Natural Gas STAR International: An Overview of Compressor Emission Reduction Best Practices

Natural Gas STAR International Meeting with Turkmenistan

November 9, 2011
Farmington, New Mexico

Sandy Seastream
ICF International
Agenda

- 2009 U.S. Methane Emissions from Compressors
- Reciprocating Compressor Rod Packing
  - Methane Losses
  - Solution and Economics
- Contacts and Further Information
2009 U.S. Transmission Sector Methane Emissions from Compressors

- **Reciprocating Compressors**: 1,246 MMcm
- **Centrifugal Compressors**: 368 MMcm
- **Station Fugitives**: 227 MMcm
- **Gas Engine Exhaust**: 312 MMcm
- **Pneumatic Devices**: 340 MMcm
- **Station Venting**: 255 MMcm
- **Pipeline Leaks**: 227 MMcm
- **Other Sources**: 140 MMcm

**Total Methane Emissions from Compressors = 1,614 MMcm**
52% of gas transmission

Methane Losses from Reciprocating Compressors

- Reciprocating compressor rod packing leaks some gas by design
  - Newly installed packing may leak 0.3 to 1.7 m$^3$/hour
  - Worn packing has been reported to leak up to 25.5 m$^3$/hour
Reciprocating Compressor Rod Packing

- A series of flexible rings fit around the shaft to prevent leakage
- Leakage may still occur through nose gasket, between packing cups, around the rings, and between rings and shaft
Impediments to Proper Sealing

Where packing case can leak
- Nose gasket
- Packing to rod
- Packing to cup
- Packing to packing
- Cup to cup

What makes packing leak?
- Dirt or foreign matter (trash)
- Worn rod (.015 mm/ per cm diameter)
- Insufficient/too much lubrication
- Packing cup out of tolerance (≤ 0.05 mm)
- Improper break-in on startup
- Liquids (dilutes oil)
- Incorrect packing installed (backward or wrong type/style)
## Methane Losses from Rod Packing

| Source: Cost Effective Leak Mitigation at Natural Gas Transmission Compressor Stations – PRCI/ GRI/ EPA PR-246-9526 |
|---|---|---|---|---|
| Emission from Running Compressor | 24,600 | m³/year-packing |
| Emission from Idle/Pressurized Compressor | 36,000 | m³/year-packing |
| Leakage from Packing Cup | 19,500 | m³/year-packing |
| Leakage from Distance Piece | 8,500 | m³/year-packing |

**Leakage from Rod Packing on Running Compressors**

<table>
<thead>
<tr>
<th>Packing Type</th>
<th>Bronze</th>
<th>Bronze/Steel</th>
<th>Bronze/Teflon</th>
<th>Teflon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leak Rate (m³/year)</td>
<td>17,300</td>
<td>15,700</td>
<td>37,300</td>
<td>5,900</td>
</tr>
</tbody>
</table>

**Leakage from Rod Packing on Idle/Pressurized Compressors**

<table>
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</tr>
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<tbody>
<tr>
<td>Leak Rate (m³/year)</td>
<td>17,400</td>
<td>N/A</td>
<td>36,500</td>
<td>5,400</td>
</tr>
</tbody>
</table>
Solution: Economic Replacement

- **Measure rod packing leakage**
  - When new packing installed—after worn-in
  - Periodically afterwards
- **Determine cost of packing replacement**
- **Determine economic replacement threshold**
  - Partners can determine economic threshold for all replacements
  - This is a capital recovery economic calculation
- **Replace packing when leak reduction expected will pay back cost**

Economic Replacement Threshold (m³/hour) = \[
\frac{CR \times DF \times 1,000}{(H \times GP)}
\]

Where:
- **CR** = Cost of replacement (TMT)
- **DF** = Discount factor at interest \(i\)
- **H** = Hours of compressor operation per year
- **GP** = Gas price TMT/thousand cubic meters

\[
DF = \frac{i(1+i)^n}{(1+i)^n - 1}
\]
Contacts 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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