Williams Experience in Methane Emissions Mitigation

Producers and Processors Technology Transfer Workshop

Western Gas Resources and EPA’s Natural Gas STAR Program
Rock Springs, WY
May 11, 2006
Reduced Emission Completions (Green Completions)

Agenda
- Green Completions
- Flowback Skids
- Piceance Basin Well Completions
- Green Completion Economics
- Conclusion
Green Completions

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

At Williams, Green Completion technology is a flowback separator skid leased from Breco

Flowback skids used to separate sand, water and gas during initial flowback
Breco Flowback Skid
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
Flowback Skid - Operation

- Sand Vessel separates sand from field gas
- Gas Vessel separates gas from water used for hydraulic frac’ing
  - 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
Flowback Skid – Wellhead Equipment
Flowback Skid – Reserve Pit and Water Holding Tanks
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
Piceance Well Completions

- Williams Fork Formation – 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 Skid resides on typical 4 well pad for 32 days
Piceance Well Completions

Risks Associated with Green Completions

1 – Wellbore/Reservoir Risk

- Fluids pumped downhole must be recovered as quickly as possible
- Flowing fluids to flowback skid results in decreased flowback rates
- Wellbore damage by fluids can diminish production

2 – Operational Risk

- When plugs drilled out well flows to remove produced sand and lift fluids used during frac.
- Flowing to Breco skid increases backpressure/decreases flow rates
Piceance Well Completions

Risks Associated with Green Completions, con’t

3 – Safety

- Flowing gas, condensate, water, and sand during completion can cause pipe and vessel washouts
- Elbows reinforced with high strength metal
- Breco person visits each location every 1 to 1.5 hrs to identify leaks before they become washouts
Flowback Skid – Washout Safety Feature
Flowback Skid - Safety

WASHOUT
## Green Completion Economics

<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 (MMscf)</th>
<th>Actual Completion Gas Vented/Flared (MMscf)</th>
<th>Flowback Gas Recovered (MMscf)</th>
<th>Flowback Gas Recovered (%)</th>
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</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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<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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<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>
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<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>
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<tr>
<td>Total</td>
<td>710</td>
<td>58</td>
<td>653</td>
<td>14300</td>
<td>1021</td>
<td>13279</td>
<td>92.9</td>
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## 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>
<th>Actual Methane Generated (MMscf)</th>
<th>Flowback Methane Recovered (MMscf)</th>
<th>Potential Methane Flared (MMscf)</th>
<th>Potential Methane Vented (MMscf)</th>
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<tbody>
<tr>
<td>2002</td>
<td>1.28</td>
<td>.22</td>
<td>1.06</td>
<td>533</td>
<td>434</td>
<td>89</td>
<td>11</td>
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<tr>
<td>2003</td>
<td>6.32</td>
<td>.99</td>
<td>5.43</td>
<td>1200</td>
<td>1065</td>
<td>120</td>
<td>15</td>
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<tr>
<td>2004</td>
<td>27.87</td>
<td>2.85</td>
<td>25.02</td>
<td>5018</td>
<td>4344</td>
<td>600</td>
<td>74</td>
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<tr>
<td>2005</td>
<td>42.68</td>
<td>6.72</td>
<td>35.96</td>
<td>5982</td>
<td>5982</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Total</td>
<td>78.15</td>
<td>10.68</td>
<td>67.48</td>
<td>12733</td>
<td>11824</td>
<td>809</td>
<td>100</td>
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### Green Completion Economics continued

<table>
<thead>
<tr>
<th><strong>AVERAGE PER WELL FLOWBACK STATISTICS</strong></th>
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<tbody>
<tr>
<td>Average Number of Days of Flowback</td>
<td>32</td>
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<tr>
<td>Average MMcf Gas Recovered During Flowback</td>
<td>23</td>
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<tr>
<td>Average MMcf Gas Flowback Recovered/Day</td>
<td>.71</td>
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<td>Average Revenue Per Flowback ($)</td>
<td>$139,941</td>
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<td>Average Cost Drill/Complete Well ($)</td>
<td>$1.3 to $1.5 MM</td>
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<td>Average Cost Per Flowback ($)</td>
<td>$11,855</td>
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<td>Average Net Saving Per Flowback ($)</td>
<td>$129,510</td>
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**\( \text{CH}_4 \) recovered in 2005** = 5982 MMscf or 16 MMscf/day

**Estimated Mean Methane Concentration Gas:** 89.043 vol. %
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
Contacts

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