Reducing Methane Emissions from Pneumatic Devices

Seminar with Russian Independent Oil and Gas Producers on Methane Mitigation Technologies and Strategies
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Don Robinson, Vice President
ICF International
Pneumatic Devices: Agenda

- Methane Losses
- Methane Recovery
- Is Recovery Profitable?
- Industry Experience
- Discussion
Methane to Markets

2008 Production Sector Methane Emissions (103 Bcf)

- Offshore Operations: 23 Bcf
- Pneumatic Devices: 37 Bcf
- Storage Tank Venting: 4 Bcf
- Other Sources: 6 Bcf
- Well Venting and Flaring: 6 Bcf
- Meters and Pipeline Leaks: 6 Bcf
- Dehydrators and Pumps: 11 Bcf
- Compressor Fugitives, Venting, and Engine Exhaust: 10 Bcf
- Offshore Operations: 23 Bcf

Bcf = billion cubic feet

What is the Problem?

- Pneumatic devices are collectively a major source of methane emissions in the U.S. the natural gas industry
- Natural gas powered pneumatic devices are used throughout the U.S. oil and natural gas industry

<table>
<thead>
<tr>
<th></th>
<th>Number of Devices in Natural Gas Systems</th>
<th>Number of Devices in Petroleum Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production and</td>
<td>443,000</td>
<td>396,000</td>
</tr>
<tr>
<td>Gathering</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Processing</td>
<td>11,000</td>
<td>-</td>
</tr>
<tr>
<td>Transmission and</td>
<td>85,000</td>
<td>-</td>
</tr>
<tr>
<td>Storage</td>
<td></td>
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</tbody>
</table>

Pneumatic Devices: Methane Emissions

- As part of normal operations, pneumatic devices release natural gas to atmosphere

- High-bleed devices are defined as those that bleed in excess of 4 m³ per day
  - Aggregates to more than 1,416 m³/year in the U.S.
  - Typical high-bleed pneumatic devices bleed an average of 3,965 m³/year

- Actual bleed rate is largely dependent on device’s design and maintenance

Methane Losses from Pneumatic Devices

- Pneumatic devices are used to actuate process controls on equipment throughout the natural gas industry.

SOV  =  Shut-off Valve (Unit Isolation)
LC   =  Level Control (Separator, Contactor, Glycol Regenerator)
TC   =  Temperature Control (Regenerator Fuel Gas)
FC   =  Flow Control (Glycol Circulation, Compressor Bypass)
PC   =  Pressure Control (Flash Tank Pressure, Compressor Suction/Discharge)
How Gas Pneumatic Devices Work

Regulator

Gas
7.8+ atm\(^1\)

Process Measurement
Liquid Level
Pressure
Temperature
Flow

Regulated Gas Supply
2.4 atm\(^1\)

Weak Pneumatic Signal (1.2 to 2 atm)\(^1\)

Pneumatic Controller

Weak Signal Bleed (Continuous)
Strong Signal Vent (Intermittent)

Strong Pneumatic Signal
Valve Actuator

Process Flow
Control Valve

\(^1\) 1 atmosphere (atm) = 0 pounds per square inch gauge (psig) and 14.7 pounds per square inch atmospheric (psia)

1 atm = 1.013 bar and 101.3 kilopascals (kPa)
Methane Recovery from Pneumatic Devices

- **Option 1:** Replace high-bleed devices with low-bleed devices
  - Replace at end of device’s economic life
  - Typical cost range from RUB 21,500 to RUB 92,200 per device
- **Option 2:** Retrofit controller with bleed reduction kits
  - Retrofit kit costs approximately RUB 20,700
  - Payback time approximately 6 months
- **Option 3:** Maintenance aimed at reducing losses
  - Field survey of controllers
  - Re-evaluate the need for pneumatic positioners
  - Cost is low

Field experience shows that up to 80% of all high-bleed devices can be replaced or retrofitted with low-bleed equipment.

All data are based on Partners’ experiences and represented in U.S. economics converted to Russian currency.
Five Steps for Reducing Methane Emissions from Pneumatic Devices

1. LOCATE and INVENTORY high-bleed devices
2. ESTABLISH the technical feasibility and costs of alternatives
3. ESTIMATE the savings
4. EVALUATE economics of alternatives
5. DEVELOP an implementation plan
Suggested Analysis for Replacement

-Replacing high-bleed controllers at end of economic life
  - Determine incremental cost of low-bleed device over high-bleed equivalent
  - Determine gas saved with low-bleed device using manufacturer specifications
  - Compare savings and cost

- Early replacement of high-bleed controllers
  - Compare gas savings of low-bleed device with full cost of replacement

<table>
<thead>
<tr>
<th>Implementation</th>
<th>Replace at End of Life</th>
<th>Early Replacements</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Level Control</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15,760</td>
</tr>
<tr>
<td>Cost (RUB)</td>
<td>4,600 to 7,700</td>
<td>15,760</td>
</tr>
<tr>
<td>Annual Gas Savings (m³)</td>
<td>1,400 to 5,660</td>
<td>4,700</td>
</tr>
<tr>
<td>Annual Gas Savings (Mcf)</td>
<td>50 to 200</td>
<td>166</td>
</tr>
<tr>
<td>Annual Value of Saved Gas (RUB)c</td>
<td>15,900 to 64,300</td>
<td>53,400</td>
</tr>
<tr>
<td>IRR (%)</td>
<td>345 to 835</td>
<td>339</td>
</tr>
<tr>
<td>Payback (months)</td>
<td>2 to 6</td>
<td>4</td>
</tr>
</tbody>
</table>

a All data based are based on Partners’ experiences and represented in U.S. economics converted to Russian currency.
b Range of incremental costs of low-bleed over high bleed equipment
c 2008 Russian gas sales price for European Market at $370/Mcm (RUB 11,360/Mcm) - eia.doe.gov/cabs/Russia/NaturalGas.html
Suggested Analysis for Retrofit

- Retrofit of low-bleed kit
  - Compare savings of low-bleed device with cost of conversion kit
  - Retrofitting reduces emissions by average of 90%

<table>
<thead>
<tr>
<th>Implementation Costs(^b)</th>
<th>Retrofit(^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RUB 20,700</td>
<td></td>
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<table>
<thead>
<tr>
<th>Bleed rate reduction (m(^3)/device/year)</th>
<th>6,200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bleed rate reduction (Mcf/device/year)</td>
<td>219</td>
</tr>
<tr>
<td>Value of gas saved (RUB/year)(^c)</td>
<td>RUB 70,400</td>
</tr>
<tr>
<td>Payback (months)</td>
<td>4</td>
</tr>
<tr>
<td>Internal Rate of Return</td>
<td>340%</td>
</tr>
</tbody>
</table>

\(^{a}\) On high-bleed controllers
\(^{b}\) All data based on Partners’ experiences and represented in U.S. economics converted to Russian currency.
\(^{c}\) Gas price is assumed to be RUB 11,360/Mcm
Suggested Analysis for Maintenance

- For maintenance aimed at reducing gas losses
  - Measure gas loss before and after procedure
  - Compare savings with labor (and parts) required for activity

<table>
<thead>
<tr>
<th></th>
<th>Reduce supply pressure</th>
<th>Repair &amp; retune</th>
<th>Change settings</th>
<th>Remove valve positioners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implementation Cost (RUB)a</td>
<td>6,360</td>
<td>955</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Gas savings (m³/year)</td>
<td>4,960</td>
<td>1,250</td>
<td>2,500</td>
<td>4,470</td>
</tr>
<tr>
<td>Gas savings (Mcf/year)</td>
<td>175</td>
<td>44</td>
<td>88</td>
<td>158</td>
</tr>
<tr>
<td>Value of gas saved (RUB/year)b</td>
<td>56,350</td>
<td>14,200</td>
<td>28,400</td>
<td>50,780</td>
</tr>
<tr>
<td>Payback (months)</td>
<td>2</td>
<td>1</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>IRR</td>
<td>886%</td>
<td>1487%</td>
<td>--</td>
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</tbody>
</table>

a All data based on Partners’ experiences and represented in U.S. economics converted to Russian currency.
b Gas price is assumed to be RUB 11,360/Mcm
Industry Experience: Marathon Oil (U.S. Production Company)

- Marathon surveyed 158 pneumatic devices at 50 production sites in the U.S.
- Half of the controllers were low-bleed
- High-bleed devices included
  - 35 of 67 level controllers
  - 5 of 76 pressure controllers
  - 1 of 15 temperature controllers
Marathon Oil: Industry Experience

- Marathon measured gas losses total 145 thousand m$^3$/year
- Level controllers account for 86% of losses
  - Losses averaged 0.2 m$^3$/hour/device
  - Losses ranged up to 1.4 m$^3$/hour/device (11.9 thousand m$^3$/year)
- Concluded that excessive losses can be heard or felt
Lessons Learned

- Most high-bleed pneumatics can be replaced with lower bleed models
- Replacement options save the most gas and are often economic
- Retrofit kits are available and can be highly cost-effective
- Maintenance is low-cost and reduces gas loss
Discussion

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

- More detail is available on these practices and over 80 others online at: epa.gov/gasstar/tools/recommended.html
- For further assistance, direct questions to:

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