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Utilization of a Vapor Recovery Tower For The Reduction of Tank Emissions

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Agenda

- Need & Concerns
- VRT Functionality
- Process Model
- Benefits of Limiting Tank Flash
- Benefits of Higher MAWP of VRT
- Considerations
- Summary & Conclusions
- Q&A

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Need & Concerns

The Issues and Concerns That Exist Today

Need: Atmospheric Tank Design

- General design criteria: API 12F [1]
  - 90-500 BBL tanks design:

Table 1: API 12F Tank Design Pressures

Design Vacuum	$^1/_2 \frac{oz}{in^2}$
Design Pressure	$16 \frac{oz}{in^2}$
Emergency Venting	$24 \frac{oz}{in^2}$

- Relief methods
  - Vent Line
    - Creates back pressure
    - Large line size
  - Thief/Gauge hatches
    - Sealing concerns: (reseating & wear)
    - Flame propagation

Need: Vapor Recovery Unit

- Operating VRU on tank vent line
  - Small suction pressure range
  - Potential to pull vacuum
  - Oxygen in tanks from tank breathing & gauging
    - Compressing air and gas
    - Oxygen in sales line

(Unimac Gas Compression Solutions)[2]

Need: Operator Safety

- Tank gauging process
  - Open thief hatch
  - Lower tank gauge tape
  - Standing over/by hatch

- Operator exposed to flashed gas
  - Explosive, irritant, & asphyxiant
  - Possibility of H_2S

Need: New Regulations

- 40 CFR 60, Subpart OOOO
  - Tanks with more than 6 tons/year VOC
- Colorado:
  - CDPHE: Regulation 7
  - COGCC: Series 800

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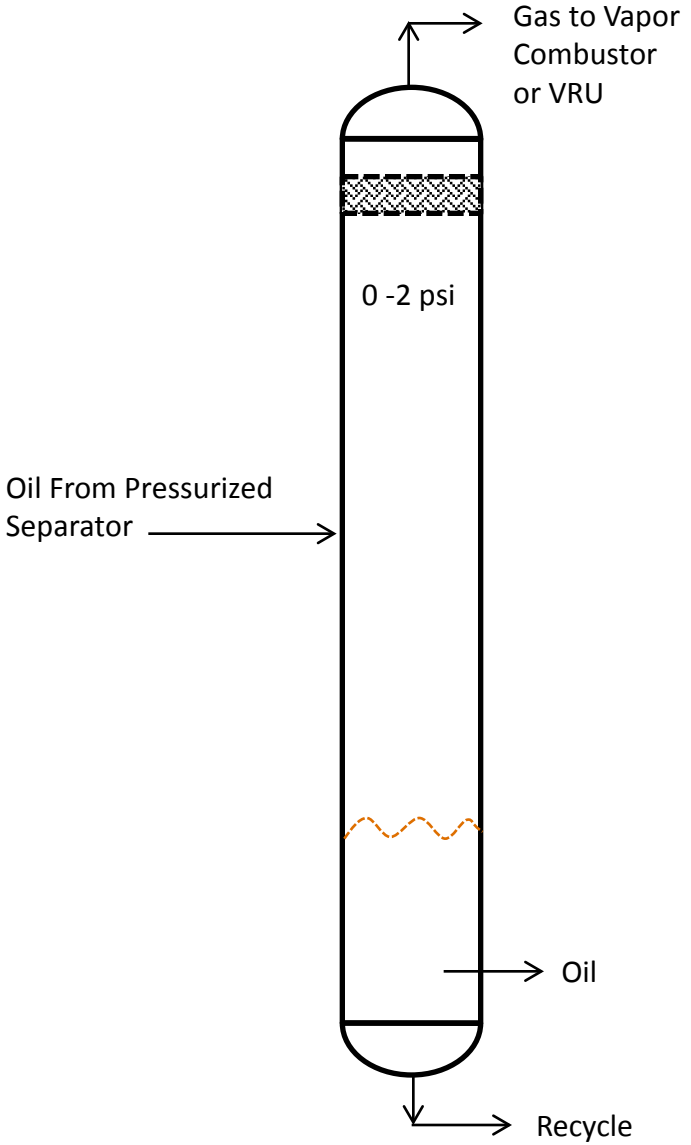
Vapor Recovery Tower

VRT: Functionality & Computer Models

VRT: Functionality

- Separation mechanisms:
  - Low pressure: Flashing of light ends
  - Greater diameter than inlet: lower velocity lessens gas entrainment
  - Vessel height: gravitational separation
  - Mist pad: Liquid impingement
- Stream destinations
  - Gas: Combustion device/VRU
  - Oil: Oil tanks
  - Recycle: Separator inlet



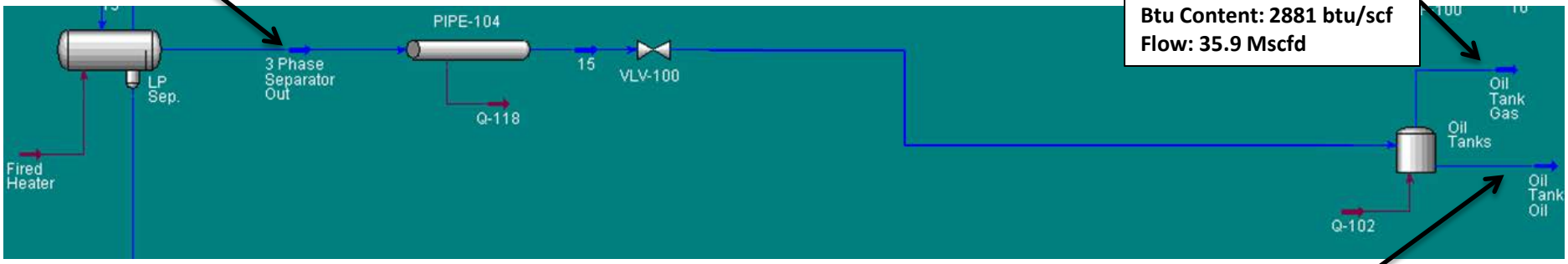
VRT: Functionality

- Vessel construction
  - Larger pressure operating range
    - Pressure vessel: makes higher operating pressure possible
    - Fluid driven by hydraulic head: Makes low-pressure operation possible
  - No low-pressure/vacuum vents
    - No process gas to environment
    - No oxygen can enter

Process Model[3]: Without VRT

Temp: 120°F
Pressure: 39.7 psia
API Gravity: 51.1
Flow: 1030 bbl/day

Temp: 108°F
Pressure: 12.7 psia
Btu Content: 2881 btu/scf
Flow: 35.9 Mscfd



Temp: 108°F
Pressure: 12.7 psia
API Gravity: 49.6
Flow: 1005 bbl/day

Sales Gas Properties

Temp: 70°F
Pressure: 39.7 psia
Btu Content: 1397 btu/scf
Flow: 704 Mscfd

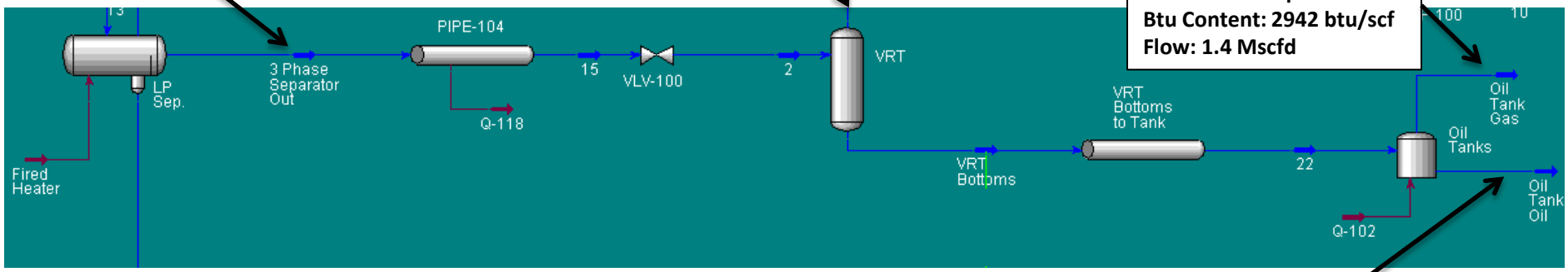
***Note:** Atmospheric pressure is based off of Denver, CO [12.2psia]

Process Model[3]: With VRT

Temp: 120°F
Pressure: 39.7 psia
API Gravity: 51.1
Flow: 1030 bbl/day

Pressure: 13.7 psia
Btu Content: 2825 btu/scf
Flow: 34 Mscfd

Temp: 112°F
Pressure: 12.7 psia
Btu Content: 2942 btu/scf
Flow: 1.4 Mscfd



Temp: 106°F
Pressure: 12.7 psia
API Gravity: 49.7
Flow: 1005 bbl/day

Sales Gas Properties

Temp: 70°F
Pressure: 39.7 psia
Btu Content: 1397 btu/scf
Flow: 704 Mscfd

***Note:** Atmospheric pressure is based off of Denver, CO [12.2psia]

Process Analysis

Table 2: Tank Flash Gas Comparison

	With VRT	Without VRT
Initial Production Rate	1.4 (Mscfd)	35.9 (Mscfd)
Yr. 1 Average Rate	0.7 (Mscfd)	17.95 (Mscfd)
Yr. 1 Total Volume	255.5 (Mscf)	6,552 (Mscf)
Yr. 1 Total VOC	4.5 tons	115 tons

Assumptions:

1. 35 lb/Mscf VOC emissions factor
2. Decline rate based of unconventional decline curve and equates to the average first years production being 50% of initial production
3. Based on 1000 bbl/day initial production

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Vapor Recovery Tower: Installation Consideration

VRT: Benefits and Considerations

VRT: Benefits of Installation

- Limits volumetric gas flow through tanks
  - Less back pressure on tanks
    - Keep thief hatches from opening
      - Lower uncontrolled emissions
      - Increase process/operating safety (ignition potential)
    - Manual tank gauging
      - Limits emissions while hatch is open
      - Reduces operators risk
        - Explosion/fire
        - Operator exposure/H_2S hazard
    - May allow vent line size reduction
      - Lower material cost
      - Lower labor cost
      - Lower construction time
    - Quad O

VRT: Benefits of Installation

- Allows for higher working pressure of gas
  - Easier measurement if desired
    - Flow meter can be allowed to create lbs. of back pressure
    - Measurements can be more accurate
  - Higher pressure to combustor
    - Move more gas volume
    - Higher burner tip velocity
      - Better fuel air mixing
      - Better combustion of heavier components
  - Protection for tank overpressure
    - Oil dump valve sticking open
    - High oil dump rate
  - Higher VRU suction pressure
    - May simplify controls
    - Protect from pulling vacuum on tanks

VRT: Added Benefits

- Additional point for separation
  - Water off the bottom of the tower
  - Mist pad to coalesce entrained liquid in gas
- Liquids surge vessel
  - More continuous flow to tanks
  - Help eliminate liquid slugging in tanks
  - Lessen pressure spikes due to filling tank

VRT: Special Considerations

- Stake holder view/height restriction
- Additional capital cost
- Lightning strike concerns
- Process considerations

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Summary & Conclusion

Summary/Conclusions

- Installation of a VRT can be used as an engineering solution to reduce VOC emissions
- Installation of a VRT can help to improve operator/process safety
- Installation of a VRT gives you additional overpressure/vacuum protection for atmospheric tanks
- Installation of a VRT would lessen the likelihood of gauge hatches unseating and thus lower the chance of infractions
- Cost, stakeholder perspective, lightning risk, and process conditions must be examined when considering VRT installation

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Questions & Answers

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— Beth Aldrich, Environmental Coordinator

Citations:

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2. *Unimac Gas Compression Solutions*. Unimac, 2013. Web. 17 Sept. 2013. <http://www.unimaclp.com/>.
3. *Aspen HYSYS*. Vers. V7.3. N.p.: Aspen Technology, Inc, n.d. Computer software.

Biography

- Bachelor of Science in Mechanical Engineering
  - Texas A&M: graduated *magna cum laude*
- Research Positions
  - High temperature metallic/ceramic compounds: 2yr
  - Down-hole shaped charge design: 1yr
- Oilfield Positions
  - Downstream refining
    - Projects engineer: 2010
    - Maintenance engineer:2011
  - Exploration & production
    - Facilities engineer: 2012-present