Processor Best Practices and Opportunities

Lessons Learned from Natural Gas STAR

DCP Midstream and the Gas Processors Association

Processors Technology Transfer Workshop
Houston, Texas
April 24, 2007

epa.gov/gasstar
Processor Opportunities: Agenda

- Industry Emissions
- Recommended Technologies and Practices
- Selected Methane Saving Opportunities
  - Pipeline Pigging
  - Installing Vapor Recovery Units
  - Dehydrators
    - Optimized glycol circulation rates
    - Flash tank separator (FTS) installation
    - Electric pump installation
- Discussion
Processor Recommended Technologies and Practices

- 89% of the processing sector reductions came from Partner reported opportunities

- Eliminate Unnecessary Equipment: 14%
- Storage Related: 5%
- Pipe Leak Related: 8%
- Dehydrator Related: 3%
- Compressor Related: 1%
- Flash Tank Separators: <1%
- DI&M: 5%
- Pneumatics: 5%
- Others: (50% from Leak Imaging of Flowlines) 58%
- Others: 58%

Source: iSTAR Database – 10/6/06
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

Source: www.girardind.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.

Source: 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.
- MORE than twice: isolation valve leaks may cause excessive venting to depressurize.

Source: www.girardind.com/
Methane Recovery

- Pipeline maintenance requires pipe section blowdown before work can begin
- Gas in pipeline is usually vented to the atmosphere
- Use inert gas and pig
  - 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 vented to the atmosphere, avoiding methane loss
- Route vent to vapor recovery system or fuel gas
  - One Partner reported connecting pig receiver vent to fuel gas to recover gas while working a tight isolation
Is Recovery Profitable?

- One partner pigged gathering lines 30 to 40 times per year, collecting several thousand barrels of condensate per application
- Partner reported saving 21,400 Mcf/year from recovering flash gases
- Dedicated vapor recovery unit (VRU) was installed with an electric compressor at an installation cost of $24,000 and an annual operating cost of $40,000 mostly for electricity
- Large gas savings and increasing gas prices will offset costs

<table>
<thead>
<tr>
<th>Gas Price ($/Mcf)</th>
<th>$5.00</th>
<th>$7.00</th>
<th>$10.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas Saved (Mcf/year)</td>
<td>21,400</td>
<td>21,400</td>
<td>21,400</td>
</tr>
<tr>
<td>Annual Savings ($/year)</td>
<td>$107,000</td>
<td>$149,800</td>
<td>$214,000</td>
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<tr>
<td>Installed Cost</td>
<td>$24,000</td>
<td>$24,000</td>
<td>$24,000</td>
</tr>
<tr>
<td>Operating Cost</td>
<td>$40,000</td>
<td>$40,000</td>
<td>$40,000</td>
</tr>
<tr>
<td>Payback Period (years)</td>
<td>0.4</td>
<td>0.3</td>
<td>0.2</td>
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</table>
Vapor Recovery Units: What is the Problem?

- **Flashing losses**
  - Occur when crude is transferred from a gas-oil separator at higher pressure to a storage tank at atmospheric pressure

- **Working losses**
  - Occur when crude levels change and when crude in tank is agitated

- **Standing losses**
  - Occur with daily and seasonal temperature and barometric pressure changes

- **Scrubber dump valve losses**
  - Solids or liquids freeze in the valve preventing closure
  - Natural gas is lost through condensate tank vents
Conventional Vapor Recovery Unit

Source: Evans & Nelson (1968)
Options for Vapor Recovery Units

- The solution to these losses are vapor recovery units to capture the emissions.

- Recommended choices
  - Rotary compressors – require electrical power or engine driver
  - Sliding vane or rotary screw compressors
  - Scroll compressors

- Alternative, niche technologies
  - EVRU™ – replaces rotary compressor and contains no moving parts
  - Vapor Jet system – requires high pressure water motive

- Choices not recommended
  - Reciprocating compressors
  - Centrifugal compressors
Vapor Recovery Most Applicable to:

- Steady source and sufficient quantity of losses
  - Condensate oil stock tanks
  - Flash tanks
  - Gas pneumatic controllers and pumps

- Outlet for recovered gas
  - Access to low pressure gas pipeline, compressor suction, or on-site fuel system

- Tank batteries
Methane Savings: Vapor Recovery

- Vapor recovery can capture up to 95% of hydrocarbon vapors from tanks
- Recovered vapors have higher heat content than pipeline quality natural gas
- Recovered vapors are more valuable than natural gas and have multiple uses
  - Re-inject into sales pipeline
  - Use as on-site fuel
  - Recover valuable natural gas liquids
What is the Recovered Gas Worth?

- Value depends on heat content of gas
- Value depends on how gas is used
  - On-site fuel
    - Valued in terms of fuel that is replaced
  - Natural gas pipeline
    - Measured by the higher price for rich (higher heat content) gas
  - Gas processing plant
    - Measured by value of natural gas liquids and methane, which can be separated
# Is Recovery Profitable?

## Financial analysis for a conventional VRU project

<table>
<thead>
<tr>
<th>Peak Capacity (Mcf/day)</th>
<th>Installation &amp; Capital Costs² ($)</th>
<th>O&amp;M³ Costs ($/year)</th>
<th>Value of Gas³ ($/year)</th>
<th>Annual Savings ($/year)</th>
<th>Simple Payback (months)</th>
<th>Internal Rate of Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>35,738</td>
<td>7,367</td>
<td>30,300</td>
<td>22,933</td>
<td>19</td>
<td>58%</td>
</tr>
<tr>
<td>50</td>
<td>46,073</td>
<td>8,419</td>
<td>60,600</td>
<td>52,181</td>
<td>11</td>
<td>111%</td>
</tr>
<tr>
<td>100</td>
<td>55,524</td>
<td>10,103</td>
<td>121,360</td>
<td>111,257</td>
<td>6</td>
<td>200%</td>
</tr>
<tr>
<td>200</td>
<td>74,425</td>
<td>11,787</td>
<td>242,725</td>
<td>230,938</td>
<td>4</td>
<td>310%</td>
</tr>
<tr>
<td>500</td>
<td>103,959</td>
<td>16,839</td>
<td>606,810</td>
<td>589,971</td>
<td>3</td>
<td>567%</td>
</tr>
</tbody>
</table>

1 – For VRUs with low discharge pressure  
2 - Unit cost plus estimated installation at 75% of unit cost, updated to 2006 capital costs  
3 - Operation & Maintenance  
4 - $7/Mcf x 1/2 capacity x 365 days/year
Dehydrators: What is the Problem?

- Produced gas is saturated with water, which must be removed for gas transmission
- Glycol dehydrators are the most common equipment to remove water from gas
  - 36,000 dehydration units in natural gas production, gathering, and boosting
  - Most use triethylene glycol (TEG)
- Glycol dehydrators create emissions
  - Methane, Volatile Organic Compounds (VOCs), Hazardous Air Pollutants (HAPs) from reboiler vent
  - Methane from pneumatic controllers

Source: www.prideofthehill.com
Basic Glycol Dehydrator System Process Diagram

- **Inlet Wet Gas**
- **Motive Gas Bypass**
- **Glycol Contactor**
- **Glycol Energy Exchange Pump**
- **Driver**
- **Lean TEG**
- **Rich TEG**
- **Glycol Reboiler/Regenerator**
- **Dry Sales Gas**
- **Water/Methane/VOCs/HAPs To Atmosphere**
- **Fuel Gas**
Methane Recovery: Three Options

- Optimized glycol circulation rates
- Flash tank separator installation
- Electric pump installation

Glycol Dehydrator Unit
Source: GasTech
Optimizing Glycol Circulation Rate

- Gas pressure and flow at gathering/booster stations vary over time
  - Glycol circulation rates are often set at a maximum circulation rate
- Glycol overcirculation results in more methane emissions without significant reduction in gas moisture content
  - Partners found circulation rates two to three times higher than necessary
  - Methane emissions are directly proportional to circulation
- Lessons Learned study: optimize circulation rates
Flash Tank Recovers Methane

- Recovers about 90% of methane emissions
- Reduces VOCs by 10 to 90%
- Must have an outlet for low pressure gas

- Fuel
- Compressor suction
- Vapor recovery unit
Flash Tank Costs

Lessons Learned study provides guidelines for scoping costs, savings and economics

Capital and installation costs:
- Capital costs range from $3,500 to $7,000 per flash tank
- Installation costs range from $1,200 to $2,500 per flash tank

Negligible Operational & Maintenance costs
Electric Pump Eliminates Motive Gas

- **Inlet Wet Gas**
- **Glycol Contactor**
- **Dry Sales Gas**
- **Electric Motor Driven Pump**
- **Lean TEG**
- **Rich TEG**
- **Pump**
- **Glycol Reboiler/Regenerator**
- **Water/Methane/VOCs/HAPs To Atmosphere**
- **Fuel Gas**
Overall Benefits

- Financial return on investment through gas savings
- Increased operational efficiency
- Reduced O&M costs (fuel gas, glycol make-up)
- Reduced compliance costs (HAPs, BTEX)
- Similar footprint as gas assist pump
Is Recovery Profitable?

**Three Options for Minimizing Glycol Dehydrator Emissions**

<table>
<thead>
<tr>
<th>Option</th>
<th>Capital Costs</th>
<th>Annual O&amp;M Costs</th>
<th>Emissions Savings</th>
<th>Payback Period¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimize Circulation Rate</td>
<td>Negligible</td>
<td>Negligible</td>
<td>394 to 39,420 Mcf/year</td>
<td>Immediate</td>
</tr>
<tr>
<td>Install Flash Tank</td>
<td>$6,500 to $18,800</td>
<td>Negligible</td>
<td>710 to 10,643 Mcf/year</td>
<td>4 to 11 months</td>
</tr>
<tr>
<td>Install Electric Pump</td>
<td>$1,400 to $13,000</td>
<td>$165 to $6,500</td>
<td>360 to 36,000 Mcf/year</td>
<td>&lt; 1 month to several years</td>
</tr>
</tbody>
</table>

¹ Gas price of $7/Mcf
Discussion

- Industry experience applying these technologies and practices
- Limitations on application of these technologies and practices
- Actual costs and benefits