Reducing Methane Emissions During Completion Operations

2006 Natural Gas STAR Annual Implementation Workshop

Houston, TX
October 24, 2006
Reducing Methane Emissions during Completion Operations

Williams Production RMT – Piceance Basin Operations

**Agenda**
- Objectives
- Piceance Basin Well Completion Process Description
- Equipment Needed
- Economics
- Conclusion
Objectives:

- Virtually eliminate venting of natural gas produced during new well completions.
- Capture produced gas and deliver to sales.
- Meter produced gas for revenue distributions.
- Ensure safety of personnel during entire process.
Piceance Basin Well Completions

- Williams Fork Formation – low permeability, tight, lenticular sandstone
- 10-acre Spacing
- Wells drilled to depths of 6,500 ft to 9,000 ft.
- Reservoir pressures as high as 4000 psi.
- Fracture stimulation required to make wells economical.
- Typically fracture stimulate 5 to 6 separate stages per well.
Piceance Basin Well Completions

- Perforate casing prior to Stage 1 – makes fracture stimulation possible
- Fracture Stimulate Stage 1. Flowback until next step.
- Shut in well. Set casing plug to isolate next stage to be fracture stimulated.
- REPEAT for each stage (avg. 5 to 6 stages/well)
- Once fracture stimulations are done, all of the plugs are drilled out using a Workover Rig.
- Stimulation fluids and gas are produced while plugs are drilled out.
- Drillout phase is when most of the gas is vented.
Sand Flowback Problems

WASHOUT
Green Completions

- Technology used to recover gas that is otherwise vented or flared during the completion phase of natural gas well.

- Williams designed equipment to handle high pressure, high rate flowback fluids so as to safely handle and to sell the natural gas produced during flowback period.

- Flowback equipment is used to separate sand, water and gas during initial flowback.
Flowback Unit

Sand Vessel

Gas Vessel
Flowback Unit - Operation

- Sand Vessel separates sand from flowback liquids.
- Sand is dumped to reserve pit. Gas and Liquids dump to the Gas Vessel.
Flowback Unit - Operation

- Gas Vessel separates gas from water used for fracture stimulation.
  - Gas routed to sales line.
- Water dumps to holding tanks automatically
  - Water is filtered and reused for future fracture stimulation jobs.
- Vessels operate at 275 to 300 psi.
Risks

Safety – Primary Concern

- High pressure gas, liquids and sand can erode steel pipe.
- To mitigate safety concerns:
  - Pipe, Fittings and Vessels use high strength metal
  - Flowback Units are monitored 24/7.
Simultaneous Operations

Drilling
Completion
Drillout
Production
Risks

Operations & Reservoir Risks

- Fluids pumped downhole must be recovered as quickly as possible
- Wellbore damage by fluids can diminish production
- Flowing fluids to flowback skid results in decreased flowback rates because of high backpressure (versus no backpressure when venting)
## Economics – Volume Recovered

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Number of Well Spuds</th>
<th>No. of Spuds Not Completed or Completed Without Flowback</th>
<th>Actual Number of Flowback Completions</th>
<th>Actual Completion Gas Generated (MMCF)</th>
<th>Actual Completion Gas Vented/Flared (MMCF)</th>
<th>Flowback Gas Recovered (MMCF)</th>
<th>Flowback Gas Recovered (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>75</td>
<td>14</td>
<td>61</td>
<td>599</td>
<td>112</td>
<td>487</td>
<td>81.3%</td>
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<tr>
<td>2003</td>
<td>80</td>
<td>9</td>
<td>71</td>
<td>1348</td>
<td>152</td>
<td>1196</td>
<td>88.8%</td>
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<tr>
<td>2004</td>
<td>253</td>
<td>34</td>
<td>219</td>
<td>5635</td>
<td>757</td>
<td>4878</td>
<td>86.6%</td>
</tr>
<tr>
<td>2005</td>
<td>302</td>
<td>0</td>
<td>302</td>
<td>6718</td>
<td>0</td>
<td>6718</td>
<td>100.0%</td>
</tr>
<tr>
<td>2006*</td>
<td>445</td>
<td>0</td>
<td>445</td>
<td>9740</td>
<td>0</td>
<td>9740</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

* - Forecasted

Prior to “Green Completions” only 88% of the Completion gas was recovered.
Economics – Savings Realized

Vent/Flare Volumes with and without Green Completions

1.8 BCF would have been vented/flared if Green Completions were not used.

1.0 BCF of completion gas vented or flared since 2002.
## Flowback Revenue/Cost Analysis

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Revenue (MM$)</th>
<th>Recovery Cost (MM$)</th>
<th>Net Savings (MM$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>1.28</td>
<td>0.22</td>
<td>1.06</td>
</tr>
<tr>
<td>2003</td>
<td>6.32</td>
<td>0.89</td>
<td>5.43</td>
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<tr>
<td>2004</td>
<td>27.87</td>
<td>2.85</td>
<td>25.02</td>
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<tr>
<td>2005</td>
<td>42.68</td>
<td>6.72</td>
<td>35.96</td>
</tr>
<tr>
<td>2006*</td>
<td>50.06</td>
<td>11.38</td>
<td>38.68</td>
</tr>
</tbody>
</table>

* - Forecasted
Conclusion

- Reduces methane emissions, a potent Green House 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
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