas separators.

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REC Partner Experience: Williams

AVERAGE PER WELL FLOWBACK STATISTICS	
Average Number of Days of Flowback =	32
Average MMcf Gas Recovered During Flowback =	23
Average MMcf Gas Flowback Recovered/Day =	0.71
Average Revenue Per Flowback ($) =	$139,941
Average Cost Drill/Complete Well ($) =	$1.3 to $1.5 MM
Average Cost Per Flowback ($) =	$11,855
Average Net Saving Per Flowback ($) =	$129,510
CH_4 recovered in 2005 = Estimated Mean Methane Concentration Gas: 89.043 vol. %	5982 MMscf or 16 MMscf/day

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Discussion Questions

- What industry experiences do you have applying these technologies and practices?
- What are your limitations on applying these technologies and practices?
- Actual costs and benefits

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