International Methane Recovery and Project Opportunities In the Oil and Gas Industry

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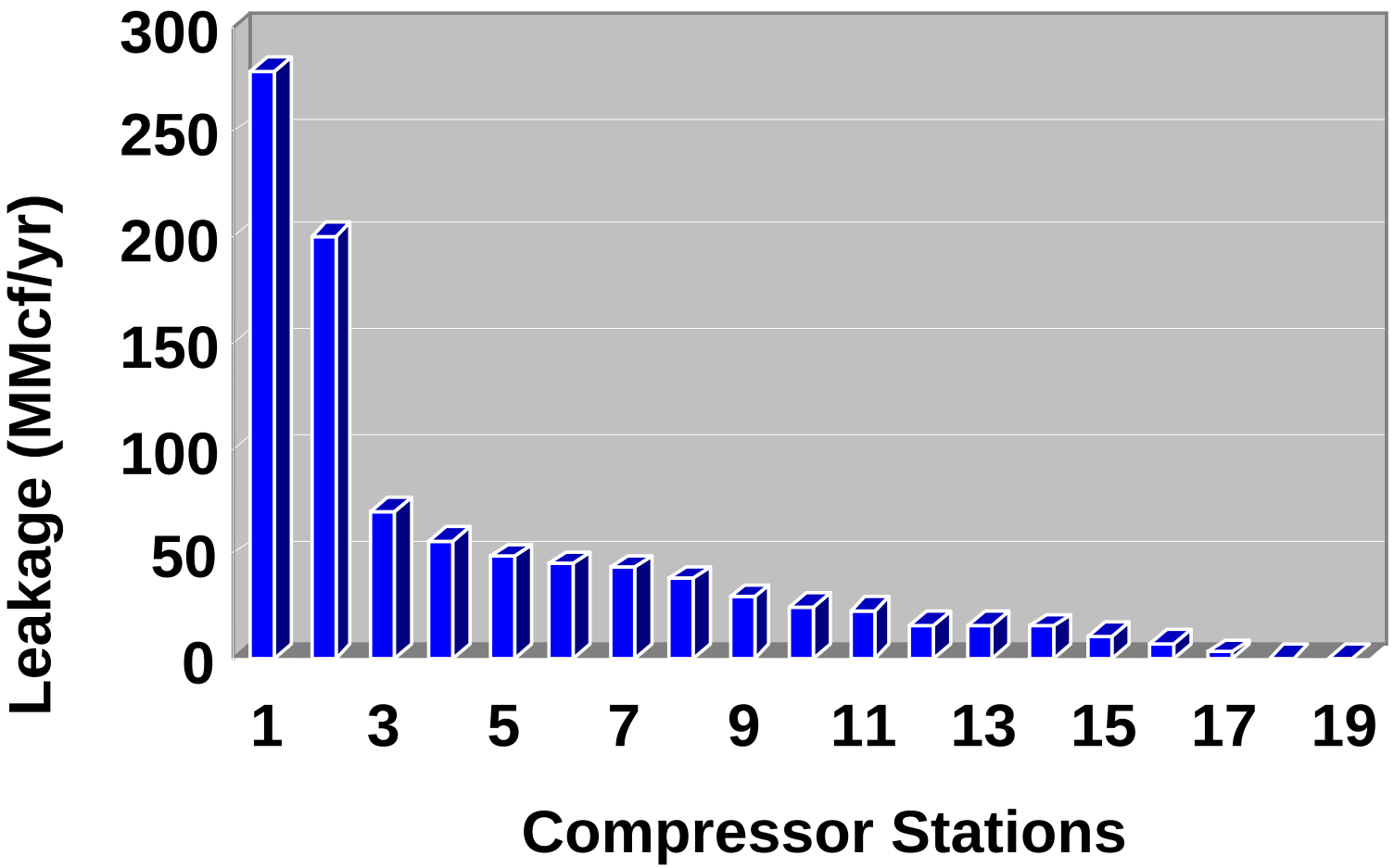
Experiences in North America and Western Europe

Fugitive Equipment Leaks

- NOTEWORTHY CHARACTERISTICS:
  - THC and CH4 emissions are mostly from components in gas service.
  - Emission vary greatly between sites but older facilities tend to leak more than newer ones.
  - 75 to 85% of emissions economic to reduce.
  - Top 10 leaks typically contribute more than 80% of emissions from leaks.
  - Leak control is an ongoing effort.
  - Maintenance/repair costs tend to increase with component size but leaks don't.

- CHRONIC OR FREQUENT LEAKERS:
  - Compressor Seals (34% leak)
  - Open-ended lines (vent, drain, and blowdown systems) (20% leak).
  - Components in vibration or thermal-cycling service.
  - Components in fuel gas service (18% leak).
  - Stem packings on rising stem valves.
  - PVSVs and hatches on blanketed storage tanks.
  - Pressure relief valves.

Leakage at Transmission Facilities



Venting and Flaring

- KEY SOURCES:
  - Disposal of waste associated gas at oil production facilities.
  - Casing gas vents at heavy oil wells.
  - Gas operated devices.
  - Still column off-gas vents on glycol dehydrators.
  - Leakage into vent/flare header (5-10% of valves leak and 1-2% of these contribute 75%).
  - Excessive purge gas rates.
  - Other: I&M activities, well testing/servicing and pipeline tie-ins.
- NOTEWORTHY CHARACTERISTICS:
  - High uncertainty in values:
    - Flows usually not metered and often reported as zero.
    - Vented volumes often reported as flared.
    - Leakage into vent and flare systems typically unaccounted.
    - Reliability of pilot or ignition systems sometimes a problem.
  - Many systems based on outdated gas prices.

Storage Tanks

- CONTROL OPPORTUNITIES:
  - Flashing losses at production facilities.
  - Unintentional gas carry-through to storage tanks:
    - Leaking drain and dump valves.
    - Malfunctioning level controllers.
    - Inefficient upstream gas/liquid separation.
    - Piping changes resulting in unstabilized product going to tanks.
  - Malfunctioning vapor recovery systems:
    - Faulty blanket gas regulators or pressure controllers.
    - Fouled vapor collection lines.

- NOTEWORTHY CHARACTERISTICS
  - Methane content minimal downstream of production facilities.
  - Emissions often unnoticed on site.
  - Vapors rich with NMVOCs and often difficult to utilize without processing.

Combustion Sources

- CONTROL OPPORTUNITIES:
  - Poor Thermal Efficiencies
    - Oversized engines, heaters and boilers.
    - Out of tune (e.g., poor air/fuel ratio).
    - Leakage past pistons in engines.
    - Internal valve and cylinder leakage in reciprocating compressors.
  - Poor Overall Process Efficiencies
    - Excessive pressure drops.
    - Lack of waste heat utilization.
    - Fouled heat exchangers.
    - Excessive reboiler duties due to high chemical circulation rates.
- NOTEWORTHY CHARACTERISTICS:
  - Low CH4 emissions but good control economics due to value of avoided fuel/energy consumption.

Why Target CH4 Emissions?

- CH4 and associated NMVOC emissions are significant (1.1% x production in Canada,$1Billion/y).
- Attractive payback periods based on value of avoided losses alone (<1 yr).
- More immediate impact on climate change than CO_2 reductions
  (CH4 has a life of 12 yrs in the atmosphere & GWP of 56 on 20-yr time horizon).
- Reductions are eligible for GHG credits:
  - Vented or leaked natural gas:
    - Worth $1.26/GJ at $3/tonne of CO2E.
    - Worth $4.19/GJ at $10/tonne of CO2E.
  - Reduced flaring or fuel consumption:
    - Worth only about 13 percent of the corresponding value of unburned natural gas.

Why are fugitive emissions and energy inefficiencies so large?

- Inadequate monitoring systems to detect & evaluate sensible reduction opportunities.
- Fuel gas often available at no cost or at wholesale prices.
- Inadequate reward or incentive programs:
  - Increased operating costs discouraged.
  - Facilities not credited for avoided production losses.
  - Facilities not credited for reduced environmental emissions.
  - Potential ownership issues (e.g., midstream operators).
  - Avoided losses may simply prolong the reservoir life rather than show an immediate economic benefit.
- Energy efficiency and emissions reduction not the primary business of oil & gas companies.

International Experiences

General Comments

- Key causes of CH4 emissions vary between facilities & countries:
  - Inadequate I&M programs.
  - Use of poor quality components and materials.
    - Compressor seal leaks in Uzbekistan (>2 x max value in N America).
    - Frequent pipeline ruptures in China.
  - Poor designs and operating practices due to capital constraints.
    - Undersized piping.
    - Lack of adequate process controls.
    - Poor QA/QC.
    - Outdated or lack of emission control technologies.
  - Restricted market for associated gas production.
  - Less sensitized to environmental and energy efficiency issues.
- Generally greater control opportunities, but additional constraints & more difficult to evaluate.

Romgas/ Transgas Gas Transmission System in Romania

A comparison of measured emissions from each of the compressor stations to average Canadian compressor station emissions.

Site	Measured Emissions		Estimated Based on Canadian Factors	
	Methane Emissions (m^3/d)	CO_2E Emissions (tonnes/year)	Methane Emissions (m^3/d)	CO_2E Emissions (tonnes/year)
Butimanu	4 720	24 548	619	3 320
Danes	370	1 924	276	1 433
Deleni	207	1 074	46	238
Sinca	47.2	246	46	237

Compressor seals – 82% Leak
Pressure safety valves – 45% Leak
Valve stem packings – 35% Leak

Measurement Data for China

Pipeline	Length (km)	Methane Emissions (tonnes/y)	Methane Emissions/km (t/year/km)	Annual Throughput (10^9 m^3/y)	Methane Emissions/Throughput (percent)
Production and Gathering System in China	**4,687**	**77,628**	**16.6**	**3.325**	**3.53**
Transmission/ Distribution System in China	**2,952**	**21,620**	**7.2**	**3.15**	**1.06**
U.S. Gas Production and Gathering System[3]	**144,036**	**1,080,000**	**7.5**	**609**	**0.26**
U.S. Gas Transmission Pipeline[3,4]	**450,777**	**1,040,000**	**2.3**	**526**	**0.28**
Canadian Transmission System[5]	**15,520**	**85,892**	**5.5**	**81.2**	**0.15**

Differences in Design Approaches

Potential Barriers

- Absence of domestic or foreign financial support.
- Lack of data for proper evaluation of opportunities by the investment and banking communities.
- Reluctance of industry and government agencies to release information due to perceived security issues.
- Domestic energy pricing polices that do not reflect the actual cost of energy supply.
- Resource ownership issues and corruption.
- Validation & verification of reductions are potentially difficult and costly.

Noteworthy Considerations

- Simply burning methane instead of venting it reduces GHG emissions by a factor of 7.8.

- Flare gas recovery:
  - 9.2 percent of conserved gas is consumed as fuel (production, processing and transmission).
  - Negative GHG reduction if venting and fugitive equipment leaks >13% of system throughput.
    - Losses >0.7% of gas system throughput are high.
    - Russia (Gazprom) claims losses of 5 to 10%+
    - Some eastern block countries claim losses of 10 to 30%.
    - Theft a potential factor in many of these cases.

Conclusions

- Optimized or targeted approach is warranted.
- Oil Systems:
  - Opportunities for large reductions in venting/flaring through conservation of associated gas.
  - Economic access to local markets or practicable opportunities to re-inject or utilize the gas production are critical.
  - Best opportunities at central batteries and heavy oil batteries.
- Gas Systems:
  - Value of gas increases in moving downstream while emissions tend to increase in moving upstream (i.e., more infrastructure, more venting and flaring).
  - Gas transmission systems primarily candidates for leak control.
  - Gas plants and gathering compressor stations candidates for energy management & leak control opportunities.