Replacing Glycol Dehydrators with Desiccant Dehydrators

Lessons Learned
from Natural Gas STAR Partners

Small and Medium Sized Producer Technology Transfer Workshop

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Southern Gas Association and

EPA's Natural Gas STAR Program

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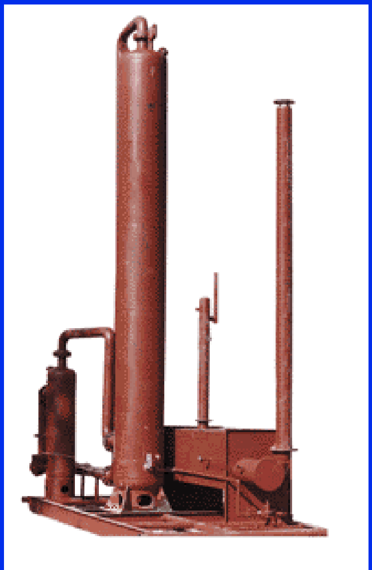
Desiccant Dehydrators: Agenda

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

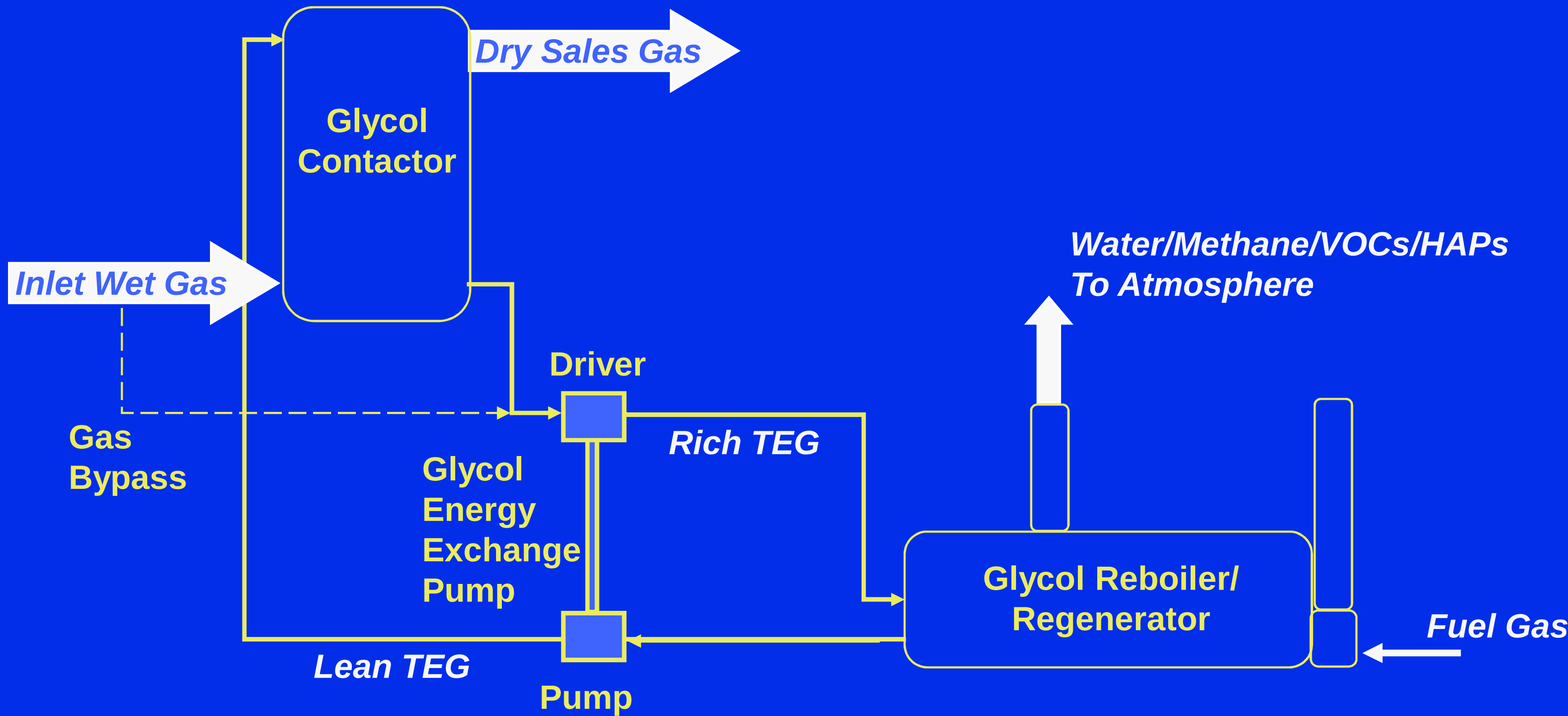
What is the Problem?

- 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
  - **38,000 dehydration systems in the natural gas production sector**
  - **Most use triethylene glycol (TEG)**
- Glycol dehydrators create emissions
  - **Methane, VOCs, HAPs from reboiler vent**
  - **Methane from pneumatic controllers**
  - **CO_2 from reboiler fuel**
  - **CO_2 from wet gas heater**



Source: www.prideofthehill.com

Dehydrator Schematic



Reducing Emissions, Increasing Efficiency, Maximizing Profits

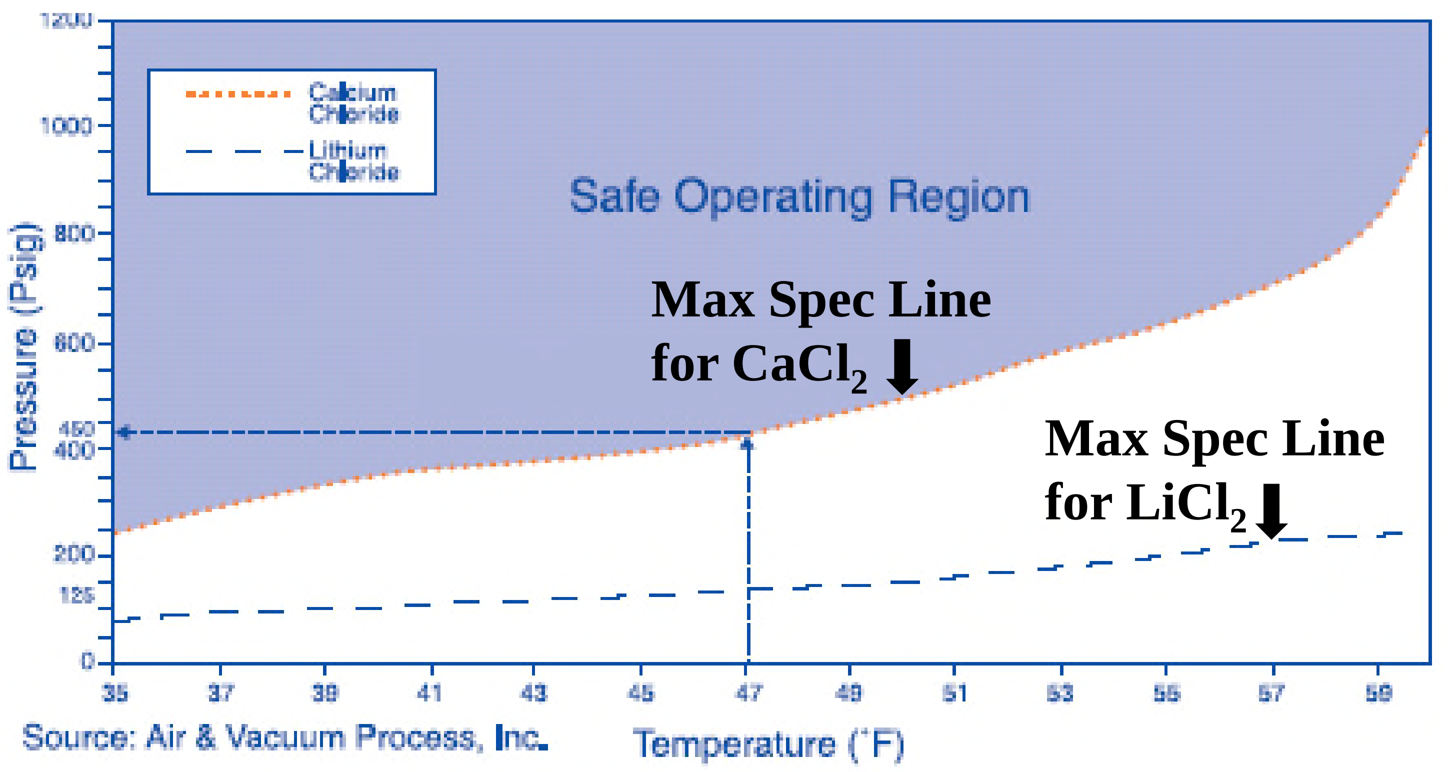
Methane Recovery Alternative

- Desiccant Dehydrator
  - **Very simple process**
  - **No moving parts**
- Moisture removed depends on
  - **Type of desiccant (salt)**
  - **Gas temperature and pressure**
- Desiccants gradually dissolves into brine

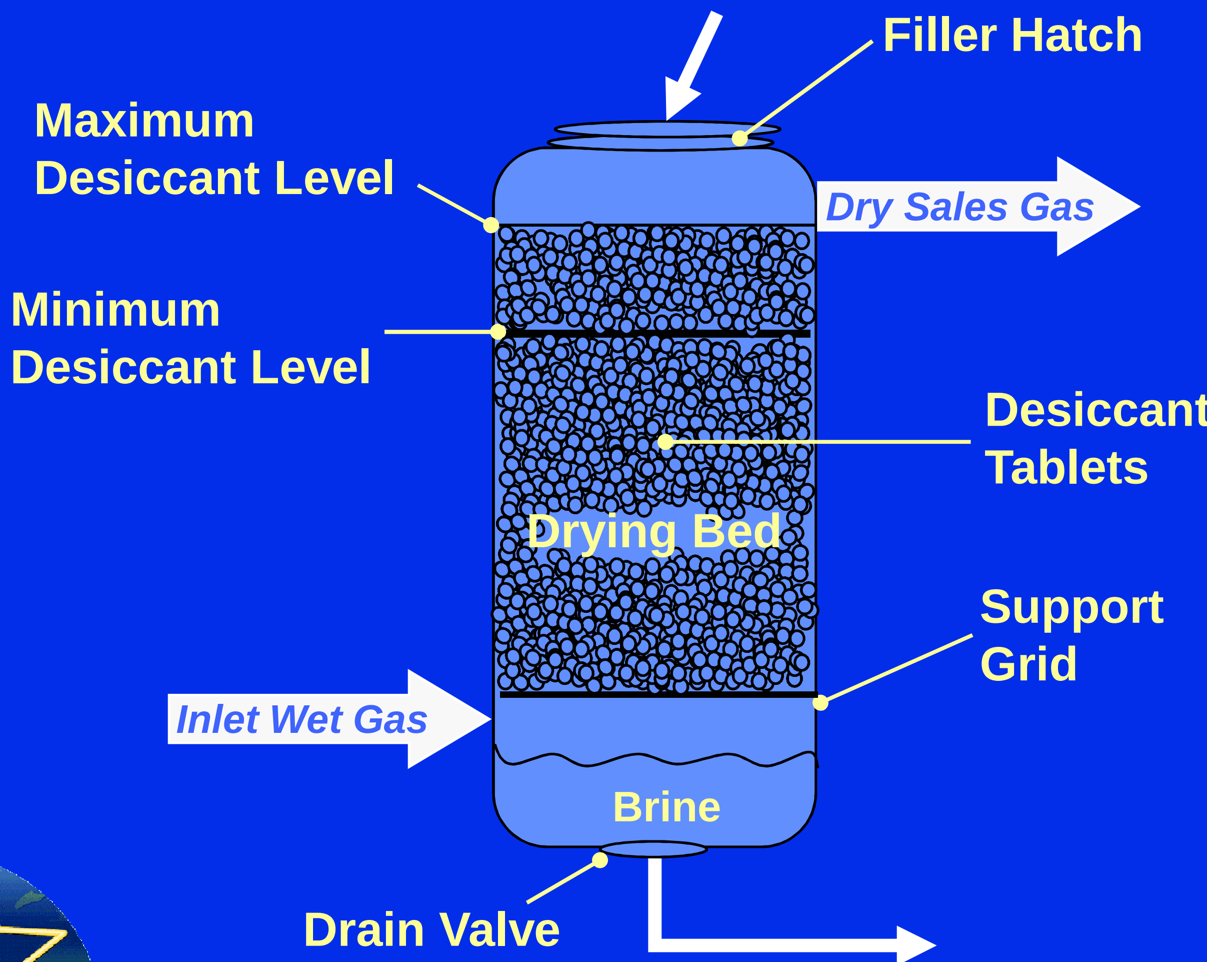
Hygroscopic Salts	Typical T and P for Pipeline Spec	Cost
Calcium chloride	47^{o}F 440 psig	Least expensive
Lithium chloride	60^{o}F 250 psig	More expensive

Desiccant Performance

Desiccant Performance Curves at Maximum Pipeline Moisture Spec (7 lb water / MMcf)



Desiccant Dehydrator Schematic



Economic and Environmental Benefits

- Reduce capital cost
  - **Only capital cost is the vessel**
  - **Desiccant dehydrators do not use pumps or fired reboiler/regenetador**
- Reduce maintenance costs
- Less methane, VOCs and HAPs emissions
  - **Desiccant tablets only absorb water**
  - **No hydrocarbons vented to atmosphere by brine**

Desiccant Dehydrator Unit
Source: GasTech

Five Steps for Implementing a Desiccant Dehydrator

IDENTIFY possible locations for desiccant dehydrators

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DETERMINE dehydrator capacity

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ESTIMATE capital and operating costs

↓

ESTIMATE savings

↓

CONDUCT economic analysis

Optimum Operating Conditions

- Works best in high pressure and low temperature conditions

	Low Pressure (<300 psig)	**High Pressure (>300 psig)**
Low Temperature (<70 ºF)	Desiccant/ Glycol[1]	Desiccant
High Temperature (>70 ºF)	Glycol	Glycol/ Desiccant[2]

[1] The gas needs to be heated to apply glycol dehydrators or the gas has to be compressed to apply desiccant dehydrators.

[2] The gas needs to be cooled to apply desiccant dehydrator.

Estimate Capital Costs

- Determine amount of desiccant needed to remove water
- Determine inside diameter of vessel
- Costs for single vessel desiccant dehydrator
  - **Capital cost varies between $3,000 and $17,000**
  - **Gas flow rates from 1 to 20 MMcf/d**
    - **Capital cost for 20-inch vessel with 1 MMcf/d gas flow is $6,500**
    - **Installation cost assumed to be 75% of capital cost**

How Much Desiccant Is Needed?

Example:

$D = ?$

$F = 1$ MMcf/d

$I = 21$ lb/MMcf

$O = 7$ lb/MMcf

$B = 1/3$

Where:

D = Amount of desiccant needed (lb/d)

F = Gas flow rate (MMcf/d)

I = Inlet water content (lb/MMcf)

O = Outlet water content (lb/MMcf)

B = Desiccant/water ratio vendor rule of thumb

Calculate:

$D = F * (I - O) * B$

$D = 1 * (21 - 7) * 1/3$

$D = $ **4.7 lb desiccant/d**

Source: Van Air

Calculate Vessel Inside Diameter

Example:

ID = ?

D = 4.7 lb/d

T = 7 days

B = 55 lb/cf

H = 5 in

Where:

ID = Inside diameter of the vessel (in)

D = Amount of desiccant needed (lb/d)

T = Assumed refilling frequency (days)

B = Desiccant density (lb/cf)

H = Height between minimum and maximum bed level (in)

Calculate:

$$ID = 12*\sqrt{\frac{4*D*T*12}{H*B*\pi}} = 16.2 \text{ in}$$

Commercially ID available = 20 in.

Source: Van Air

Operating Costs

- Operating costs
  - **Desiccant: $2,059/yr for 1 MMcf/d example**
    - **$1.20/lb desiccant cost**
  - **Brine Disposal: negligible**
    - **$1/bbl brine or $14/yr**
  - **Labor: $1,560/yr for 1 MMcf/d example**
    - **$30/hr**
- Total: ~$3,633/yr

Savings

- Gas savings
  - **Gas vented from glycol dehydrator**
  - **Gas vented from pneumatic controllers**
  - **Gas burner for fuel in glycol reboiler**
  - **Gas burner for fuel in gas heater**
- Less gas vented from desiccant dehydrator
- Methane emission savings calculation
  - **Glycol vent + Pneumatics vents - Desiccant vents**
- Operation and maintenance savings
  - **Glycol O&M + Glycol fuel – Desiccant O&M**

Gas Vented from Glycol Dehydrator

Example:

GV = ?
F = 1 MMcf/d
W = 21 – 7 lb water/MMcf
R = 3 gal/lb
OC = 150%
G = 3 cf/gal

Where:

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

Calculate:

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

GV = 69 Mcf/yr

Glycol Dehydrator Unit
Source: GasTech

Gas Vented from Pneumatic Controllers

Example:

GE= ?

PD= 4

EF = 126 Mcf/device/yr

Where:

GE = Annual gas emissions (Mcf/yr)

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/yr

Norriseal Pneumatic Liquid Level Controller

Source: www.norriseal.com

Gas Lost from Desiccant Dehydrator

Example:

GLD = ?

ID = 20 in (1.7 ft)

H = 76.75 in (6.4 ft)

%G = 45%

P_1= 15 Psia

P_2 = 450 Psig

T = 7 days

Where:

GLD = Desiccant dehydrator gas loss (Mcf/yr)

ID = Inside Diameter (ft)

H = Vessel height by vendor specification (ft)

%G = Percentage of gas volume in the vessel

P_1 = Atmospheric pressure (Psia)

P_2 = Gas pressure (Psig)

T = Time between refilling (days)

Calculate:

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

GLD = 10 Mcf.yr

Desiccant Dehydrator Unit
Source:www.usedcompressors.com

NaturalGas EPA POLLUTION PREVENTER

Desiccant Dehydrator and Glycol Dehydrator Cost Comparison

- Gas savings for 1 MMcf/d example
  - **Glycol: 69 Mcf/yr vented + 504 Mcf/yr pneumatics**
  - **Desiccant: 10 Mcf/yr**
    - **563 Mcf/yr savings, or $2,292/yr gas savings**
  - **Glycol: fuel gas savings of 500 Mcf/yr**
    - **500 Mcf/yr savings, or $2,000/yr fuel savings**
  - **Total gas savings: ~ $4,252/yr**

Based on $4/Mcf

Desiccant Dehydrator - Lessons Learned

- Example calculations of gas savings
  - **Glycol dehydration vent**
  - **Glycol dehydration pneumatic bleed**
  - **Glycol dehydration reboiler fuel gas**
  - **Gas heater fuel for glycol dehydration**
- Other savings
  - **Make-up glycol**
  - **Glycol dehydration O&M**
  - **Glycol dehydrator surplus equipment value**

Discussion Questions

- To what extent are you implementing this BMP?
- How can this BMP be improved upon or altered for use in your operation(s)?
- What are the barriers (technological, economic, lack of information, regulatory, etc.) that are preventing you from implementing this technology?