

Use of Vapor Recovery Towers & VRU's to Reduce Emissions

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Why the current focus on tank battery emissions?

- **Technology advancements to see and analyze these gas streams**
- **Realization that industry and nationwide inventories understated**
- **Dramatically higher volumes of VOC's & other contaminants**
- **Focus on reduction of greenhouse gases**
- **All resulted in heightened regulations & enforcement**



GasFindIR Camera

The invention of the FLIR Gas Find IR Camera's in 2004 allowed industry (and regulators) to see these gas streams for the first time



Understanding this gas stream

- **3 Phase separation – as pressure is reduced on the liquid, heavier hydrocarbon gases are released.**
- **Methane versus ethane, butane & propane**
- **Higher levels of contaminants & H₂S**
- **Some is heavier than air, so exposure to employees and community is higher**
- **Higher BTU, so more valuable**
 - **2,000 to 3,000 BTU vs. 1,000 BTU typical pipeline gas**
 - **Sells for 2.5X normal NYMEX gas prices**

Challenges in Compression

- **Analogy is compressing steam versus air**
- **Heavier, wetter gas stream to compress**
- **Liquids fall out in piping from tanks**
- **Dew point can cause the gas to return to liquid form at higher discharge pressures (based on compression ratios)**
- **H₂S and CO₂ (often with water vapor) cause higher levels of corrosion**
- **Volume of gas spikes & drops during separator dumps; and over life of battery**
- **Low pressure system must NEVER pull in oxygen into the pipeline**

“Best in Class” Solutions for Effective Capture & Control

Requires a Total Solutions Approach

Emission Surveys to Accurately determine volumes, gas analysis & pressures

Vapor Recovery Towers

“Real” Vapor Recovery Units

Enclosed Combusters

Maintenance & Tracking program

Vapor Recovery Tower



What is a VRT?

- A *vapor recovery tower* is a tall pressure vessel which is installed between the production separator(s) and the liquid storage tanks
- “Best in Class” VRT’s are engineered for proper retention time to allow gas to separate from the liquid, and have no potential for liquid traps in gas vapor piping to VRU.
 - Although VRT’s are normally rated for pressures between 50 and 175 psig, they typically gravity feed to the liquid storage tanks at very low pressure (~1 psig)
 - In most installations, the flash gas from the liquids in the VRT flow to a vapor recovery unit for compression



Typical Tank Battery with a Vapor Recovery Tower & VRU installed

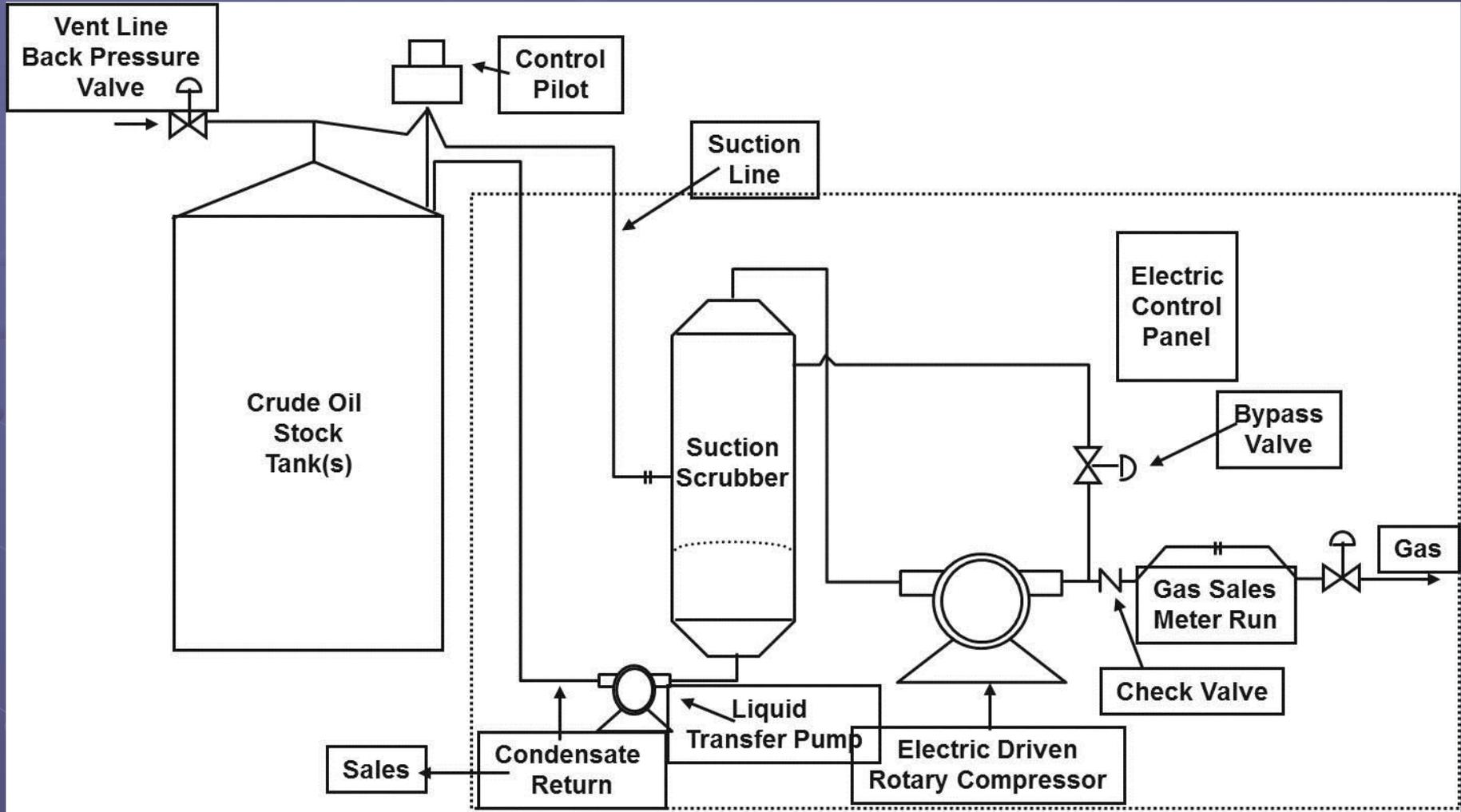


What is a VRU?

- *A vapor recovery unit is a specialized compression package designed specifically to capture low pressure, wet gas streams from oil and condensate storage tanks*
- A Vapor Recovery Unit meets the following technical definition of a VRU as defined by the Natural Gas STAR Program, the EPA, and multiple state regulatory agencies:
 - Correct compressor selection (for wet gas streams) including rotary vane, rotary screw, vapor jet, or eductor/venturi jet / Recips are not recommended
 - Pressure sensing devices off the tanks or tower
 - An automated bypass system
 - Ability to vary the speed of the compressor based on changing volumes of the gas.
- VRU's are automated systems which start, stop and bypass automatically as pressure is increased in the tanks or tower. Variable frequency drives are recommended.
- "Best in Class" VRU's incorporate Variable frequency drives for changing volumes, automation packages to document compliance, and versatile designs for long term changes in tank battery oil volumes and corrosive gas streams



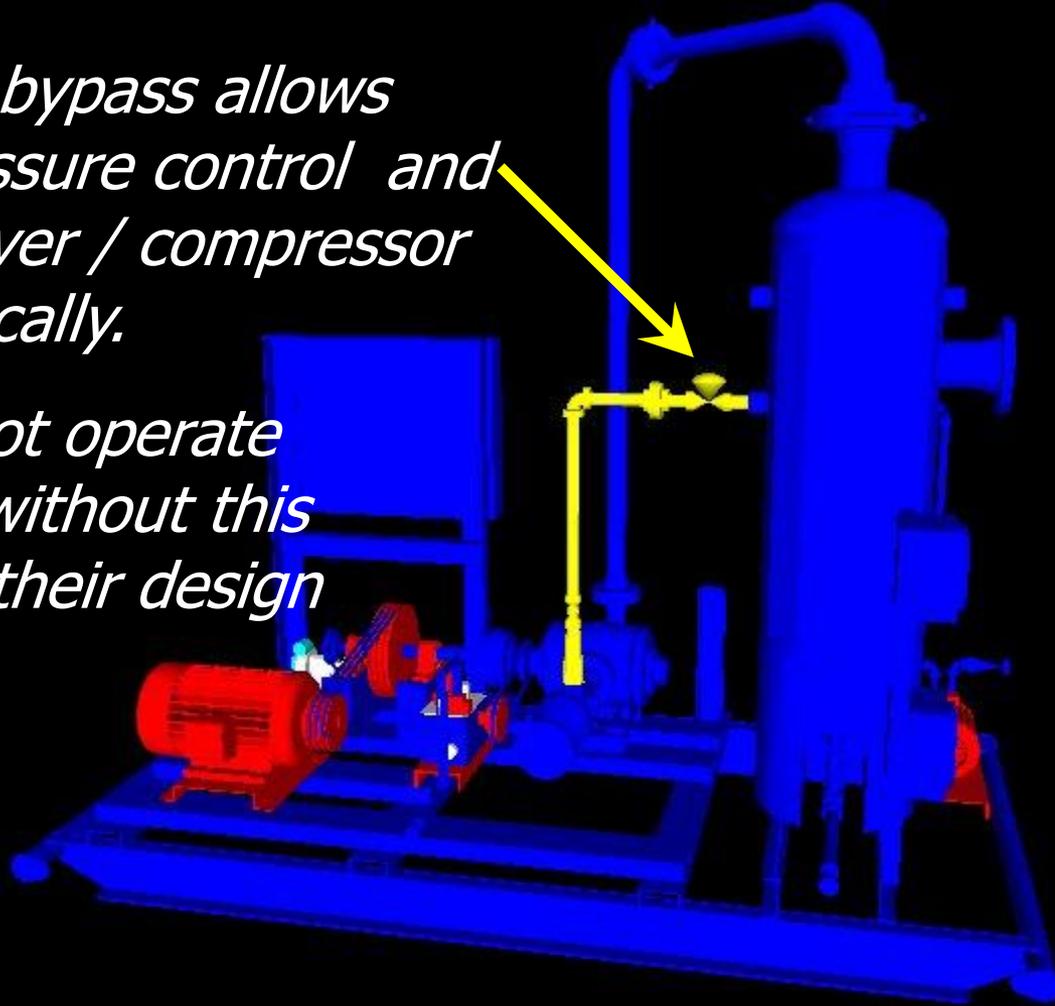
Standard Vapor Recovery Unit



System Configuration

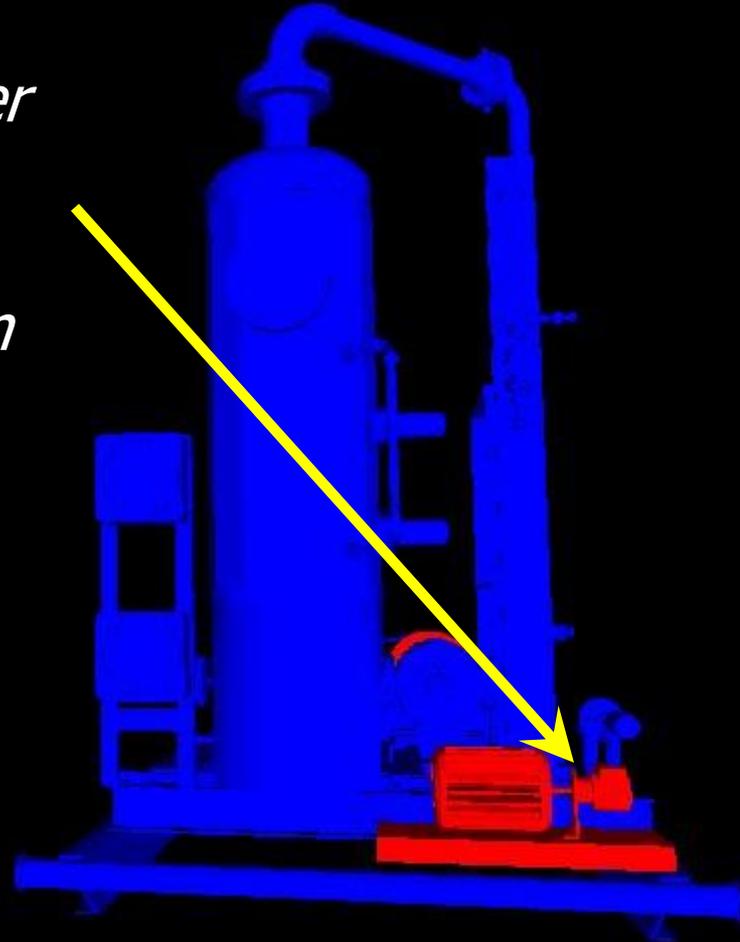
Automated bypass allows precise pressure control and extends driver / compressor life dramatically.

VRU's cannot operate effectively without this element in their design



System Configuration

Automated liquid transfer systems are imperative due to the amount of condensate derived from this wet gas stream.



Industry Experience: ConocoPhillips 2005/2006

- Vapor recovery units installed in Baker, MT
- Anticipated multiple sites, so detailed technical review of options was conducted
- Volumes per site ranged from 30 mcf/d to 400 mcf/d
- Pipeline pressure ranged from 20 to 40 psig
- Captures vapors from
 - Crude oil storage tanks
 - Produced Water tanks
 - All manifolded together in closed loop system
 - Gas blanket system used to backfill tanks













Industry Experience: ConocoPhillips

- Evaluated rotary screw, rotary vane, vapor jet and EVRU
- Selected rotary vane VRU's due to wide range of volumes of gas and low discharge pressure across the sites
- Pilot project on 3 locations, then added 6 addt'l sites
- Designed for optimum gas capture
 - Pressure transmitter on the tanks
 - Sloping lines to the VRU
 - Package specifically designed for vapor recovery service
 - Automated liquid handling and bypass systems

Industry Experience: ConocoPhillips

● Payback Economics – Project for 9 Tank Batteries

- Purchase Price for 9 VRU's \$475,000
- Estimate Install Cost \$ 237,500
- Total Capital Costs \$ 712,500

● Approx Gas Revenue

- $1,490 \text{ mcf/d} \times \$6/\text{mcf} (2005 \ \& \ 6) \times 30 \text{ days} = \$268,200/\text{mo}$
- Payback on Capital Investment < 3 months







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What is an Enclosed Combuster?

- An enclosed combuster is a form of gas flare that burns or “combusts” the gas at a much higher combustion efficiency than a typical open flare design
- The enclosed design eliminates visibility of the flame from the road or community – it appears like a piece of production equipment
- “Best in Class” enclosed combusters maintain 99% + control efficiency – which largely eliminates smoke trails and soot emissions (black carbon)
- New regulations (EPA Quad O) require data logging to document control requirements are being met.
- Testing ports for emissions testing are highly recommended for pending regulations



“Best in Class” Solution

- **Conduct emission surveys to get accurate field data on gas analysis, 24 hour volumes and required discharge pressures.**
- **Use of Vapor Recovery Towers to eliminate oxygen ingress potential, especially in truck loaded batteries**
- **Use of “real” Vapor Recovery Units to capture gas volume off the towers or tanks. Document run times & volumes. Can be used straight off tanks, or off VRTs.**
- **When volumes off tanks are below 10 to 20 mcf (company specific payback threshold), consider utilizing an enclosed combustor to burn residual gas in a prudent and compliant manner**
- **Install a maintenance program on the equipment and track / document run times and compliance**