Methane to Markets

Transmission Pipeline Opportunities

Advancing Project Development in India through Public Private Partnerships

22 – 23 February, 2007
Pipeline Maintenance and Repair: Agenda

- Methane Losses from Pipeline Maintenance
- Hot Taps
- Composite Wrap
- Pipeline Pumpdowns
- Pipeline Pigging
- Discussion Questions
Methane Losses from Current Pipeline Maintenance Practices

- Natural gas is often vented to the atmosphere when performing pipeline repairs and new connections
  - Up to 56,600 m$^3$ natural gas vented when making a new connection
  - Up to 170,000 m$^3$ natural gas vented when replacing pipe that has non-leaking, external damage

- These practices result in methane emissions
  - Loss of sales
  - Service disruption and customer inconvenience
  - Costs of evacuating the existing piping system

*pipelines ranging from 4 to 18 inches (10 – 46 centimeters) diameter operating at 100 to 1,000 pounds per square inch gauge pressure (7.8 – 69 atmospheres)*
Methane Losses from Major Repairs

- Not always possible to repair a pipeline without taking it out of service
- Major pipeline repairs often involve closing off the repair area and venting gas to the atmosphere
  - Major repairs
  - Internal corrosion
  - Leak repairs
  - Installing large connections
- 850 to 170,000 m$^3$ natural gas vented to the atmosphere with each repair

*pipelines ranging from 4 to 18 inches (10 – 46 cm) diameter operating at 100 to 1,000 pounds per square inch gauge pressure (7.8 – 69 atm)
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Hot Taps for New Connections

- Connecting pipelines without service disruption or methane emissions

Source: Williamson Industries Inc.
Hot Tapping Procedure

- Connect branch fitting and permanent valve on the existing pipeline while in service
- Install hot tapping machine on the valve
- Cut through pipeline wall and extract coupon through the valve
- Close valve and remove hot tapping machine
- Connect branch line
Hot Tap Benefits

- Continuous system operation – shutdown and service interruptions are avoided
- No gas released to the atmosphere
- Avoided cutting, realignment and re-welding of pipeline sections
- Avoid inerting / gas freeing pipeline section for hot work
- Reduced planning and coordination costs
- Increased worker safety
## Project Summary for India

- Using hot taps for in-service pipeline connections

### Project Description:
Using hot taps for 320 in-service pipeline connections (305 small taps and 15 large taps)

<table>
<thead>
<tr>
<th>Methane Saved:</th>
<th>691,000 cubic meters per year (24,400 Mcf per year)</th>
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</thead>
<tbody>
<tr>
<td>Sales Value(^1):</td>
<td>$73,200</td>
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<tr>
<td>Capital and Installation Cost(^2):</td>
<td>($57,800)</td>
</tr>
<tr>
<td>Operating and Maintenance Cost(^3):</td>
<td>($1,800) per year</td>
</tr>
<tr>
<td>Payback Period:</td>
<td>10 months</td>
</tr>
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</table>

\(^1\) – Gas price in India $3/Mcf ($106/thousand m\(^3\))

\(^2\) – All costs have been converted to an Indian basis using the methodology described in *US Natural Gas STAR program success points to global opportunities to cut methane emissions cost-effectively*, Oil and Gas Journal, July 12, 2004

\(^3\) – O&M Cost for purchased small hot tap equipment and contract service cost for larger taps.
Pipeline Maintenance and Repair: Agenda

- Methane Losses from Pipeline Maintenance
- Hot Taps
- **Composite Wrap**
- Pipeline Pumpdowns
- Pipeline Pigging
- Discussion Questions
Composite Wrap for External Repair

- Permanent On-Line Pipeline Repair Technology

Source: Duke Energy
Composite Wrap: What Are They?

- 1) A high-strength glass fiber composite or laminate
- 2) An adhesive or resin bonding system
- 3) A high-compressive-strength load transfer filler compound

Source: Clock Spring® Company L. P.
Composite Wrap Installation

- After excavation and pipe preparation
  - External defects filled with filler
  - Composite wrap wound around pipe with adhesive or laminating agents
  - Typically 5 centimeters (2 inches) of wrap must extend beyond damage
  - Excavation site refilled after curing time

- Reducing pressure improves quality of repair

Source: Armor Plate
Composite Wrap Lessons Learned

- Trained but not skilled crafts persons required
- Specialized welding and lifting equipment not required
- Minimizes access concerns
- No delays awaiting metal sleeve
- Cathodic protection remains functional
- Proven permanent repair for external defects
- Temporary repair for internal faults
- In-service pipeline repair methodology
- Ideal for urgent and quick repair
- Avoid service disruptions
- Cost-effective
Clock Spring® was tested on a 61 centimeter (24 inch) diameter pipeline affected by external damage.

- Pipeline had 75% diameter deflection and a defect length of 1.83 meters (6 feet).
- Clock Spring® used 87 ten centimeter (four inch) wide wrap kits and 150 filler kits to repair the damage.
- Clocks Spring® wrap passed pressure cycles lasting 15 minutes at pressures up to 1800 pounds per square inch gauge (psig) *

* 1800 psig = 123 atm
Project Summary for India

- Composite wrap for repair of non-leaking pipeline defects

Project Description: Using composite wrap to repair a 15 centimeter (6 inch) pipeline defect

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Methane Saved:</td>
<td>105,000 cubic meters per year (3,690 Mcf per year)</td>
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<td>Sales Value(^1):</td>
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<tr>
<td>Capital and Installation Cost(^2):</td>
<td>($5,800)</td>
</tr>
<tr>
<td>Operating and Maintenance Cost(^2):</td>
<td>($0) per year</td>
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<tr>
<td>Payback Period:</td>
<td>6 months</td>
</tr>
</tbody>
</table>

1 – Gas price in India $3/Mcf ($106/thousand m\(^3\))

2 – All costs have been converted to an Indian basis using the methodology described in *US Natural Gas STAR program success points to global opportunities to cut methane emissions cost-effectively*, Oil and Gas Journal, July 12, 2004
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Pipeline Pumpdown

- Minimizing emissions when you must cut out a section of pipeline

Source: Duke Energy
Methane Recovery by Pipeline Pumpdown

- Use in-line compressors to “pull down” the pressure to minimum suction pressure
- Use portable compressor to “pull down” pressure even further
- Cost is justified by immediate payback in gas savings
- About 90% of gas usually vented is recoverable
Sequence of Depressurization Events

1. Identify Pipeline Segment Needing Repair
   - Pipeline
   - Compressor Block Valve Open
   - Compressor Block Valve Open
   - Pipeline

2. Depressurize Segment by 50% Using In-line Pipeline Compressor
   - Pipeline
   - Compressor Block Valve Closed
   - Compressor Block Valve Open
   - Pipeline

3. Depressurize Segment Further to 90% Using Portable Compressor In Sequence With an In-line Compressor
   - Pipeline
   - Compressor Block Valve Closed
   - Compressor Block Valve Closed
   - Pipeline
   - Portable Compressor

Legend:
- Normal pipeline pressure
- Pipeline with pressure reduced to 50%
- Pipeline with pressure reduced to 90%
Pipeline Pumpdown Equipment

- **In-line pipeline compressor**
  - Typically has compression ratio of 2 to 1
  - Blocking upstream valve reduces pipeline pressure to safe limits for maintenance

- **Portable compressor**
  - Typically has compression ratio of 5 to 1
  - Can be used in conjunction with in-line compressor to further reduce pressure in the pipeline section
  - Justifiable only when multiple sections of pipeline are to be serviced (i.e. long sections of maintenance or pipeline valve station maintenance where stopples are not feasible)
Economics of Pipeline Pumpdown

- Calculate gas vented to atmosphere by depressuring pipeline
- Calculate gas saved with in-line compressors
- Calculate gas saved with portable compressor
  - Consider cost of a portable compressor
  - O&M costs of a portable compressor
  - Consider fuel costs for operating portable compressor
- Calculate the difference in gas savings
Project Summary for India

- Using pipeline pump-down techniques to lower gas line pressure before maintenance

Project Description: Performing a pump-down four times per month on a 76 cm (30 inch) pipeline at 600 psig with a portable compressor

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
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<tr>
<td>Methane Saved</td>
<td>7,500,000 cubic meters per year</td>
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<td></td>
<td>(265,000 Mcf per year)</td>
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<tr>
<td>Sales Value 1</td>
<td>$795,000</td>
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<td>Fuel Cost 2</td>
<td>($9,900) per year</td>
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<td>Lease and Maintenance Cost 3</td>
<td>($454,000) per year</td>
</tr>
<tr>
<td>Payback Period</td>
<td>7 months</td>
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</table>

1 – Gas price in India $3/Mcf ($106/thousand m³)
2 – Fuel cost is based on consuming 1,950 m³ (69 Mcf) of gas per application at $3/Mcf ($106/thousand m³)
3 – All costs have been converted to an Indian basis using the methodology described in US Natural Gas STAR program successes points to global opportunities to cut methane emissions cost-effectively, Oil and Gas Journal, July 12, 2004
Pipeline Maintenance and Repair: Agenda

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Methane Losses from Pipeline Pigging

- Gas lost when launching and receiving a pig
- Fugitive emissions from pig launcher/receiver valves
- Gas lost from storage tanks receiving condensate removed by pigging
- Gas vented from pipeline blowdowns
Pigging Pipelines

- Hydrocarbons and water condense inside pipelines, causing pressure drop and reducing gas flow
- Periodic line pigging removes liquids and debris to improve gas flow
  - Also inspect pipeline integrity
- Efficient pigging:
  - Keeps pipeline running continuously
  - Keeps pipeline near maximum throughput by removing debris
  - Minimizes product losses during launch/capture
Pigging Applications

- Pipeline pigs come in a variety of shapes and sizes for different applications
  - Cleaning pigs
    - Have brushes or blades to help remove debris
  - Sealing pigs
    - Make tight seal for removing liquids from the pipe
  - Inspection pigs
    - Specialized pigs outfitted with instruments to monitor the pipeline integrity

www.westernfilterco.com
How Does Pigging Vent Methane?

- Pig launchers have isolation valves for loading pigs, pressurizing pigs, and launching pigs with gas bypassed from the pipeline.
- Launcher pressuring/depressuring loses methane out the vent valve.

www.girardind.com/
Pigging Vents Methane Twice!

- Methane lost through vent valve on the launcher and again through vent valve on the receiver
  - Once receiver is isolated from the line, it must be depressured to remove the pig
  - Liquids ahead of the pig drain to a vessel or tank
- Isolation valve leaks may cause excessive venting to depressure

www.girardind.com/
Estimating Pigging Vents

\[ E = \frac{P \times V}{14.7 \times n \times f} \]

where:
- \( E \) = methane emissions (m\(^3\))
- \( P \) = Gathering line pressure (psia)
- \( V \) = Launcher and receiver volume (m\(^3\))
- \( n \) = % methane
- \( f \) = number of piggings

- Pig trap isolation valve leakage greatly increases this minimum amount of gas venting

`psia = pounds per square inch absolute`
Estimating Emissions from Pigging

- **Estimating V**

<table>
<thead>
<tr>
<th>Line Diameter (inches)</th>
<th>Methane Emissions Volume</th>
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<tbody>
<tr>
<td></td>
<td>(cm)</td>
</tr>
<tr>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>12</td>
<td>30</td>
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<td>34</td>
<td>86</td>
</tr>
<tr>
<td>48</td>
<td>122</td>
</tr>
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</table>

Adapted from www.pigsunlimited.com

- **Estimating P**
  - Default: 315 psia*
  - * 315 psia = 21.4 atm

- **Estimating n**
  - Default: 78.8 % methane
Methane Recovery: Use Inert Gases

- Pipeline maintenance requires pipe section blowdown before work can begin.
- Gas in pipeline is usually vented to the atmosphere.
- Inert gas can be used to drive a pig down the section of pipe to be serviced, displacing the natural gas to a product line rather than venting.
- Inert gas is then blown down to the atmosphere, avoiding methane loss.
Inert Gas Setup

- Existing pig launcher can be used, set up to work with inert gases
- Portable nitrogen supply connected to the pig launcher vent
- Close valve on the main pipeline, pressurize launcher with inert gas, open launcher to main pipeline
- Supply nitrogen until pig reaches receiver
Industry Experience

- One partner reported using inert gas to purge six pipelines for maintenance.
- Gas savings from these applications was 15,200 m$^3$ (538 Mcf).
- These savings correspond to a typical application of:
  - 3.2 kilometers (2 miles) of 25 centimeters (10 inch) diameter pipeline.
Is Recovery Profitable?

- No capital costs with existing pigging facilities
- Labor costs are estimated at eight hours for two operators
- Increased safety is the primary benefit of this project
- Gas savings are a secondary benefit, as the labor and nitrogen costs outweigh the gas value
Project Summary for India

- Using inert gases and pigs to perform pipeline purges

Project Description: Purging 3.2 kilometers (2 miles) of 25 centimeters (10 inch) diameter pipeline using nitrogen from a nitrogen rejection unit (NRU)

<p>| | |</p>
<table>
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<th></th>
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<tbody>
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<td>Methane Saved:</td>
<td>2,500 cubic meters per year</td>
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<td>(90 Mcf per year)</td>
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<td>Sales Value¹:</td>
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<td>Capital and Installation Cost²:</td>
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<td>Operating and Maintenance Cost²:</td>
<td>($16) per year</td>
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<tr>
<td>Payback Period:</td>
<td>1 month</td>
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</tbody>
</table>

1 – Gas price in India $3/Mcf ($106/thousand m³)
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Discussion Questions

- To what extent are you implementing these practices?
- How could these practices be improved upon or altered for use in your operation(s)?
- What are the barriers (technological, economic, lack of information, regulatory, focus, manpower, etc.) that are preventing you from implementing these practices?