Methane to Markets

Production/Processing Best Practices: Natural Gas Dehydrator and Pneumatic Controller Optimization for Methane Emission Reductions

Oil & Gas Subcommittee Technology Transfer Workshop

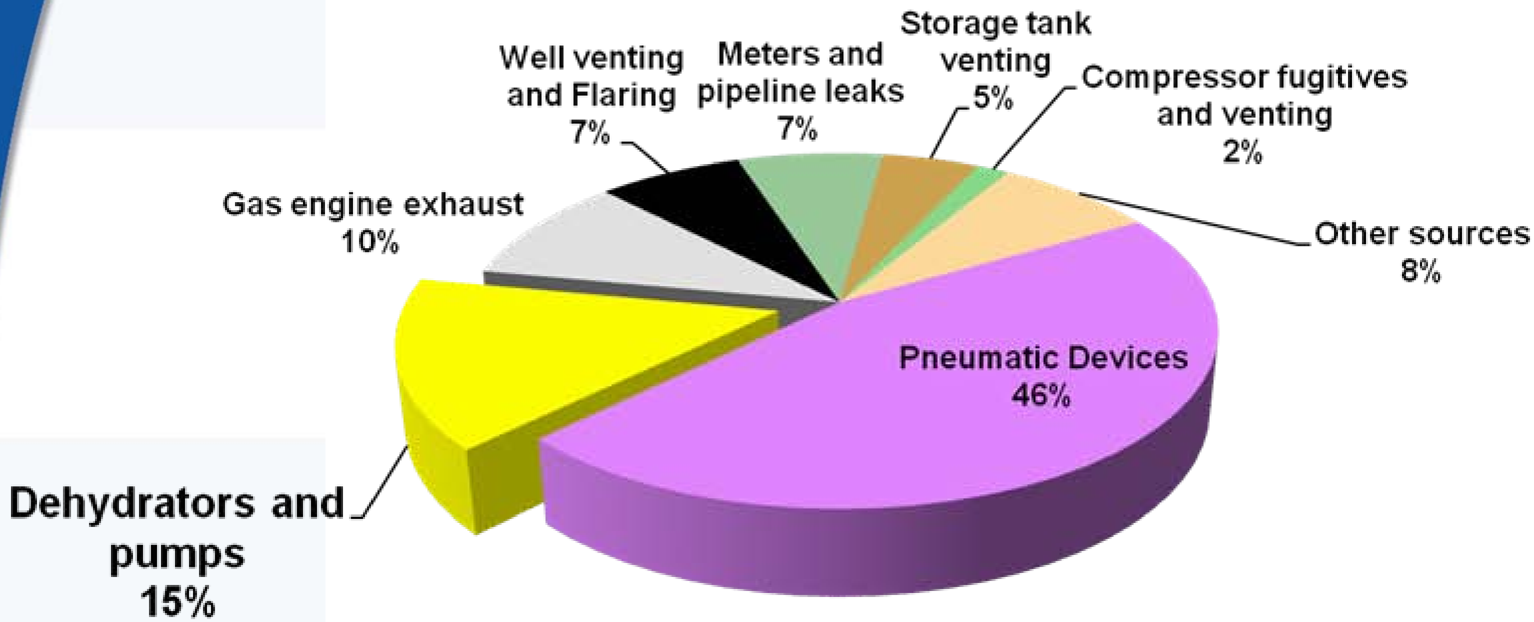
January 28, 2009
Monterrey, Mexico

Natural Gas Dehydration: Agenda

- Methane Losses
- Methane Recovery
- Is Recovery Profitable?
- Industry Experience
- Discussion

Methane Losses from Dehydrators

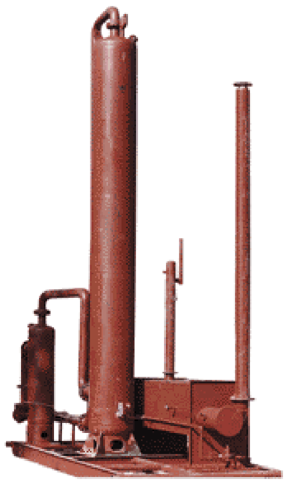
- Dehydrators and pumps account for:
  - 15% of methane emissions in the U.S. production, gathering, and boosting sectors (excl. offshore operations)



EPA. *Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990 – 2005.* April, 2007. Available on the web at: http://yosemite.epa.gov/oar/globalwarming.nsf/content/ResourceCenterPublicationsGHGEmissions.html
Natural Gas STAR reductions data shown as published in the inventory.

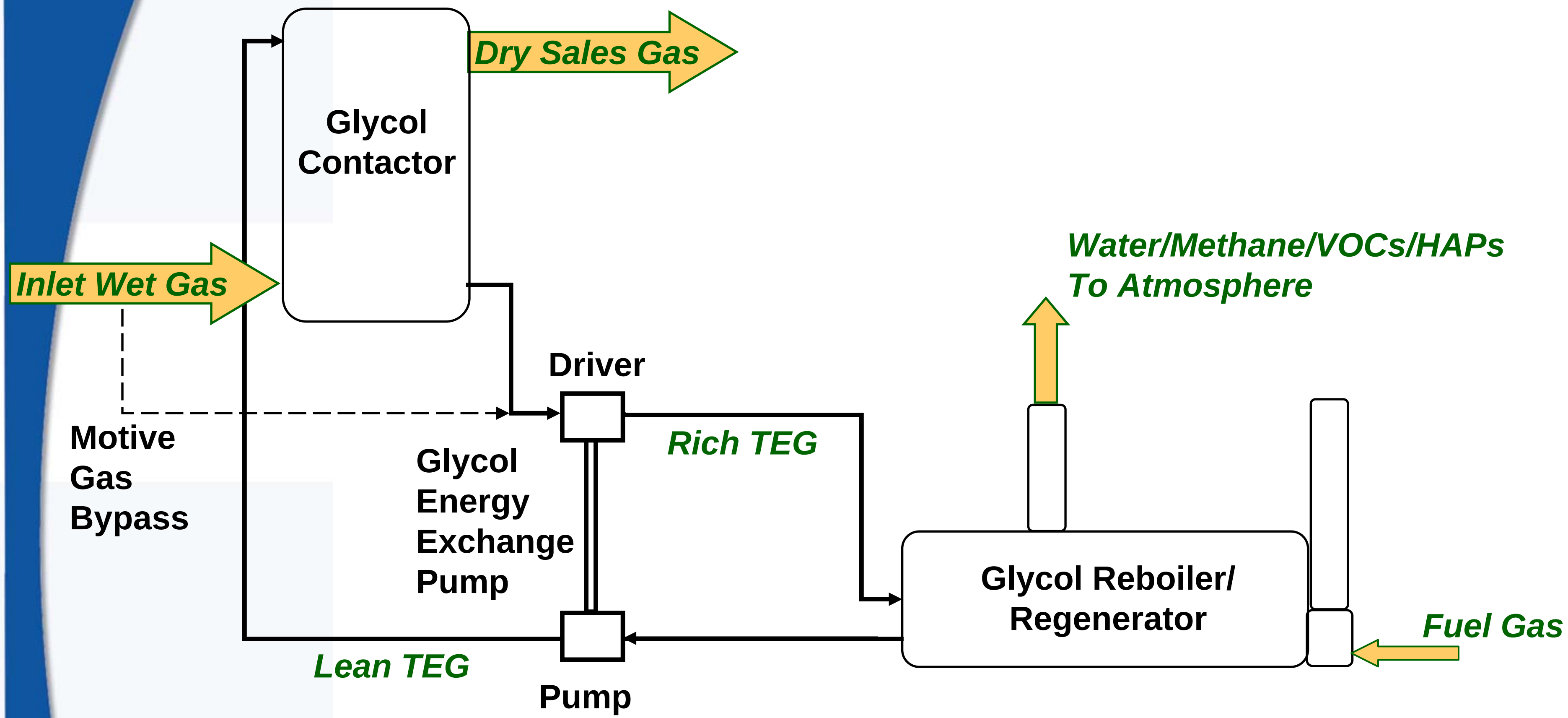
What is the Problem?

- Produced gas is saturated with water, which must be removed for gas transmission
- Glycol dehydrators are the most common equipment to remove water from gas
  - Most use Triethylene Glycol (TEG)
- Glycol dehydrators generate emissions
  - Methane, Volatile Organic Compounds (VOCs), Hazardous Air Pollutants (HAPs) from reboiler vent
  - Methane from pneumatic controllers



Source: www.prideofthehill.com

Basic Glycol Dehydrator System Process Diagram



Methane Recovery

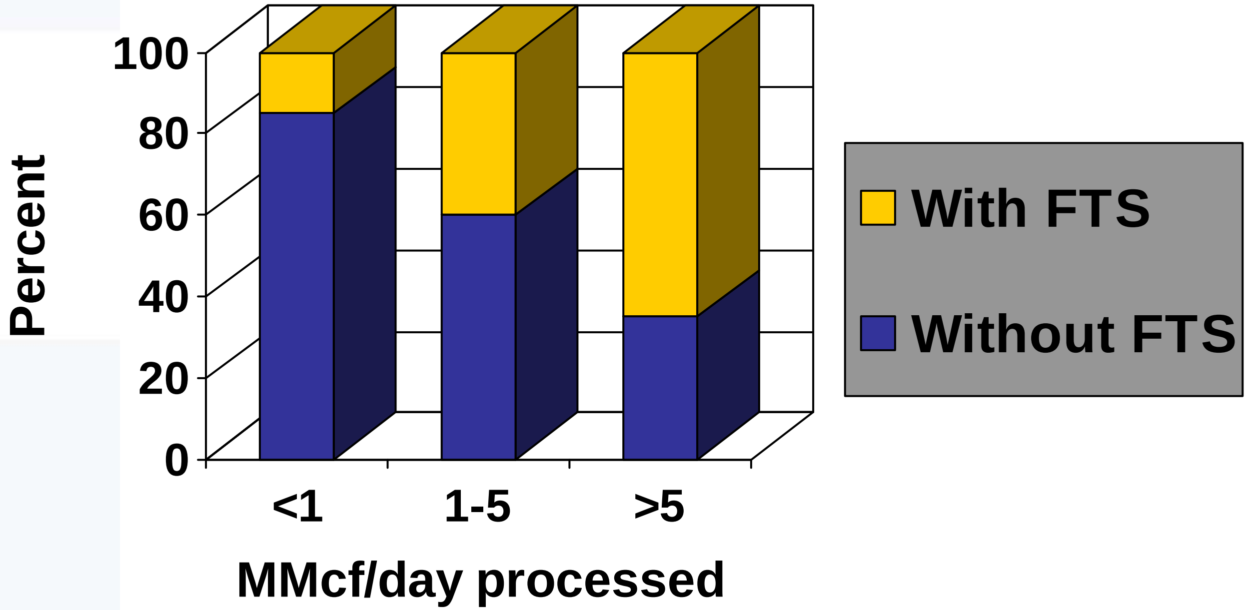
- Optimize glycol circulation rates
- Flash tank separator (FTS) installation
- Electric pump installation
- Zero emission dehydrator
- Replace glycol unit with desiccant dehydrator
- Other opportunities

Optimizing Glycol Circulation Rate

- Gas pressure and flow at wellhead dehydrators generally declines over time
  - Glycol circulation rates are often set at a maximum circulation rate
- Glycol overcirculation results in more methane emissions without significant reduction in gas moisture content
  - Partners found circulation rates two to three times higher than necessary
  - Methane emissions are directly proportional to circulation
- Lessons Learned study: optimize circulation rates

Installing Flash Tank Separator (FTS)

- Methane that flashes from rich glycol in an energy-exchange pump can be captured using an FTS
- Many units are not using an FTS

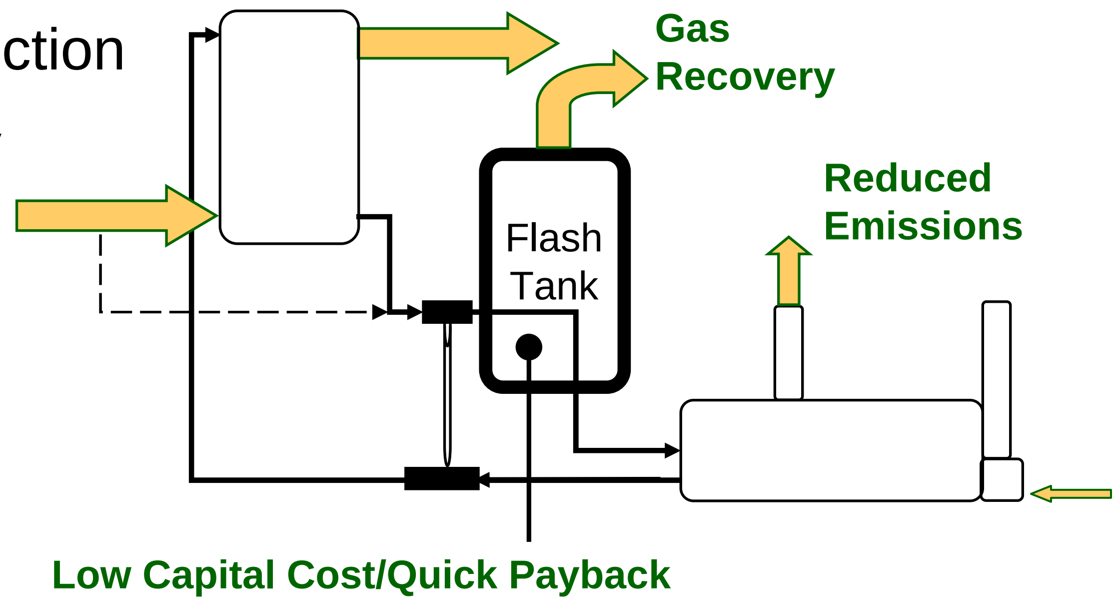


MMcf = Million cubic feet

Source: API

FTS Methane Recovery

- Recovers about 90% of methane emissions
- Reduces VOCs by 10 to 90%
- Must have an outlet for low pressure gas
  - Fuel
  - Compressor suction
  - Vapor recovery unit

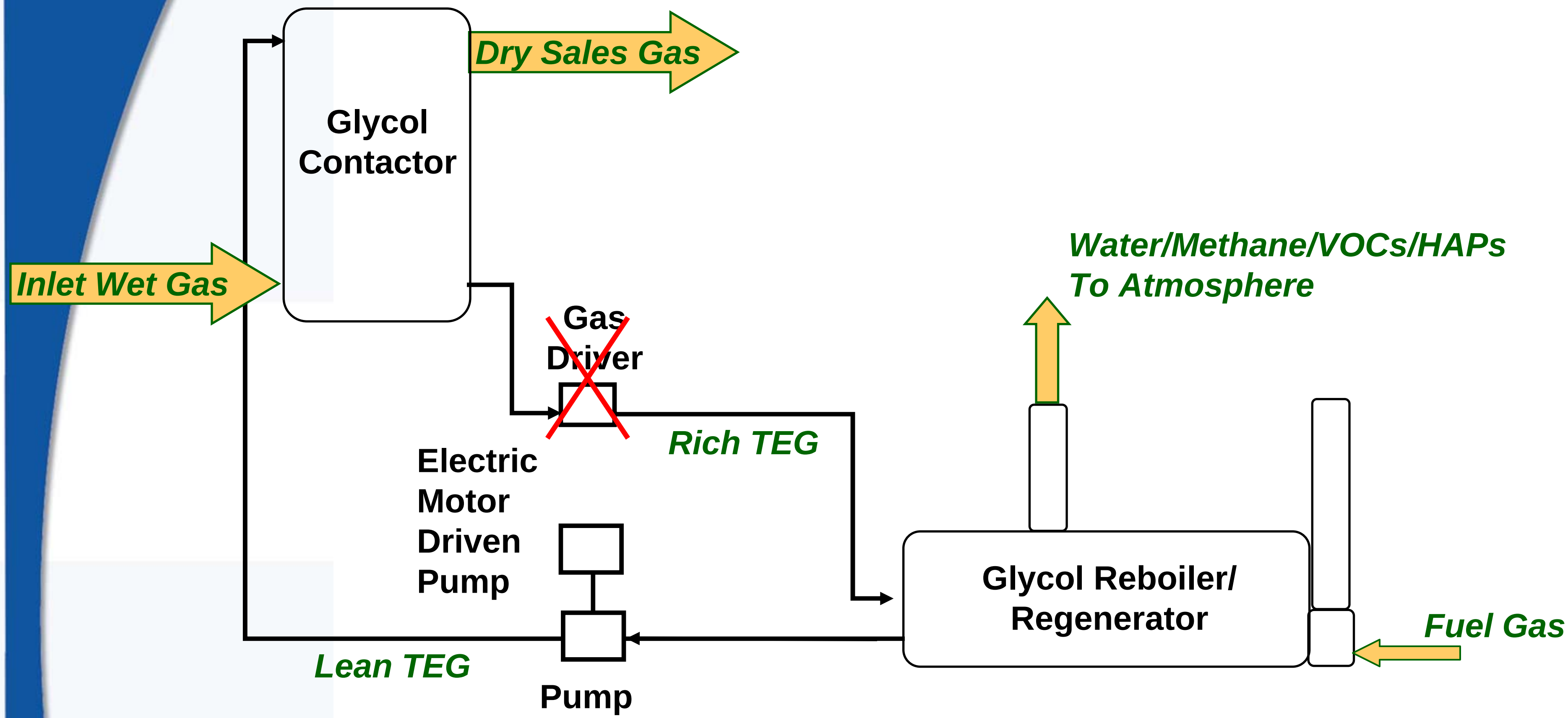


Methane to Markets

Flash Tank Costs

- U.S. EPA Lessons Learned study provides guidelines for scoping costs, savings and economics
- Capital and installation costs:
  - Capital costs range from $3,500 to $7,000 per flash tank
  - Installation costs range from $1,200 to $2,500 per flash tank
- Negligible Operational & Maintenance (O&M) costs

Electric Pump Eliminates Motive Gas



Is Recovery Profitable?

Three Options for Minimizing Glycol Dehydrator Emissions

Option	Capital Costs	Annual O&M Costs	Emissions Savings	Payback Period[1]
Optimize Circulation Rate	Negligible	Negligible	400 to 40,000 Mcf/year	Immediate
Install Flash Tank	$6,500 to $18,800	Negligible	700 to 10,500 Mcf/year	0.4 to 1.9 years
Install Electric Pump	$1,400 to $13,000	$165 to $4,300	360 to 36,000 Mcf/year	0.1 to 0.8 years

1 – Gas price of $5/Mcf

Overall Benefits

- Financial return on investment through gas savings
- Increased operational efficiency
- Reduced O&M costs (fuel gas, glycol make-up)
- Reduced compliance costs (HAPs, BTEX)
- Similar footprint as gas assist pump

Zero Emission Dehydrator

- Combines many emission saving technologies into one unit
  - Vapors in the still gas coming off of the glycol reboiler are condensed in a heat exchanger
  - Non-condensable skimmer gas is routed back to the reboiler for fuel use
  - Electric driven glycol circulation pumps used instead of energy-exchange pumps

Overall Benefits: Zero Emissions Dehydrator

- Reboiler vent condenser removes heavier hydrocarbons and water from non-condensables (mainly methane)
- The condensed liquid can be further separated into water and valuable gas liquid hydrocarbons
- Non-condensables (mostly methane) can be recovered as fuel or product
- By collecting the reboiler vent gas, methane (and VOC/HAP) emissions are greatly reduced

Replace Glycol Unit with Desiccant Dehydrator

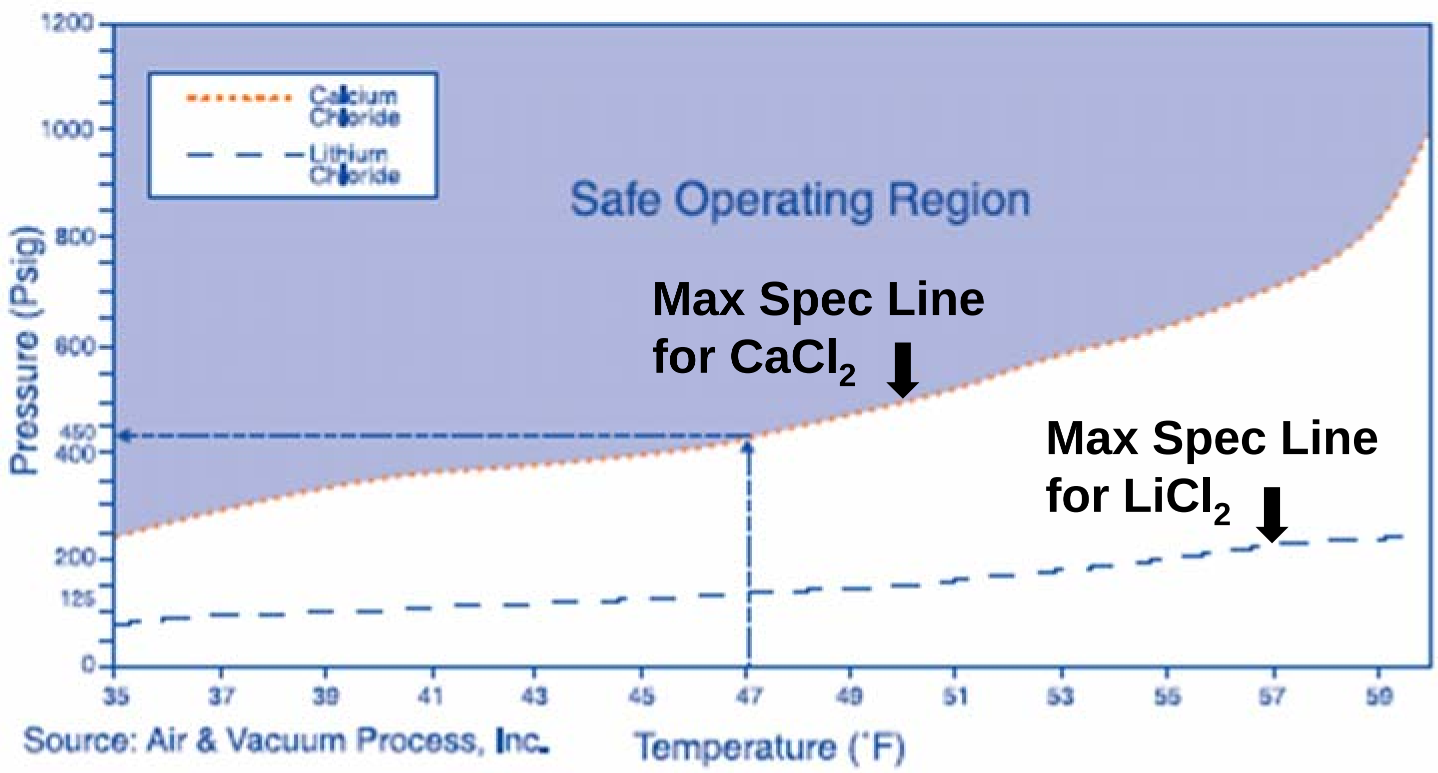
- Desiccant Dehydrator
  - Wet gasses pass through drying bed of desiccant tablets
  - Tablets absorb moisture from gas and dissolve
- Moisture removal depends on:
  - Type of desiccant (salt)
  - Gas temperature and pressure

Source: Van Air

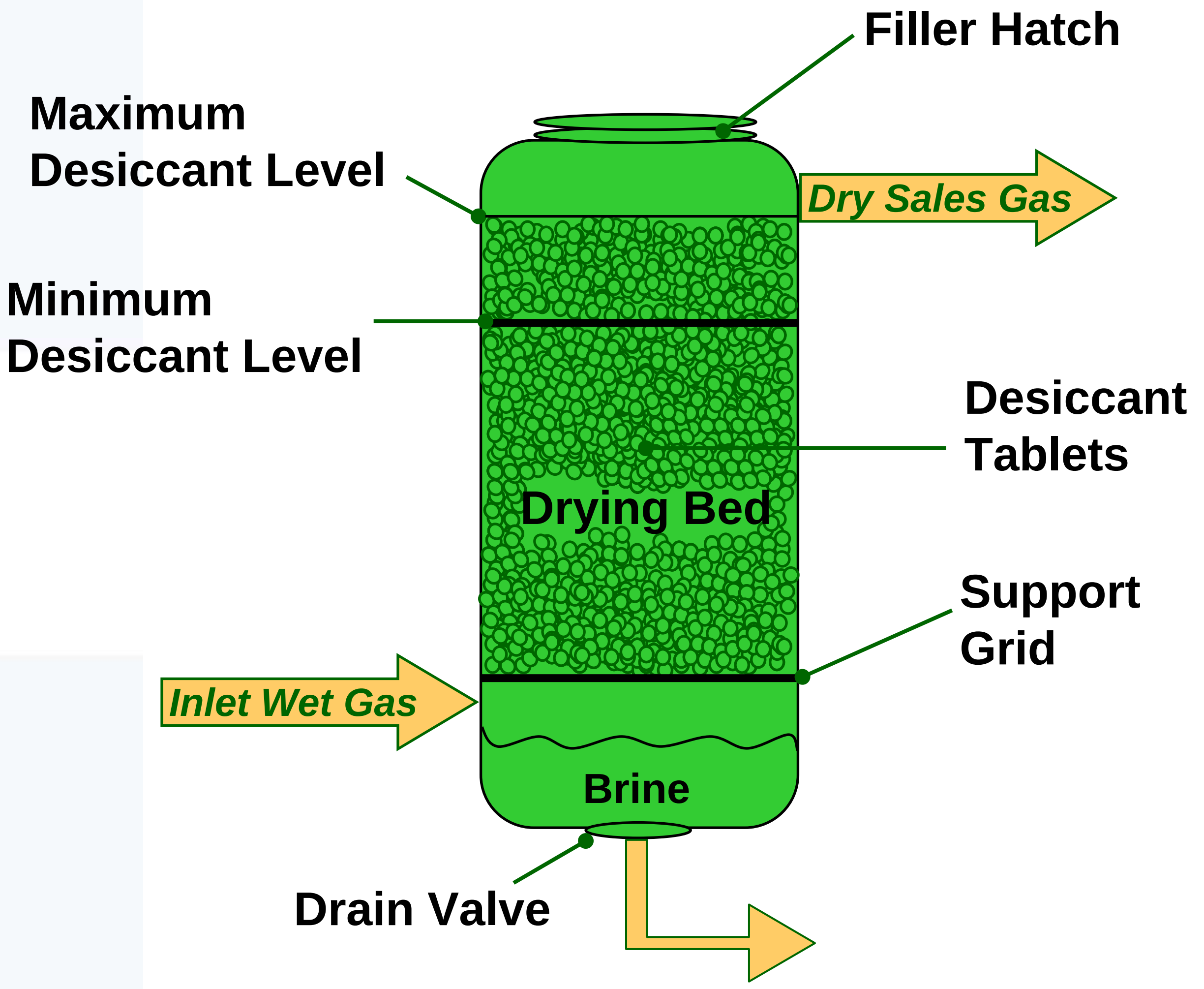
Hygroscopic Salts	Typical T and P for Pipeline Spec	Cost
Calcium chloride	< 8°C @ 30 atm	Least expensive
Lithium chloride	< 60°C @ 17 atm	More expensive

Desiccant Performance

Desiccant Performance Curves at Maximum Pipeline Moisture Spec (3.2 kg water / MMcf)



Desiccant Dehydrator Schematic



Gas Vented from Glycol Dehydrator

Example:

GV = ?
F = 1 MMcf/day
W = 10-3.2 kg H_2O/MMcf
R = 25 L/kg
OC = 150%
G = 0.8 ft^3/L

Where:

GV= Gas vented annually (Mcf/year)
F = Gas flow rate (MMcf/day)
W = Inlet-outlet H_2O content (pounds/MMcf)
R = Glycol/water ratio (rule of thumb)
OC = Percent over-circulation
G = Methane entrainment (rule of thumb)

Calculate:

$$GV = \frac{(F * W * R * OC * G * 365 \text{ days/year})}{1{,}000 \text{ cf/Mcf}}$$

GV = 69 Mcf/year

Glycol Dehydrator Unit
Source: GasTech

Desiccant Dehydrator Savings: Gas Vented from Pneumatic Controllers

Example:

GE = ?
PD = 4

EF = 126 Mcf/device/year

Where:

GE = Annual gas emissions (Mcf/year)
PD = Number of pneumatic devices per dehydrator
EF = Emission factor
(Mcf natural gas leakage/ pneumatic devices per year)

Calculate:

GE = EF * PD

GE = **504 Mcf/year**

Norriseal Pneumatic Liquid Level Controller

Source: norriseal.com

Gas Burned as Fuel for Glycol Dehydrator

- Gas fuel for glycol reboiler
  - 1 MMcf/day dehydrator
  - Removing 6.4 kg water/MMcf
  - Reboiler heat rate: 281 Btu/L TEG
  - Heat content of natural gas: 1,027 Btu/scf
- Fuel requirement: 17 Mcf/year

- Gas fuel for gas heater
  - 1 MMcf/day dehydrator
  - Heat gas from 8ºC to 16ºC
  - Specific heat of natural gas: 0.441 Btu/kg-ºC
  - Density of natural gas: 0.0228 kg/cf
  - Efficiency: 70%
- Fuel requirement: 483 Mcf/year

Gas Lost from Desiccant Dehydrator

Example:

GLD = ?

ID = 20 inch (0.508 m)

H = 76.75 inch (1.949 m)

%G = 45%

P_1 = 1 atm

P_2 = 31 atm

T = 7 days

Where:

GLD = Desiccant dehydrator gas loss (Mcf/year)

ID = Inside Diameter (feet)

H = Vessel height by vendor specification (feet)

%G = Percentage of gas volume in the vessel

P_1 = Atmospheric pressure (atm)

P_2 = Gas pressure (atm)

T = Time between refilling (days)

Calculate:

$$GLD = \frac{H * ID^2 * \pi * P_2 * \%G * 365 \text{ days/year}}{4 * P_1 * T * 1{,}000 \text{ cf/Mcf}}$$

GLD = 10 Mcf/year

Desiccant Dehydrator Unit
Source: usedcompressors.com

Natural Gas Savings

Gas vented from glycol dehydrator:	69 Mcf/year
Gas vented from pneumatic controls:	+504 Mcf/year
Gas burned in glycol reboiler:	+ 17 Mcf/year
Gas burned in gas heater:	+483 Mcf/year
Minus desiccant dehydrator vent:	- 10 Mcf/year
Total savings:	1,063 Mcf/year
Value of gas savings (@ $5/Mcf):	$5,315/year

Desiccant Dehydrator and Glycol Dehydrator Cost Comparison

Type of Costs and Savings	Desiccant ($/yr)	Glycol ($/yr)
Implementation Costs		
Capital Costs		
Desiccant (includes the initial fill)	16,097	
Glycol		24,764
Other costs (installation and engineering)	12,073	18,573
Total Implementation Costs:	28,169	43,337
Annual Operating and Maintenance Costs		
Desiccant		
Cost of desiccant refill ($1.50/pound)	2,556	
Cost of brine disposal	14	
Labor cost	1,040	
Glycol		
Cost of glycol refill ($4.50/gallon)		206
Material and labor cost		3,054
Total Annual Operation and Maintenance Costs:	**3,610**	**3,260**

Based on 1 MMcf per day natural gas operating at 30 atm and 8°C
Installation costs assumed at 75% of the equipment cost

Desiccant Dehydrator Economics

- Payback= 3.3 years
  - Without potential carbon market benefits

Type of Costs and Savings	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Capital costs (US$)	-28,169					
Avoided O&M costs (US$)		3,260	3,260	3,260	3,260	3,260
O&M costs - Desiccant (US$)		-3,610	-3,610	-3,610	-3,610	-3,610
Value of gas Saved [1] (US$)		5,135	5,135	5,135	5,135	5,135
Glycol dehy. salvage value [2] (US$)	12,382					
Total (US$)	-15,787	4,785	4,785	4,785	4,785	4,785

[1] Gas price = US$5/Mcf

[2] Salvage value estimated as 50% of glycol dehydrator capital cost

Methane to Markets

Industry Experiences

- One Partner installed flash tank separators on its glycol dehydrators
  - Recovers 98% of methane from glycol degassing
  - 1,200 to 1,700 Mcf/year reductions per dehydrator
  - US$5,925 to US$8,295/year[1] savings per dehydrator
- Another Partner routes gas from flash tank separator to fuel gas system
  - 8.75 MMcf/year reductions per dehydrator
  - US$43,750/year[1] savings per dehydrator

[1] Gas valued at $5/Mcf

Lessons Learned

- Optimizing glycol circulation rates increase gas savings, reduce emissions
  - Negligible cost and effort
- FTS reduces methane emissions by about 90 percent
  - Require a low pressure gas outlet
- Electric pumps reduce O&M costs, reduce emissions, increase efficiency
  - Require electrical power source
- Zero emission dehydrator can virtually eliminate emissions
  - Requires electrical power source
- Desiccant dehydrator reduce O&M costs and reduce emissions compared to glycol
- Miscellaneous other PROs can have big savings

Discussion

- Industry experience applying these technologies and practices
- Limitations on application of these technologies an practices
- Actual costs and benefits