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

Agenda

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

\(^1\) – EPA estimate.

Williams E&P, Glenwood Springs, CO

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
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

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
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

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
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

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
- 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
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](image)

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

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
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

Two rows of four wells closely spaced.

Source: Williams
REC Partner Experience: Williams

Two pair of sand and gas separators.

Source: Williams

Estimated Mean Methane Concentration Gas: 89.043 vol. %

AVERAGE PER WELL FLOWBACK STATISTICS

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Number of Days of Flowback</td>
<td>32</td>
</tr>
<tr>
<td>Average MMcf Gas Recovered During Flowback</td>
<td>23</td>
</tr>
<tr>
<td>Average MMcf Gas Flowback Recovered/Day</td>
<td>0.71</td>
</tr>
<tr>
<td>Average Revenue Per Flowback ($)</td>
<td>$139,941</td>
</tr>
<tr>
<td>Average Cost Drill/Complete Well ($)</td>
<td>$1.3 to $1.5 MM</td>
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<tr>
<td>Average Cost Per Flowback ($)</td>
<td>$11,855</td>
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<tr>
<td>Average Net Saving Per Flowback ($)</td>
<td>$129,510</td>
</tr>
<tr>
<td>CH₄ recovered in 2005 =</td>
<td>5982 MMscf or 16 MMscf/day</td>
</tr>
<tr>
<td>Estimated Mean Methane Concentration Gas:</td>
<td>89.043 vol. %</td>
</tr>
</tbody>
</table>
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