Reducing Methane Emissions from Production Wells: Reduced Emission Completions

Lessons Learned from the Natural Gas STAR Program

Producers Technology Transfer Workshop

ConocoPhillips Petroleum Company, New Mexico Environment Department, New Mexico Oil & Gas Association

Farmington, New Mexico
May 11, 2010

Agenda

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

- Discussion
U.S. Production Sector Methane Emissions (2007)

Note: Bcf = billion cubic feet

Well Venting and Flaring 86 Bcf

Storage Tank Venting 27 Bcf

Other Sources 5 Bcf

Pneumatic Devices 79 Bcf

Dehydrators and Pumps 3 Bcf

Compressors 12 Bcf

Meters and Pipeline Leaks 8 Bcf

Offshore Operations 29 Bcf


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
- 54 Bcf\(^1\) of methane is vented or flared from completions and workovers in the U.S., 27 Bcf of methane is emitted

1 – EPA estimate – well completions and workovers only.
Bcf = billion cubic feet
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

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

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

Source: Herald
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 thousand cubic feet (Mcf) of natural gas can be recovered from each cleanup
  - $50,000 to $85,000 savings at $7/Mcf
- Estimate 1 – 580 barrels (bbls) 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 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 million cubic feet per year (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

Through the end of 2005 British Petroleum reports:

- 4.1 Bcf of gas and
- 53,000 barrels of condensate recovered

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

Piceance Well Completions

- Well Completion Type = Mechanical Isolation
- Perforate casing prior to Stage 1 – makes fracture stimulation possible
- Frac Stage 1
- Flow back well, first 12 hours is water, afterwards routed to BRECO skid
- Set plug to isolate frac stage
- REPEAT for each stage (avg. 5 to 6 stages/well)
- Plugs drilled out by workover rig
- Producing to flowback skid after frac’ing and before plugs drilled out
REC Partner Experience: Williams

BRECO Flowback Skid

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
REC Partner Experience: Williams

Flowback Skid – When Is It Used?

- Used after each zone is fracture stimulated (frac’d)
- Used when all zones are fractured and waiting for workover rig to drill out plugs for final completion (Up to 10 days)
- Production well must be located near gathering system
- Wildcat and step-out wells are not completed with Green Completion Technology
- One Month = time wells at typical 4-well pad are routed to flowback skid

Two rows of four wells closely spaced.

Source: Williams
Green Completion Economics

<table>
<thead>
<tr>
<th>AVERAGE PER WELL FLOWBACK STATISTICS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Number of Days of Flowback =</td>
</tr>
<tr>
<td>Average MMcf Gas Recovered During Flowback =</td>
</tr>
<tr>
<td>Average MMcf Gas Flowback Recovered/Day =</td>
</tr>
<tr>
<td>Average Revenue Per Flowback ($) =</td>
</tr>
<tr>
<td>Average Cost Drill/Complete Well ($) =</td>
</tr>
<tr>
<td>Average Cost Per Flowback ($) =</td>
</tr>
<tr>
<td>Average Net Saving Per Flowback ($) =</td>
</tr>
<tr>
<td>CH₄ recovered in 2005 =</td>
</tr>
</tbody>
</table>

Estimated Mean Methane Concentration Gas: 89.043 vol. %

Conclusions

- Reduces methane emissions, a potent greenhouse gas (GHG)
- Well completion type determines viability of green completion technologies
- Produced water and stimulation fluids from green completions are recycled
- Eliminates emissions, noise and citizen complaints associated with flaring
- Increases economic value added
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