Preventing Routine Tank Venting – A Transient Approach to the Design of Production Tank Battery Control Systems

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Overview

• The Problem: Routine Venting
• Causal Analyses: Transient Model
• Solutions and Benefits
• Case Studies
• Q&A
ROUTINE VENTING FROM
CONTROLLED TANK BATTERIES
Objective Hierarchy: Venting

- Eliminate “routine venting” of unburned gases
- Reduce the volume of vented gas
  - planned and unplanned nonroutine venting (e.g. maintenance and repair)
- Improve efficiency of vent systems

Alberta Energy Regulator Directive 060, 2018
What is “Routine Venting?”

• “Routine” applies to continuous or intermittent venting that occurs on a regular basis due to normal operation.

• “Nonroutine” venting is intermittent and infrequent and may be planned or unplanned.

• Normal operation generally means all periods of operation other than malfunction, maintenance and repair.
Routine Venting During Normal Operation?
Tank systems are designed to open to atmosphere during over-pressure or vacuum conditions to protect structural integrity.
Causes of “Routine Venting”

Improper O&M
- Degraded Seals
- Stuck Dump Valve
- Carelessness
- Poor Maintenance

O&M Solution

Improper Design
- Undersized – unable to handle all vapors
- Oversized – low-flow conditions

Engineering Solution

Comprehensive Solution
Continuous Improvement Process – Tank VCS Design

Engineering Design or Redesign

Corrective Action: Repair or Replace

Installation, Operation and Maintenance

Best Practices: Inspections/LDAR, Monitoring
ENGINEERING DESIGN ASSESSMENT
1. Determine whether or not VCS capacity is of sufficient design and capacity to ensure that all gas/vapor emissions from the storage vessel are routed to the control device with no routine venting.
2. Establish boundary parameters within which battery VCS capacity is sufficient

3. Target bottlenecks and cost-effective engineering solutions to optimize system
Design Assessment – Steps

1. Quantify Vapor Into System
   Potential Peak Instantaneous Vapor Flow Rate (PPIVFR)
2. Determine System Capacity
   A transient approach includes accumulation in system
3. Compare PPIVFR and Capacity
   Can system accommodate PPIVFR with no venting?
4. Identify Cost-Effective Solutions
   Increase capacity and/or decrease PPIVFR
What is VCS Capacity?

Volume of gas that can be accommodated by VCS without exceeding pressure relief setpoints during “normal operations”
Capacity Limitations

• Primary limiting factor – pressure
  – Physical volume of system vapor space
  – Losses in VCS piping/fittings, flame arrestor and combustor/flare
  – Pressure relief (thief hatches, PRDs) set points
Why A Transient Model?

- Oil and gas production facilities are dynamic systems
- Can account for accumulation (surge) capacity
- Trend pressure versus time
- Create optimal design and operating parameters
STED A Transient Model for Storage Tank VCS Systems

### Storage Tank Emissions Design Model

**Output**

<table>
<thead>
<tr>
<th>Site Name:</th>
<th>Example 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Client Name:</td>
<td>XYZ Petroleum</td>
</tr>
<tr>
<td>Location:</td>
<td>Weld County, Colorado</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Peak Instantaneous Flow Rate</th>
<th>System Capacity at Design Pressure</th>
<th>System Capacity at Relief Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil Tank Flash (scfh)</td>
<td>Burner Capacity (scfh)</td>
<td>Burner Capacity (scfh)</td>
</tr>
<tr>
<td>Water Tank Flash (scfh)</td>
<td>8,327</td>
<td>8,917</td>
</tr>
<tr>
<td>Working (scfh)</td>
<td>Vent Valve Capacity (scfh)</td>
<td>Vent Valve Capacity (scfh)</td>
</tr>
<tr>
<td>Breathing (scfh)</td>
<td>11,304</td>
<td>12,057</td>
</tr>
<tr>
<td>Other Sources (scfh)</td>
<td>Surge Capacity (scfh)</td>
<td>Surge Capacity (scfh)</td>
</tr>
<tr>
<td>Total (scfh)</td>
<td>21,844</td>
<td>24,564</td>
</tr>
</tbody>
</table>

- Total (scfh): 15,572
- Peak Tank Pressure (oz/in²): 10.14
- Flow Out Thief Hatch (scfh): 0

### Tank Pressure Over Time

- Water Tank Thief Hatch Setting
- Oil Tank Thief Hatch Setting
- Tank Pressure
- Design Pressure

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global environmental solutions
Example 1: Inadequate Design

- Tank Over pressured

Pressure (oz/in²) vs. Time (Minutes)

- Tank Pressure
- Thief Hatch Set Point
Example 2: Adequate Design

Peak Tank Pressure 13.25 oz/in²
<table>
<thead>
<tr>
<th>Objective</th>
<th>Solution</th>
</tr>
</thead>
</table>
| Increase VCS Capacity      | Increase vapor surge capacity (empty space) – e.g., “bottom out” tanks or engineered tank liquid height limits  
- *Repurpose surplus tanks from over-designed systems*  
Increase pressure relief device (PRD) set points  
Eliminate liquid accumulation in VCS piping  
- *aboveground piping optimal*  
Increase pipe/fittings diameter, remove unnecessary fittings and bottlenecks  
Additional or larger flares/burners, burner management systems |
| Decrease PPIVFR            | Staged separation or VRT to reduce flash in tanks  
- *Repurpose surplus vessels from over-designed systems*  
Reduce dump valve body and/or valve trim size |
Additional Benefits

- Eliminate routine venting, subject to proper O&M
- No production curtailment
- Little or no CAPEX($)
- Standardize design for future surface sites
- Optimize existing operations
- Reduce pad footprint for overdesigned systems
- Improved public relations
Transient Engineering Design Evaluation

CASE STUDIES
Case 1: Field-Wide Optimization
Case 1: Field-Wide Optimization

- 288 geographically dispersed multi-well batteries in Denver-Julesburg Basin
- Conventional and unconventional wells
- Gathered field-verified VCS parameters
- Developed model inputs and engineering boundary parameters
- Transient process modeling
- Targeted optimization measures
Case 1: Modeling

Transient Engineering Analysis to Identify Each Tank System VCS that was
• Adequately- or over-designed
  – Peak Tank Pressure < Relief/Design Pressure
• Under-designed
  – Peak Tank Pressure ≥ Relief/Design Pressure
Case 1: Solutions

- Increase Vapor Accumulation (Surge) Capacity
  - “Bottom Out” tank(s) (isolate from liquid service)
  - Relocate tank(s) from over-designed sites
- Decrease Vapor Flow into System
  - Relocate Vapor Recovery Tower(s) from over-designed sites to reduce solution gas
- Increase Combustor Capacity
  - Burner management systems for low-flow
  - Relocate combustor(s) from over-designed sites
Case 1: Results

- Eliminate routine venting resulting from inadequate design
- No complete re-design, no curtailment of production
- Asset-wide cost savings >$2M USD so far
- Reduced pad footprint for downsized sites
- Field operations awareness and engagement culture
- Regulator and public stakeholder relations
Case 2: Asset-Wide Design Analysis
Case 2: Asset-Wide Design Analysis

- U.S. EPA Settlement
- 170 oil and gas well pads in Williston Basin
- Developed Engineering Modeling Guideline
  - Determine PPIVFR
- Grouped similar Tank Systems
- Developed Engineering Design Standards for each Tank System group
  - Tank Systems meeting boundary criteria presumed to be adequately sized
Case 2: Results

EPA estimates system upgrades “will reduce the emission of at least 11,700 tons of VOCs, 400 tons of hazardous air pollutants, primarily benzene, toluene, ethylbenzene and xylenes, and 2,600 tons of methane annually.”
To Learn More

Colorado Air Pollution Control Division
Storage tank and vapor control system guidelines
https://www.colorado.gov/cdphe/air-oilandgas-storagetankguidelines
Questions?

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