Investigation of Fugitives and Venting from Fixed-Roof Storage Tanks

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Bottom-up emission inventories may underestimate storage tank emissions.

WHY?
Investigate Root-Causes of Fugitives & Venting

- Desk-top review of field data from 2018 & 2019 campaigns:
  - Energy Efficiency **Alberta** Baseline Opportunity Assessments (38 AB tanks).
  - **British Columbia** Climate Action Secretariat & ECCC Methane Field Study (9 tanks).

- IR camera videos identified ‘excessive’ tank emissions.

- 9 companies volunteered data & investigated possible root-causes.

- Observed three tank emission categories:
  1. Volatile liquid flashing (venting)
  2. Tank-top equipment component leak (fugitive)
  3. Unintentional gas carry-through (fugitive missing from bottom-up inventory)
Propose Field Troubleshooting Decision Tree

• Incorporate into Fugitive Emission Management Programs (FEMP).
• Systematic first attempt at root-cause identification.
• Used during LDAR surveys.
• Relevant to:
  • Uncontrolled storage tanks (controlled tanks source of component leaks).
  • Water and Hydrocarbon storage tanks.
  • Continuous venting (intermittent vent indicator of normal operation).
Root Cause = Malfunctioning Level Controller (hung-up float)

Continuous Venting from Uncontrolled Tank

Trace piping from tank to upstream vessel

- Frequent or Continuous Dump Events
- Sustained Low Liquid?

Check level gauge
Continuous Venting from Uncontrolled Tank

Trace piping from tank to upstream vessel

Check level gauge

Sustained High Liquid?

Frequent or Continuous Dump Events

Root Cause = Inefficient Separation (Insufficient Residence Time)
Root Cause = Passing Dump-Valve

Check level gauge

Frequent or Continuous Dump Events

Yes

Sustained Low Liquid?

No

Vessel is not Root Cause

Check next vessel

No

Check dump-valve noise

Yes

Sustained High Liquid?

No

No

No
Volatile Liquid Flashing

• If no equipment malfunctioning, tank emissions entirely from volatile liquid flashing. Confirm compliance with regulated methane venting limits.

• Quantify flashing using Gas-to-Oil Ratio (GOR) according to D017:
  • Direct measurement of gas and oil produced over 24 hour test period.
  • Pressurized sample and pressure-volume-temperature (PVT) analysis by laboratory.
  • Pressurized sample, compositional analysis by laboratory and simulation program.

• Validate pressurized sample integrity for reliable GOR:
  • Confirm simulated bubble point pressure is close to field sample (source) pressure.
  • Colorado Air Pollution Control Division (AP Memo 17-01) recommends range of acceptable percent differences.
Volatile Liquid Flashing

• When site-specific details are not available (e.g., emission inventories), use simple correlations to estimate GOR.

• Valko and McCain (2003) recommended for stock tank oil with API gravity between 6.0° and 56.8°.

• Vasquez & Beggs (1980) or D017 ‘Rule of Thumb’ recommended for condensates with API gravity greater than 56.8°.
Techno-Economic Assessment of Mitigation Options

• Design memorandums developed by

  • Relevant venting range of 42 to ~3000 m³/day (i.e., regulated methane limits).
  • 10 mitigation options investigated. Applicability depends on site features.
    • Capture vapours off tank top versus a flash vessel.
    • Conservation versus flaring.
  • Process flow diagrams.
  • Total Installed Capital Cost (TICC) estimates.

• Used for economic assessment (net present value and abatement cost curves).
Case #9: Tank Top to VRU for Gas Sales

Tank vent rates for which project is economic at the upper bound of levelized federal carbon pricing ($80 per t CO2E)

Tank vent rates for which project is economic at $46 per t CO2E carbon price

Average Abatement Cost (Base case, CH4 GWP = 25)
Average Abatement Cost (Base case, CH4 GWP = 34)

Upper bound levelized carbon price of $80 per t CO2E
Levelized carbon price of $46 per t CO2E

Abatement Cost ($ per t CO2E avoided)

0 50 100 150 200 250

0 200 400 600 800 1,000 1,200 1,400 1,600 1,800 2,000 2,200 2,400 2,600 2,800 3,000

Tank Vent Rate (m³ per day)