Methane to Markets

Processor Best Practices

Energy Management Workshop for Upstream and Midstream Operations

January 17, 2006

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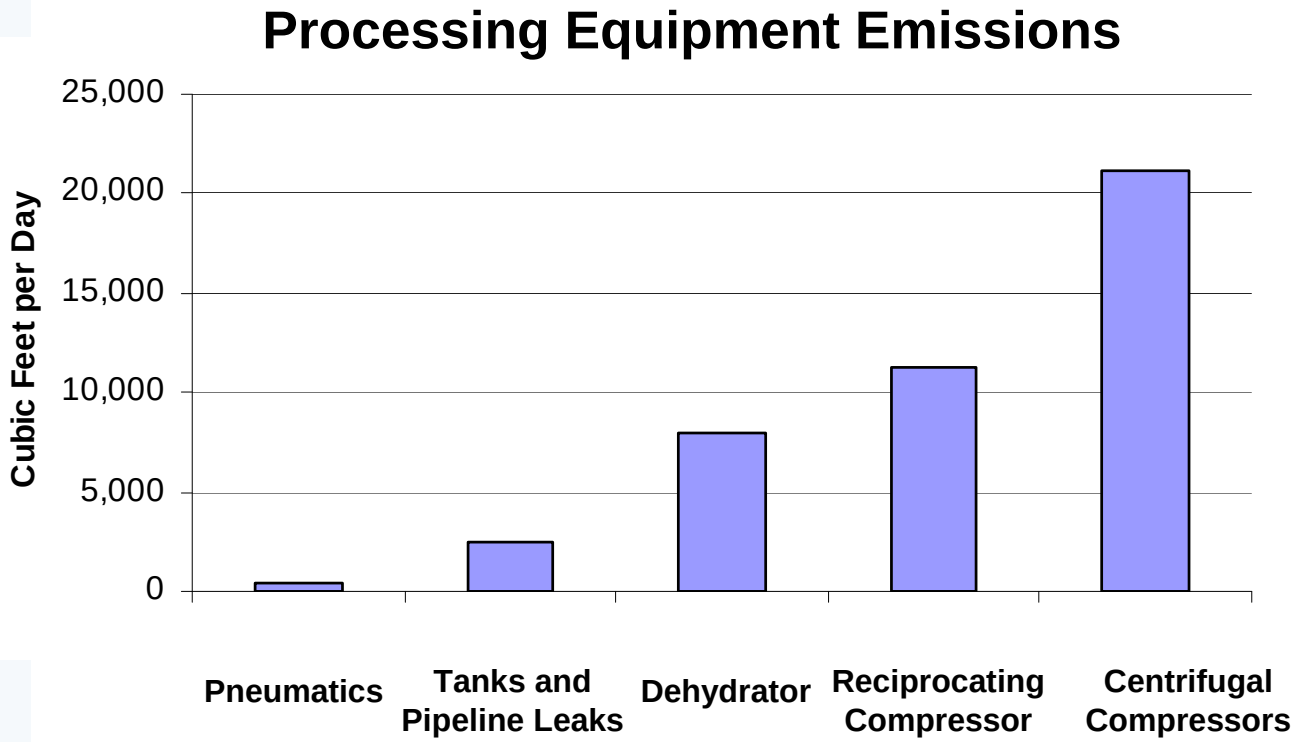
Processor Opportunities: Agenda

- Industry Emissions
- Recommended Technologies and Practices
- Selected Methane Saving Opportunities
  - Pneumatic Devices
  - Vapor Recovery Units
- Discussion

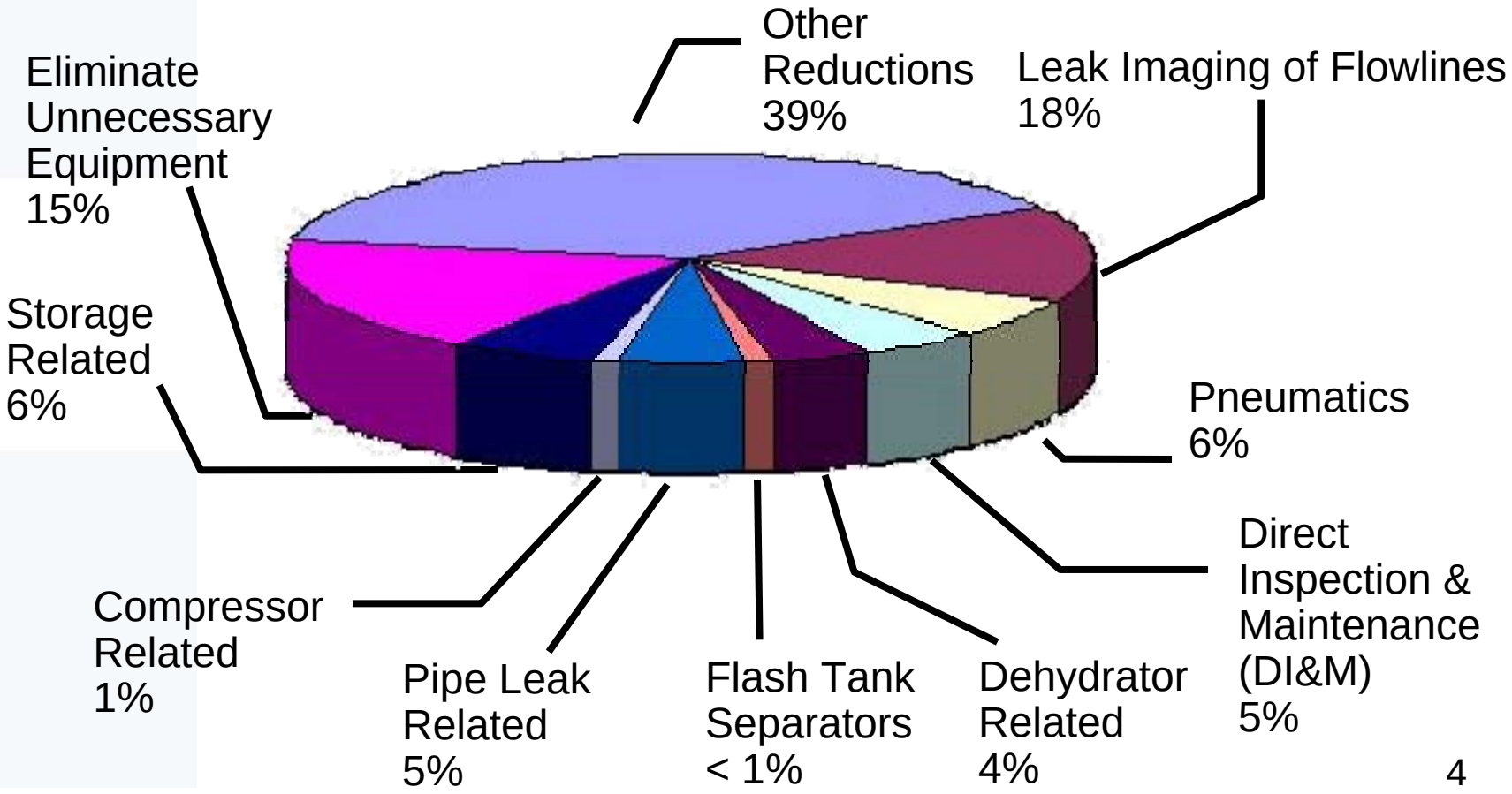
Natural Gas and Petroleum Industry Emissions

- Processing sector equipment can emit large amounts of valuable methane gas.



Methane Savings by Emissions Source

- Processors have economically reduced methane losses from all major emissions sources



Recommended Practices

- Eliminate unnecessary equipment and/or systems
  - BP, ConocoPhillips, ExxonMobil, Marathon, and more
- Rerouting of glycol skimmer gas
  - Chevron
- Pipe glycol dehydrator to vapor recovery unit
  - Marathon Oil company
- Inspect and repair compressor station blowdown valves
  - Kinder Morgan Inc.
- Begin DI&M at remote facilities
  - Bay State Gas, Gas Transmission Northwest, Kinder Morgan Inc.

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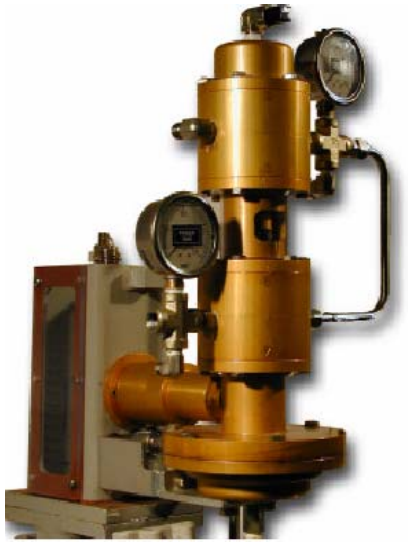
Recommended Technologies

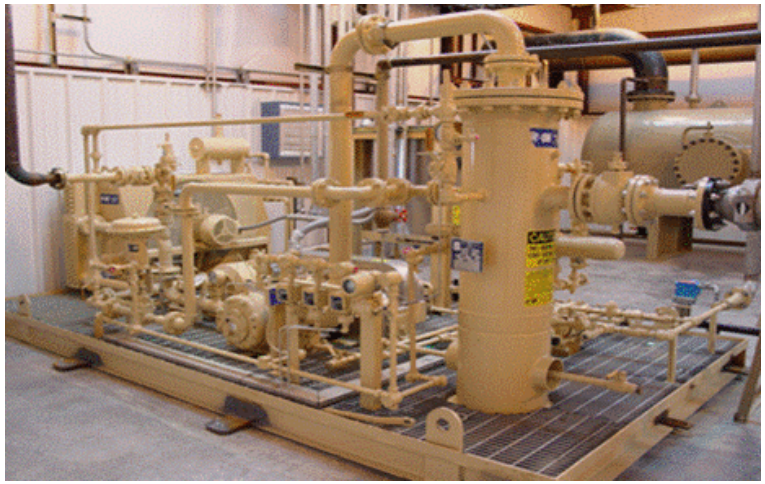
- Recycle line recovers gas during condensate loading
  - Enron Corporation
- Aerial imaging of flowlines to identify leaks
  - Enbridge Energy Partners LP, Duke Energy Field Services, Pioneer Natural Resources
- Convert gas-driven chemical pumps to instrument air
  - ExxonMobil Production Co.
- Aerial imaging of flowlines to identify leaks
  - Enbridge Energy Partners LP, Duke Energy Field Services, Pioneer Natural Resources
- Use of composite wrap repair
  - Colombia Gas Transmission
- Install pressurized storage of condensate
  - Burlington Resources

Selected Methane Reducing Opportunities

- Pneumatic Devices



- Vapor Recovery Units



Pneumatic Devices: What is the Problem?

- Pneumatic devices are major source of methane emissions from the natural gas industry
  - On average, about 165,000 cubic feet (cf) of methane emissions from pneumatic devices in gathering and boosting stations annually per processing plant1
- As part of normal operations, pneumatic devices release natural gas to the atmosphere
- High-bleed devices bleed in excess of 6 cf/hour
  - Equates to more than 50 Mcf/year
  - Typical high-bleed pneumatic devices bleed an average of 140 Mcf/year
- Actual bleed rate is largely dependent on device's design

1 – *Methane Emissions from the Natural Gas Industry, Volume 12, Pneumatic Devices*, USEPA, June 1996

Options for Methane Recovery

- Option 1: Replace high-bleed devices with low-bleed devices
- Option 2: Retrofit controller with bleed reduction kits
  - Field experience shows that up to 80% of all high-bleed devices can be replaced or retrofitted with low-bleed equipment
- Option 3: Maintenance aimed at reducing losses
- Option 4: Convert to instrument air

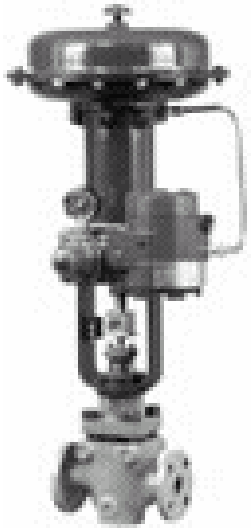
Option 1: Replace High-Bleed Devices

- Most applicable to:
  - Controllers: liquid-level and pressure
  - Positioners and transducers
- Suggested action:
  - Evaluate replacements
  - Replace at end of device's economic life
  - Early replacement

Norriseal
Pneumatic Liquid
Level Controller

Source: www.norriseal.com

Fisher
Electro-Pneumatic
Transducer



Source: www.emersonprocess.com

Option 1: Cost to Replace High-Bleed Devices

- Costs vary with size
  - Typical costs range from $700 to $3,000 per device
  - Incremental costs of low-bleed devices are modest ($150 to $250)
  - Methane savings often pay for replacement costs in short periods of time (3 to 6 months)

Option 2: Retrofit with Bleed Reduction Kits

- Applicable to most high-bleed controllers
- Suggested action: evaluate cost-effectiveness as alternative to early replacement
- Retrofit kit costs are approximately $675
- Methane savings typically have a payback time of approximately 6 months

Option 3: Maintenance to Reduce Losses

- Applies to all pneumatic devices
- Suggested action: add to routine maintenance procedures
  - Field survey of controllers
  - Where process allows, tune controllers to minimize bleed
  - Re-evaluate the need for pneumatic positioners
  - Repair/replace airset regulators
  - Reduce regulated gas supply pressure to minimum
  - Routine maintenance should include repairing/replacing leaking components
- Methane savings justify very low costs quickly

Option 4: Convert to Instrument Air

- Most applicable to:
  - Gathering & Boosting stations with high-bleed pneumatic devices and access to electricity
- Major components of instrument air system
  - Compressor
  - Power source
  - Air drier
  - Volume tank

Option 4: Instrument Air Methane Savings:

- Value of Gas = $(I_{Au} + U_{Au}) * M * P / 1{,}000$
  - I_{Au}= Instrument Air Use: e.g., 35 control loops
    - Rule of thumb: 1 cf per minute per control loop
  - U_{Au}= Utility Air Use: e.g., assume 10 cf per minute for utilities
  - M = Minutes in a year (525,600)
  - P = Price of Gas: assume $7/Mcf
- Value of Gas = (35*1 + 10) * 525,600 * 7 / 1,000
  - Value of Gas Saved = $ 165,000/year

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Industry Experience: Unocal

- Unocal installed an air compression system to convert pneumatic device control systems to instrument air in its Fresh Water Bayou facility in southern Vermillion Parish, Louisiana
- It cost $60,000 in capital and installation
- Unocal reduced methane emissions by over 69,000 Mcf/year
- Recovery of the methane saved Unocal $485,450/year[1]
- The project payback was around 2 months

1 – *At the current gas price of $7/Mcf*

Vapor Recovery Units: What is the Problem?

- Flash 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

Options for Vapor Recovery Units

- The solution to these emissions 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

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Is Recovery Profitable?

Financial Analysis for a conventional VRU Project						
Peak Capacity (Mcf / day)	Installation & Capital Costs[1]	O & M Costs ($ / year)	Value of Gas[2] ($ / year)	Annual Savings	Simple Payback (months)	Internal Rate Of Return
25	35,738	7,367	$ 30,300	$ 22,933	19	58%
50	46,073	8,419	$ 60,600	$ 52,181	11	111%
100	55,524	10,103	$ 121,360	$ 111,257	6	200%
200	74,425	11,787	$ 242,725	$ 230,938	4	310%
500	103,959	16,839	$ 606,810	$ 589,971	3	567%

1 Unit Cost plus estimated installation at 75% of unit cost

2 $7/Mcf x 1/2 capacity x 365

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Industry Experience: Chevron

- Chevron installed eight VRUs at crude oil stock tanks in 1996

Project Economics – Chevron				
Methane Loss Reduction (Mcf/unit/year)	**Approximate Savings per Unit**[1]	**Total Savings**	**Total Capital and Installation Costs**	**Payback**
21,900	**$153,300**	**$1,226,400**	**$240,000**	**3 months**

[1]Assumes a $7 per Mcf gas price; excludes value of recovered natural gas liquids. Refer to the Natural Gas STAR *Lessons Learned* for more information.

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Discussion

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

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