Marcellus Shale Production Facility
Emissions: Leak Detection Field Study

NOVEMBER 9, 2017
SUMMARY

- How many leaks? - Implementation of field-wide Leak Detection and Repair (LDAR) program generated ~68% reduction in fugitive leaks

- Where are leaks occurring? - Atmospheric stock tanks are the main contributor of emissions within a production facility

- Proper tank vent valves and set point selection are critical for reducing emissions & leak points
• Continued good environmental stewardship
• New regulations
• Public scrutiny
• Product loss
LEAK DETECTION AND REPAIR (LDAR) – AREA OF STUDY

Dry Gas + Wet Gas (60° API+)
~1000 horizontal wells
3000-5000 potential leak sources
~1MM field-wide
DEFINITION OF A LEAK

Any venting of gas or vapors to atmosphere when:

1. Outside design parameters or equipment set points

2. And visible with an optical gas imaging camera

Example: Leaking Weighted Thief Hatch (older industry standard)
DEFINITION OF A LEAK

Any venting of gas or vapors to atmosphere when:

1. Outside design parameters or equipment set points

2. And visible with an optical gas imaging camera

Example: Leaking Stainless Fitting (solenoid)
WHERE ARE LEAKS OCCURRING?

Key takeaways:

- Total leaks over 1-year period
- 77% of leaks are tank related (i.e. PRVs, thief hatches)
- 13% from Gas Production Units (GPU)
WHERE ARE LEAKS OCCURRING?

**Tank Leaks Detected (Q2 2015 - Q2 2016) in liquids-rich areas**
- Emergency Vent: 2
- Fitting/Piping: 5
- Tank Transmitter: 4
- Thief Hatch: 1
- Working Vent: 3

**GPU Leaks Detected (Q2 2015 - Q2 2016) in liquids-rich areas**
- Fitting/Piping: 2
- Pneumatic Device: 1
- Regulator: 4
- Valve: 3
REDUCTION IN OPTICAL GAS IMAGING LEAKS

31% decrease year over year

44% decrease year over year

Why the increase with non-tank leaks?

• Averaging 30-40 new non-tank leaks per quarter
• Have reached a ‘maintenance mode’ – fixing new leaks

(Leaks per Producing Wells)

Date of Inspection (Quarter)

Q2 2015
Q3 2015
Q4 2015
Q1 2016
Q2 2016
Q3 2016
Q4 2016
Q1 2017
Q2 2017
Q3 2017

Normalized Leaks

0.85
0.85
0.66
0.57
0.59
0.52
0.33
0.25
0.21

Color by Tank Leaks
• All Other Components
• Tank Related
NON-TANK LEAKS – MAIN CONTRIBUTORS

 Relay – degradation of seal, which leads to leaking - elastomer upgrade

 Pneumatic ESD – either packing or actuator diaphragm – elastomer upgrade/OGI testing prior to installation
TANK VENTING DESIGN

- Fewer leak sources
- Improved sealing
- Tank protection

Thief hatch - Accounted for >50% of leaks on tanks
PREVIOUS TANK VENTING DESIGN

Thief Hatches (various styles)
PREVIOUS TANK VENTING DESIGN

Emergency Relief (12")
PREVIOUS TANK VENTING DESIGN
ENHANCED TANK VENTING DESIGN

Lock-down Style
Thief Hatch
ENHANCED TANK VENTING DESIGN

12" Emergency Relief Valve
Over-pressure & vacuum protection

Improvements:
• SS pallet seat vs. aluminum
• Uniform weight distribution
• Elastomer selection
ENHANCED TANK VENTING DESIGN

Pilot-operated working vent (leak tight to set point)
Weight Operated Valve

Seat load decreases with increasing tank pressure and is at minimum just below set point.

Pilot Operated Valve

Seat load increases with increasing tank pressure and is at maximum just below set point.

PILOT OPERATED VALVES
TANK VENTING DESIGN – LEAK TIGHT
THIEF HATCH REPLACEMENT EXAMPLE

Challenges:

1. “Bubble-tight” seal required
2. Maintain flow capacity
3. Provide pressure/vacuum relief and tank access
TANK VALVE MAINTENANCE

- Leaks will develop over time (even on the best valve technology)

- However - Any leaks on new tank valves can be corrected by cleaning and/or replacing diaphragms

- Parts are readily available to correct leaks

- Future work needed on diaphragm elastomer longevity
ATTENTION TO DETAIL

Pressure Sealing Washers

Damage to Pallet

Mechanical Deformation
CONCLUSIONS

• Possible to significantly reduce fugitive leaks over a relatively short period of time for upstream O&G

• Focus on atmospheric stock tank valve design is essential – almost 80% of fugitive leaks are at the tank battery

• Leaks from other sources are minor and easily corrected (only 1 new leak per ~25 wells per quarter)
QUESTIONS?
NON-TANK LEAKS – WHY THE INCREASE?

- Two quarters without inspections/leak corrected prior to Q2 2017 – More leaks started during that timeframe
- Q2 2016 and Q2 2017 leak distributions are very similar
- Data shows 30-40 new non-tanks leaks per quarter

KEY TAKEAWAY – Field is approaching a “maintenance mode” for non-tank leaks

Q2 2016
- GPU, 44 (55.7 %)
- Flash Separator, 7 (8.9 %)
- Horizontal Separator, 4 (5.1 %)
- Wellhead, 15 (19.0 %)
79
No prior quarter inspection

Q3 2016
- GPU, 18 (41.9 %)
- Flash Separator, 3 (7.0 %)
62

Q2 2017
- GPU, 43 (57.3 %)
- Wellhead, 11 (14.7 %)
- Horizontal Separator, 6 (8.0 %)
- Wellhead, 20 (26.5 %)
75
No prior quarter inspection
COST OF LEAK REDUCTION

Tank Valve Upgrades

Annual Spend (M$)

2015 → 2018 = $3.5MM
2015 → 2018 = $3.5MM + maintenance/labor
~$4.7MM

Almost all upgrades go above & beyond current regulations

Older sites and working vent replacements
‘Rippling’ effect caused by mechanical deformation – often installed on vacuum pallets

Test concluded = > 7 months without leak
“Optical gas imaging equipment is capable of imaging a gas that is half methane, half propane at a concentration of 10,000 ppm at a flowrate of ≤60g/hr from a quarter inch diameter orifice”