Methane Recovery from Pneumatic Devices, Vapor Recovery Units and Dehydrators

Ministerio de Minas y Energia
Ministerio de Ambiente, Vivienda y Desarrollo Territorial
Occidental Oil & Gas Corporation and
Environmental Protection Agency, USA

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Methane to Markets

Methane Recovery: Agenda

- Pneumatic Devices
  - **Roger Fernandez, U.S. EPA**
- Vapor Recovery Units
  - **Larry Richards, Hy-Bon Engineering**
- Minimizing Emissions from Dehydrators
  - **Don Robinson, ICF Consulting**
- Discussion Questions

Pneumatic Devices

Agenda

- Methane Losses
- Methane Recovery
- Lessons Learned
- Recommendations

Methane Losses from Pneumatic Devices

- Pneumatic devices account for 24% of methane emissions in the U.S. oil and gas industry
- 84% of pneumatic devices emissions come from oil and gas production
  - **800,000 pneumatic devices in the US production sector**
- Remaining 16% is from the transmission sector and an insignificant portion from gas processing
  - **80,000 pneumatic devices in the US transmission sector**

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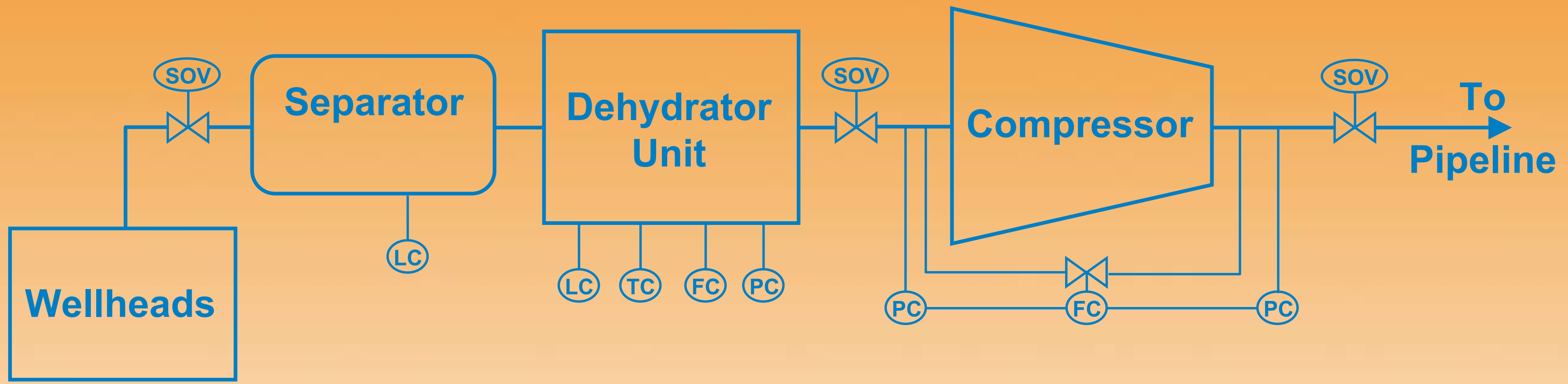
Location of Pneumatic Devices at Production Sites



SOV	=	Shut-off Valve (Unit Isolation)
LC	=	Level Control (Separator, Contactor, TEG Regenerator)
TC	=	Temperature Control (Regenerator Fuel Gas)
FC	=	Flow Control (TEG Circulation, Compressor Bypass)
PC	=	Pressure Control (FTS Pressure, Compressor Suction/Discharge)

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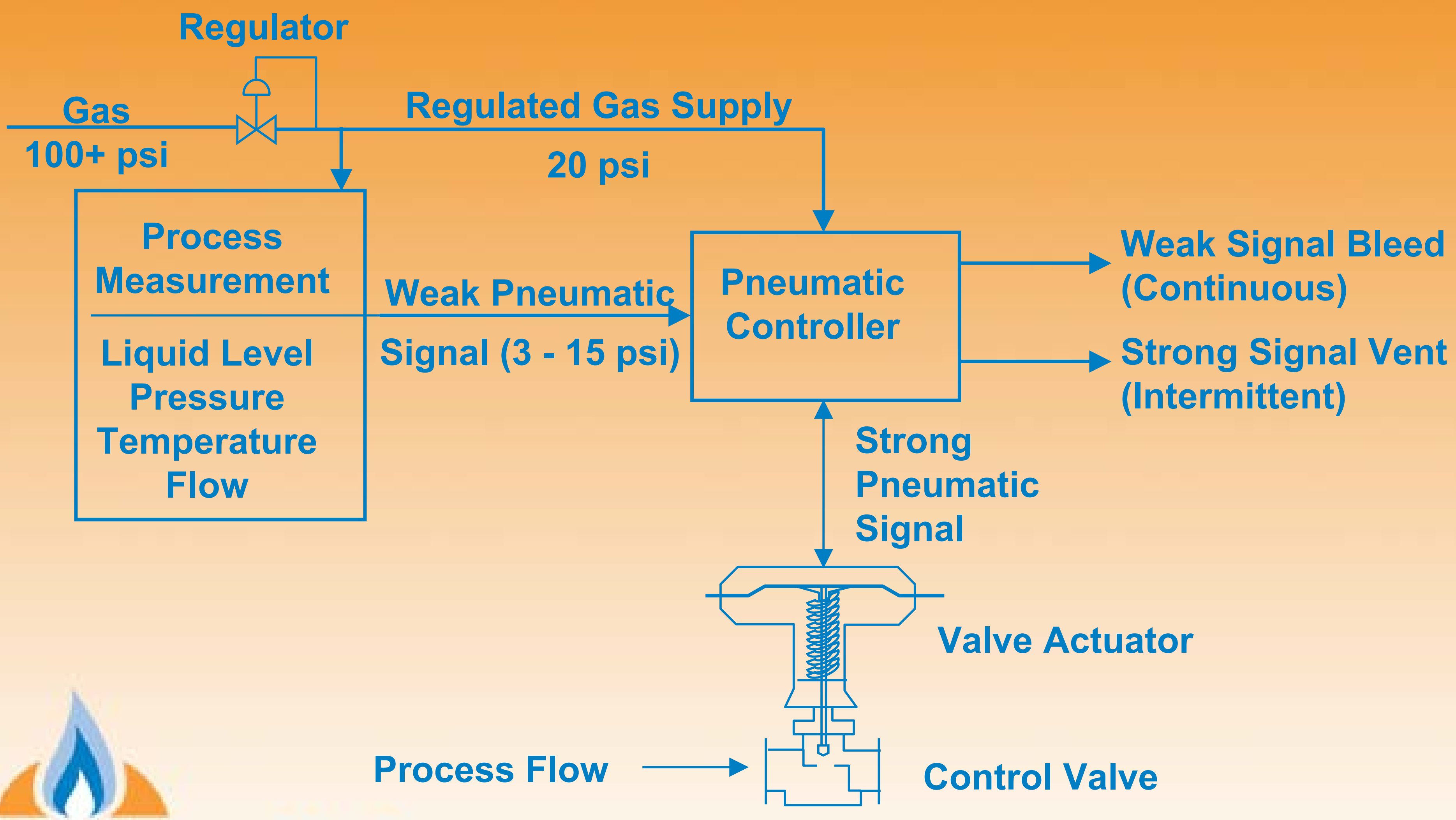
How Gas Pneumatic Devices Work



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Methane Emissions

- As part of normal operations, pneumatic devices release natural gas to atmosphere
- High-bleed devices bleed in excess of 6 cf/hr
  - **Equates to >50 Mcf/yr**
  - **Typical high-bleed pneumatic devices bleed an average of 140 Mcf/yr**
- Actual bleed rate is largely dependent on device’s design

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Methane Recovery from Pneumatic Devices

- Option 1: Replace high-bleed devices with low-bleed devices
  - **Replace at end of device's economic life**
  - **Typical cost range from $700 to $3000 per device**
- Option 2: Retrofit controller with bleed reduction kits
  - **Retrofit kit costs ~ $500**
  - **Payback time ~ 9 months**
- Option 3: Maintenance aimed at reducing losses
  - **Field survey of controllers**
  - **Re-evaluate the need for pneumatic positioners**
  - **Cost is low**
    - **Field experience shows that up to 80% of all high-bleed devices can be replaced or retrofitted with low-bleed equipment**

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Five Steps for Reducing Methane Emissions from Pneumatic Devices

1. LOCATE and INVENTORY high-bleed devices
2. ESTABLISH the technical feasibility and costs of alternatives
3. ESTIMATE the savings
4. EVALUATE economics of alternatives
5. DEVELOP an implementation plan

Suggested Analysis for Replacement

- Replacing high-bleed controllers at end of economic life
  - **Determine incremental cost of low-bleed device over high-bleed equivalent**
  - **Determine gas saved with low-bleed device using manufacturer specifications**
  - **Compare savings and cost**
- Early replacement of high-bleed controllers
  - **Compare gas savings of low-bleed device with full cost of replacement**

Implementation[a]	Replace at End of Life	Early Replacements	
		Level Control	Pressure Control
Cost ($)	210 – 350[b]	532	1,876
Annual Gas Savings (Mcf)	50 – 200	166	228
Annual Value of Saved Gas ($)[c]	75 – 300	498	684
IRR (%)	2 – 141	90	24
Payback (months)	14 – 56	13	33

[a] All data based on Partners' experiences. See US – EPA – Natural Gas Star Program's *Lessons Learned* for more information. (http://www.epa.gov/gasstar)
[b] Range of incremental costs of low-bleed over high bleed equipment
[c] Gas price is assumed to be $1.50/Mcf.

Suggested Analysis for Retrofit

- Retrofit of low-bleed kit
  - **Compare savings of low-bleed device with cost of conversion kit**
  - **Retrofitting reduces emissions by average of 90%**

	Retrofit[a]
Implementation Costs[b]	$700
Bleed rate reduction (Mcf/device/yr)	219
Value of gas saved ($/yr) [c]	329
Payback (months)	26
IRR	17%

[a] On high-bleed controllers
[b] All data based on Partners' experiences. See US – EPA – Natural Gas Star Program's Lessons Learned for more information.
[c] Gas price is assumed to be $1.50/Mcf

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Suggested Analysis for Maintenance

- For maintenance aimed at reducing gas losses
  - **Measure gas loss before and after procedure**
  - **Compare savings with labor (and parts) required for activity**

	Reduce supply pressure	Repair & retune	Change settings	Remove valve positioners
Implementation Cost ($)[a]	214	32	0	0
Gas savings (Mcf/yr)	175	44	88	158
Value of gas saved ($/yr)[b]	263	66	132	237
Payback (months)	10	6	<1	<1
IRR	121%	205%	--	--

[a] All data based on Partners' experiences. See US – EPA – Natural Gas Star Program's Lessons Learned for more information.
[b] Gas price is assumed to be $1.5/Mcf.

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Lessons Learned

- Most high-bleed pneumatics can be replaced with lower bleed models
- Replacement options save the most gas and are often economic
- Retrofit kits are available and can be highly cost-effective
- Maintenance is a low-cost way of reducing methane emissions

Recommendations

- Evaluate all pneumatics to identify candidates for replacement and retrofit
- Choose lower bleed models in new facilities where feasible
- Identify candidates for early replacement and retrofits by doing economic analysis
- Improve maintenance
- Develop an implementation plan

Vapor Recovery Units (VRUs)

Agenda

- Methane Losses
- Methane Recovery
- Quantify Losses
- Lessons Learned
- International Experiences

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Sources of Methane Losses

- Flash losses - occur when crude is transferred from a gas-oil separator at higher pressure to an atmospheric pressure storage tank
- Working losses - occur when crude levels change and when crude in tank is agitated
- Standing losses - occur with daily and seasonal temperature and pressure changes

Methane Savings: Vapor Recovery Units

- Capture up to 95% of hydrocarbon vapors vented from tanks
- Recovered vapors have higher Btu content than pipeline quality natural gas
- Recovered vapors are more valuable than natural gas and have multiple uses
  - **Re-inject into sales pipeline**
  - **Use as on-site fuel**
  - **Send to processing plants for recovering NGLs**

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Types of Vapor Recovery Units

- Conventional vapor recovery units (VRUs)
  - **Use rotary compressor to suck vapors out of atmospheric pressure storage tanks**
  - **Require electrical power or engine**
- Venturi ejector vapor recovery units (EVRU™) or Vapor Jet
  - **Use Venturi jet ejectors in place of rotary compressors**
  - **Do not contain any moving parts**
  - **EVRU™ requires source of high pressure gas and intermediate pressure system**
  - **Vapor Jet requires high pressure water motive**

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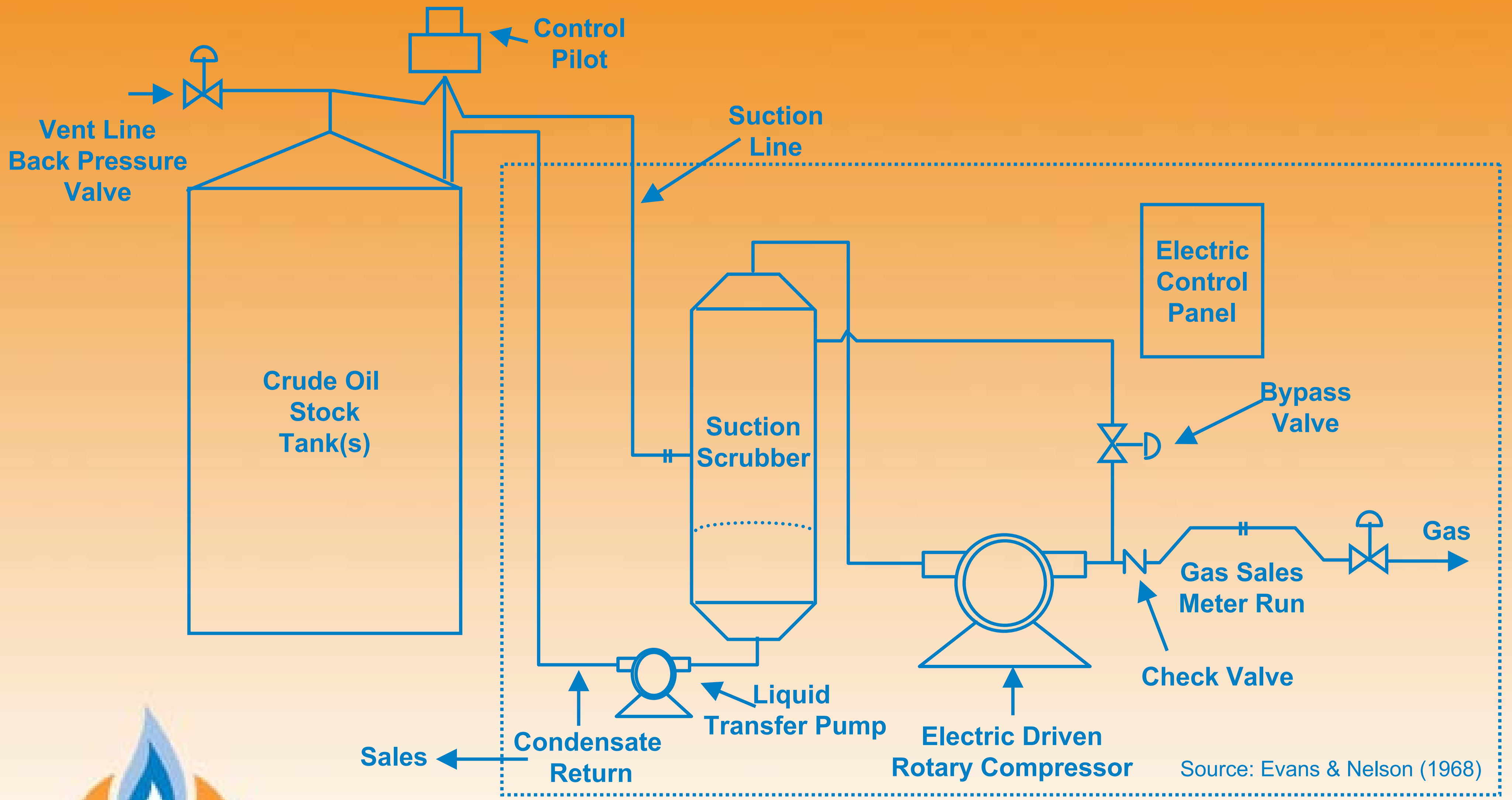
Standard Vapor Recovery Unit



Source: Evans & Nelson (1968)

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Criteria for Vapor Recovery Unit Locations

- Steady source and sufficient quantity of losses
  - **Crude oil stock tank**
  - **Flash tank, heater/treater, water skimmer vents**
  - **Leaking valve in blanket gas system**
- Outlet for recovered gas
  - **Access to gas pipeline or on-site fuel use**
- Tank batteries not subject to air regulations

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Quantify Volume of Losses

- Estimate losses from chart based on oil characteristics, pressure and temperature at each location (± 50%)
- Estimate emissions using the E&P Tank Model (± 20%)
- Measure losses using recording manometer and well tester or ultrasonic meter over several cycles (± 5%)
  - **This is the best approach for facility design**

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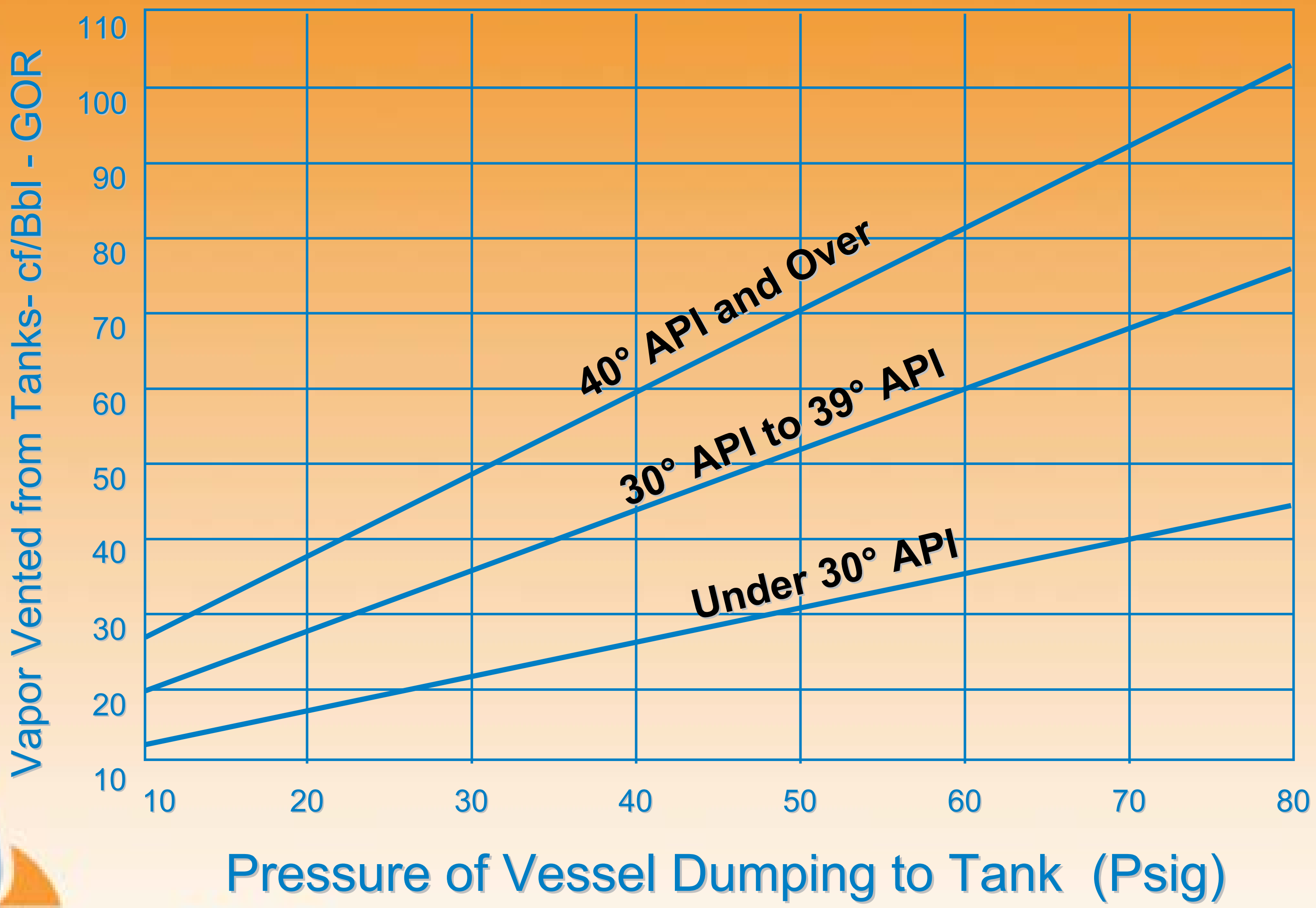
Estimated Volume of Tank Vapors



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What is the Recovered Gas Worth?

- Value depends on Btu content of gas
- Value depends on how gas is used
  - **On-site fuel - valued in terms of fuel that is replaced**
  - **Natural gas pipeline - measured by the higher price for rich (higher Btu) gas**
  - **Gas processing plant - measured by value of NGLs and methane, which can be separated**
- Value of recovered vapor calculations in the Natural Gas STAR Lessons Learned
  - **http://www.epa.gov/gasstar/pdf/lessons/ll_final_vap.pdf**

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Lessons Learned

- Vapor recovery can yield generous returns when there are market outlets for recovered gas
  - **Recovered high Btu gas or liquids have extra value**
  - **VRU technology can be highly cost-effective**
- Potential for reduced compliance costs can be considered when evaluating economics of VRU
- VRU should be sized for maximum volume expected from storage tanks (rule-of-thumb is to double daily average volume)
- Rotary vane or screw type compressors recommended for VRUs where there is no source of high-pressure gas and/or no intermediate pressure system

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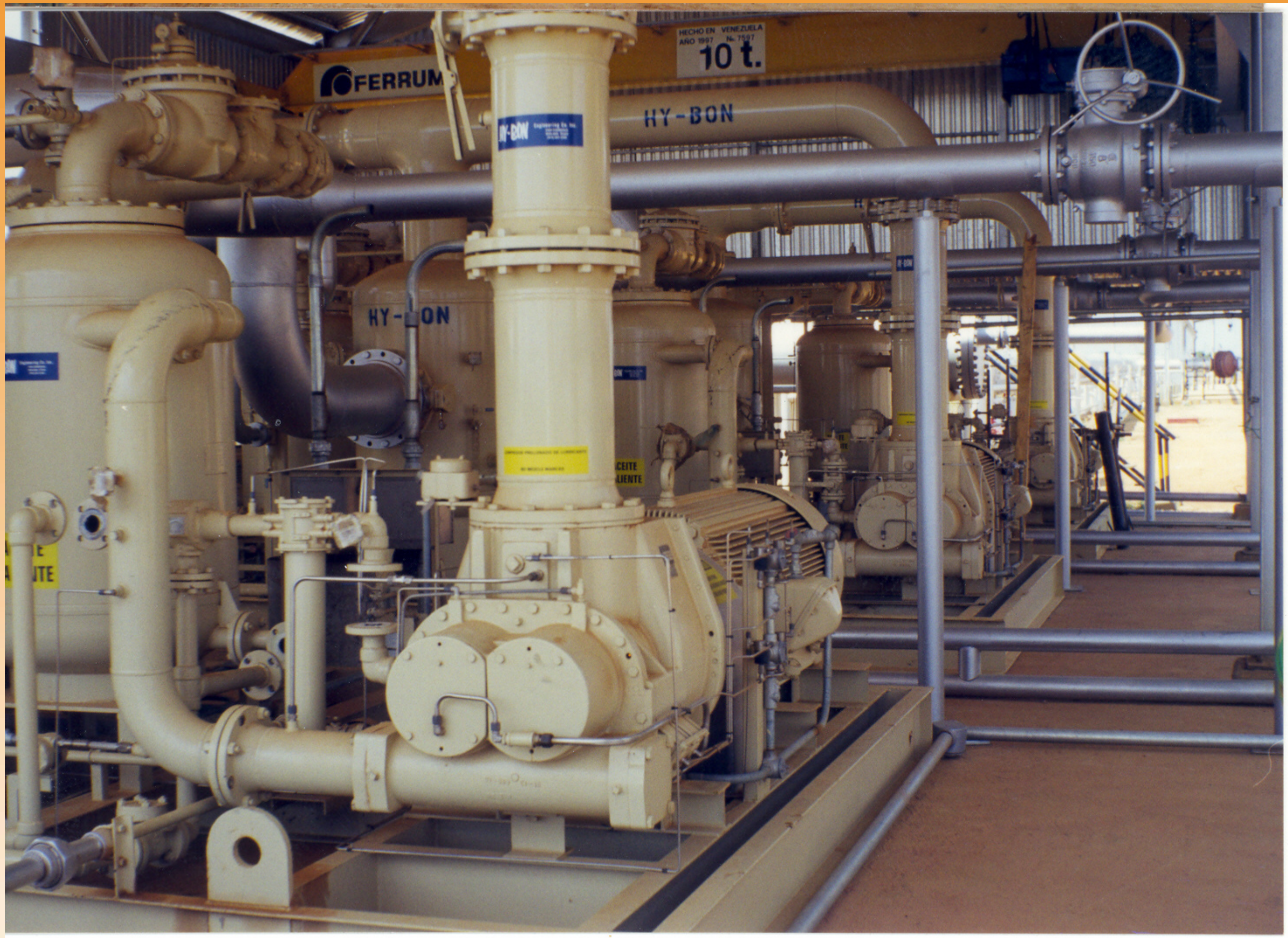
Vapor Recovery

Dual VRU bound for Venezuela... one of 17 units capturing gas currently for Petroleos de Venezuela. Flooded screw compressor for volumes to 5.0 MMSCFD; up to 200 psig.

Vapor Recovery

At this installation, three dual rotary screw compressor packages were set in tandem to move 15 MMSCFD of 2500-2600 BTU/cu ft. tank vapors.



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Minimizing Emissions from Dehydrators

Agenda

- Methane Losses
- Methane Recovery
- Recovery Options and Benefits

Methane Losses from Dehydrators

- Triethylene Glycol is the common technology for removing moisture from produced natural gas
- Glycol also absorbs methane, VOCs and HAPs
- Glycol reboilers vent absorbed water, methane, VOCs, HAPs to the atmosphere
  - **Wastes gas, costs money, reduces air quality**
- On average, 600 Mcf methane per glycol dehydrator is emitted each year

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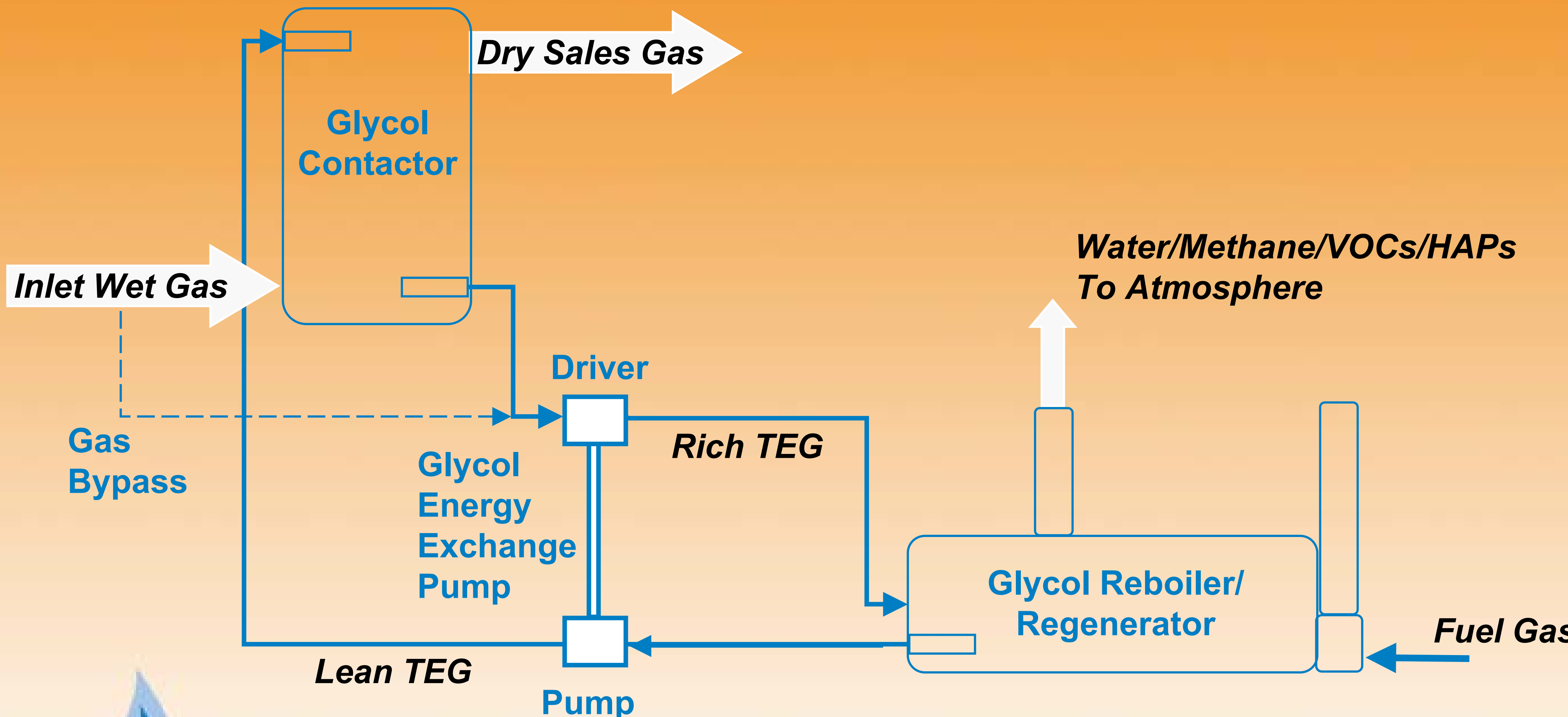
Basic Glycol Dehydrator System Process Diagram



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Methane Recovery Options and Benefits

- Optimize glycol circulation rates
  - **Methane emissions are directly proportional to glycol circulation rate**
- Install flash tank separator (FTS)
  - **Recovers all methane bypassed and most methane absorbed by glycol**
- Install electric pump
  - **Eliminates need to bypass gas for motive force; eliminates lean glycol contamination by rich glycol**
- Replace glycol with desiccant dehydrator
  - **Very simple process; no moving parts**

Optimize Glycol Circulation Rate

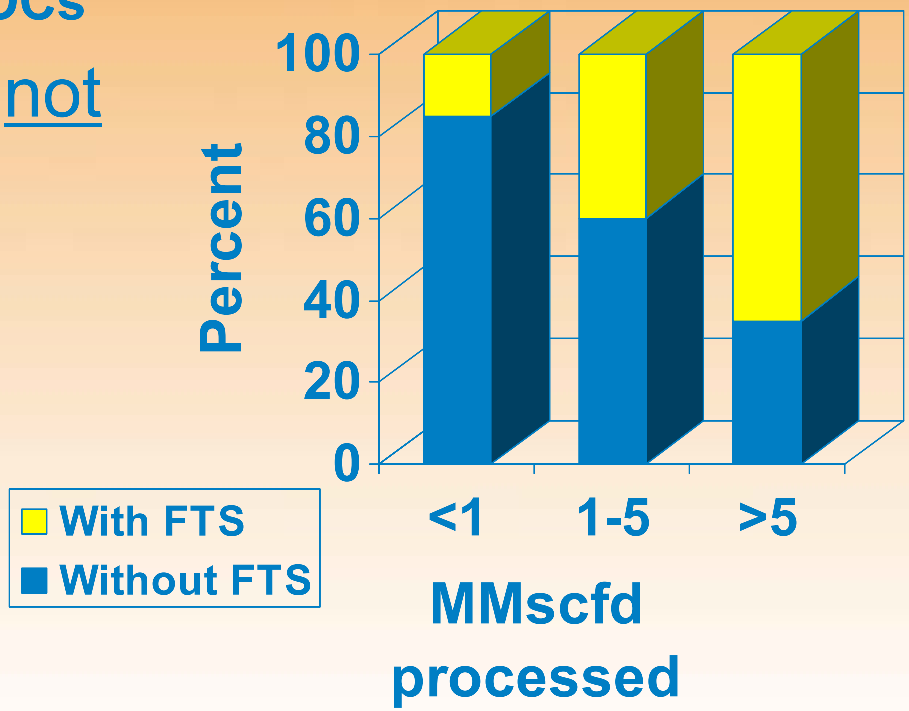
- Gas well's initial production rate decreases over its lifespan
  - **Glycol circulation rates designed for initial, highest production rate**
- Glycol overcirculation results in more methane emissions without significant reduction in gas moisture content
  - **Natural Gas STAR partners found circulation rates two to three times higher than necessary**
  - **This means two or three times more methane emissions than necessary**

Overall Benefits

- Methane gas savings
- Reduced emissions of VOCs and HAPs
- Lower operating costs
  - **Reduced glycol replacement costs**
  - **Reduced fuel costs**
- Immediate payback
- No capital costs

Install Flash Tank Separator (FTS)

- Most dehydrators send glycol/gas mixture from the pump driver to the regenerator
- Flash tank separator operating at fuel gas system or compressor suction pressure recovers ~ 90% of methane
  - **Recovers 10 to 40% of VOCs**
- Many smaller units are <u>not</u> using a FTS



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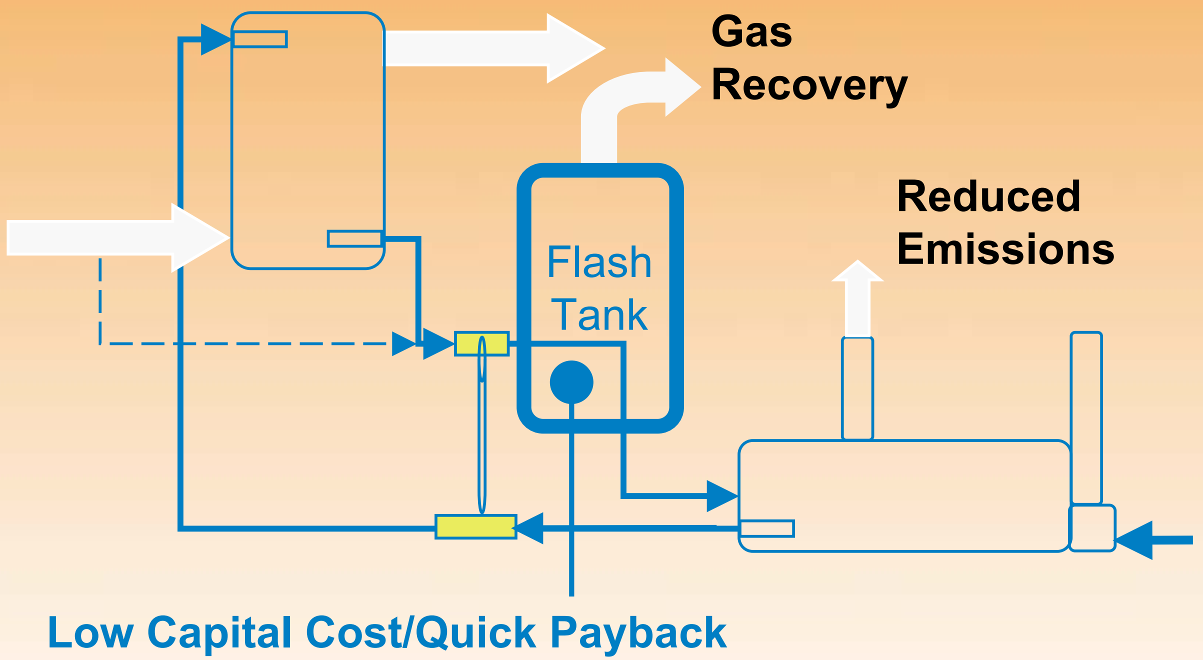
Overall Benefits

- Gas recovery
- Reduced methane and VOC emissions
- Low capital cost; low operating costs



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Install Electric Pump

- Gas-assist pumps require additional wet production gas for mechanical advantage
  - **Removes gas from the production stream**
  - **Largest contributor to emissions**
- Gas-assist pumps contaminate lean glycol with rich glycol
- Electric pump installation eliminates motive gas and lean glycol contamination
  - **Economic alternative to flash tank separator**
  - **Requires electrical power**

Overall Benefits

- Financial return on investment through gas savings
- Increased operational efficiency
- Reduced O&M costs
- Reduced compliance costs (VOCs and HAPs)
- Similar footprint as gas assist pump

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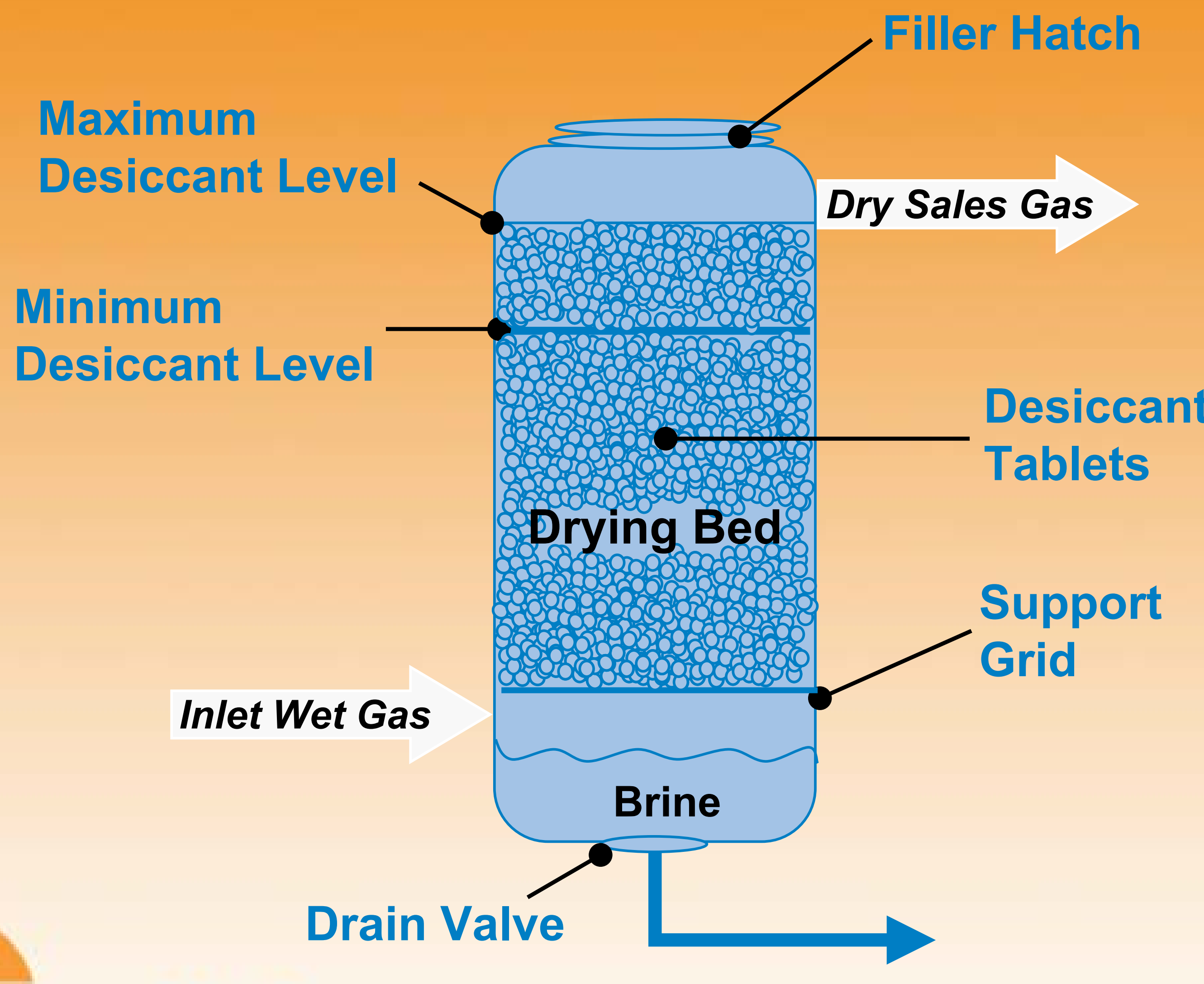
Replace Glycol Dehydrators with Desiccant Dehydrators



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Desiccant Dehydrators

- Moisture removed depends on
  - **Type of desiccant (salt)**
  - **Gas temperature and pressure**
- Desiccants gradually dissolves into brine

Hygroscopic Salts	Typical T and P for Pipeline Spec	Cost
Calcium chloride	47°F 440 psig	Least expensive
Lithium chloride	60°F 250 psig	More expensive

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Overall Benefits

- Reduce capital cost
  - **Only capital cost is the vessel**
  - **Desiccant dehydrators do not use pumps or fired reboiler/regenerator**
- Reduce maintenance costs
- Less methane, VOCs and HAPs emissions
  - **Desiccant tablets only absorb water**
  - **Minimal gas vented to atmosphere when refilling salt**

Desiccant Dehydrator Unit
Source: GasTech

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Discussion Questions

- To what extent are you implementing these practices/ options?
- How could these practices/ options be improved upon or altered for use in your operation(s)?
- What are the barriers (technological, economic, lack of information, regulatory, focus, manpower, etc.) that are preventing you from implementing these practices/ options?

Environmental Hazards

This flare in Venezuela was causing a variety of health and environmental concerns. Over 75 MMCFD of 2700 BTU tank vapors are now being captured in Eastern Venezuela that were previously flared.

Vapor Recovery

PDVSa has installed vapor recovery in the majority of their production facilities in Eastern Venezuela.

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Vapor Recovery

VRU for Petrozuata installation in Venezuela. This unit was built to process specifications, primarily those of Conoco and PDVSA.

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Vapor Recovery

Two large rotary screw compressor systems manufactured for ENI – Venezuela designed to move 1.4 MMcfd of gas at pressures to 230 psig.

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Vapor Recovery

ENI installed their vapor recovery systems with large aftercoolers in order to maximize condensate production.

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