Methane Reductions from Gas Compressors

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U. S. Natural Gas Transmission Systems

• Transmission and Gathering Systems - approximately 325,000 miles of pipe ¹
• Approximately 1,800 compressor stations ²
• Over 50,000 reciprocating compressor engines are operated within the U.S. ²

¹ U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration
² U.S. Environmental Protection Agency estimate
Methane Emissions - Natural Gas Sector

Gas Transmission Sector Reduction Technologies Since 1993

Reference: EPA Natural Gas STAR Program Web Page
Methane Emission Reduction Technologies: Compressors

• Under the Natural Gas STAR Program, EPA identifies 12 available reduction technologies
  – Directed Inspection and Maintenance Programs
  – Compressor Rod Packing Systems
    • Reciprocating Compressors
  – Centrifugal Compressors Seals
Compressor Stations

• Methane Emission Sources
  – Valves
  – Flanges
  – Connectors
  – Open-ended lines
  – Pressure Relief Devices
  – Blow Down
Directed Inspection and Maintenance

• Leak Screening Techniques:
  – Infrared cameras
  – Organic Vapor Analyzers
    – Photo or flame ionization detectors
  – Acoustic Leak Detection
    – High frequency or ultrasonic detectors
  – Electronic Gas Detectors

• Leak Measurement Techniques:
  – Organic Vapor Analyzers
    – Photo or flame ionization detectors
  – Bagging Techniques
  – High Volume Samplers
  – Rotameters
## Screening and Measurement Technique Applicability

<table>
<thead>
<tr>
<th>Instrument/Technique</th>
<th>Application and Usage</th>
<th>Effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electronic Gas Detectors</td>
<td>Flanges, vents, large gaps, and open-ended lines.</td>
<td>Screening only</td>
</tr>
<tr>
<td>Acoustic Detectors Ultrasound</td>
<td>All components. Larger leaks, pressurized gas, and inaccessible components.</td>
<td>Screening only</td>
</tr>
<tr>
<td>TVA (flame ionization detector)</td>
<td>All components</td>
<td>Best for screening only. Measurement requires site-specific leak size correlation.</td>
</tr>
<tr>
<td>Bagging</td>
<td>Most accessible components</td>
<td>Measurement only; time consuming</td>
</tr>
<tr>
<td>High Volume Sampler</td>
<td>Most accessible components (leak rate &lt;11.5 Mcfd)</td>
<td>Screening and measurement</td>
</tr>
<tr>
<td>Rotameter</td>
<td>Large leaks</td>
<td>Measurement only</td>
</tr>
</tbody>
</table>
Directed Inspection and Maintenance Program

• Identify and tag components
  – Use software to track components and results
• Survey components – identify leaks
• Quantify leakage rates
  – Experience shows the majority of leaks come from small % of components
• Evaluate cost-effectiveness of leak repair
• Repair leaks
• Quantify emission reductions
Replace Compressor Rod Packing Systems

• Reciprocating compressors are connected to a driver operating single or multiple compressor cylinders
  – Number of Compressor Cylinders vary based on the driver power rating and speed, the pipeline operating conditions, and compression volume requirements
  – Compressor rod packing systems are used to maintain a seal around the piston rod and to prevent gas leakage from the high pressure gas in the compressor cylinder
Typical Reciprocating Compressor Rod Packing System

(Side View, Cut in Half)

Cylinder

Distance Piece

Piston Rod

Piston

Rod Packing Case

OIL

Suction

Discharge

Cylinder Wall

Piston Rod

Packing Cup

Two Rings
(In Three Segments)

Springs

Lubrication

Gas Leakage

Flange

High Pressure Gas Inside Cylinder

(Side View, Cut in Half)
What Leaks?

• Leakage occurs from:
  – Around packing case through gasket between the case and cylinder
  – Between packing cups, typically mounted metal-to-metal
  – Ring movement as piston rod moves back and forth
  – Down the piston rod shaft

• All rod packing assemblies will eventually leak
Reducing Rod Packing Leaks

• Establish a leakage rate baseline for new rod packing(s)
• Regularly monitor for leakage
• Determine economic replacement thresholds
  – Thresholds will vary by service requirements and packing replacement costs
• Replace packing and rods when cost-effective
  – Conventional rod packing rings may require replacement every 3 to 5 years
Centrifugal Compressors

• Centrifugal compressors require seals around the rotating shaft to prevent gas escape.

• Two seal systems are common:
  – Older centrifugal compressors have wet seals: higher leak rates.
  – Most new centrifugal compressors have dry seals: much lower leak rates.
Centrifugal Compressor Wet Seal

Motor and Shaft Bearing Side
"Outboard"

"Outboard" Labyrinth Seal

Seal Housing

Seal Oil Inlet

Seal Oil Outlet (Uncontaminated)

Seal Oil Outlet (Contaminated with Gas)

Process Gas Leaks Through “Inboard” Labyrinth Seal

Compressor Side “Inboard”

Spinning Shaft
Centrifugal Compressor Dry Seal

- Tandem Rotating Rings with Grooves
- Very Little Process Gas Leakage (Fugitive)
- Motor End
- Spinning Shaft
- Process Gas Leaks Through Labyrinth
- Gas Pressure Between Rings Prevents Process Gas from Leaking
- Spring Pushes Stationary Ring Against Rotating Ring
Dry Seal Benefits

• Lower leak rates
• Mechanically simpler
• Reduced power consumption
• Improved reliability
• Lower maintenance costs
• Eliminates oil leakage into pipeline
Kinder Morgan’s Natural Gas Pipeline Operations

• Largest natural gas transporter and storage operator in US
  – Operates approximately 62,000 miles of natural gas pipelines

• Key Assets
  – Texas Intrastate Pipeline Group serving producers and customers in Texas
  – Tennessee Gas Pipeline serving markets from Texas to northeastern US markets (e.g., New York City and Boston)
  – Southern Natural Gas serving southeastern US markets (e.g., Atlanta)
  – Natural Gas Pipeline Company of America serving central and mid-western US markets (e.g., Chicago)
  – El Paso Natural Gas serving southwestern US markets (e.g., Phoenix, Tucson and California)
  – Colorado Interstate Gas, Wyoming Interstate Company and TransColorado Gas Transmission Company serving Rocky Mountain markets
  – Mohave Pipeline Company and the Ruby Pipeline serving California markets
Kinder Morgan’s Natural Gas STAR Program Experience

• Kinder Morgan’s natural gas pipeline companies have participated in EPA Natural Gas STAR program since 1993

• Since 1993, Kinder Morgan companies have achieved cumulative methane reductions of over 77.3 Bcf
  – Directed Inspection & Maintenance: 8.9 Bcf
  – Rod Packing & Wet Seal Replacements: 1.4 Bcf
Kinder Morgan Cumulative Methane Reductions (1993-2010): 77.3 Bcf

- Use compressors - pipeline pumpdown (23,848,456 Mcf)
- Install electric compressors (1,376,917 Mcf)
- Identify and replace high-bleed pneumatic devices (358,692 Mcf)
- Replace compressor rod packing systems (1,482,925 Mcf)
- Install VRU on pipeline liquid/condensate tank (24,874,864 Mcf)
- DI&M: compressor stations (8,914,460 Mcf)
- Use of turbines at compressor stations (4,744,894 Mcf)
- Use composite wrap repair (6,548,531 Mcf)
- DI&M: surface facilities (1,110,911 Mcf)
- Other (4,095,016 Mcf)
More Information

• Additional information regarding methane emission reduction technologies is available from EPA’s Natural Gas STAR Program Web Page:
  
  • [http://www.epa.gov/gasstar/](http://www.epa.gov/gasstar/)

• Technical Documents are available in Arabic, Chinese, Russian and Spanish