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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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
Reducing Emissions, Increasing Efficiency, Maximizing Profits

Dehydrator Schematic

- Glycol Contactor
- Dry Sales Gas
- Inlet Wet Gas
- Gas Bypass
- Glycol Energy Exchange Pump
- Driver
- Rich TEG
- Lean TEG
- Pump
- Glycol Reboiler/Regenerator
- Water/Methane/VOCs/HAPs To Atmosphere
- Fuel Gas
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 dissolve into brine

<table>
<thead>
<tr>
<th>Hygroscopic Salts</th>
<th>Typical T and P for Pipeline Spec</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium chloride</td>
<td>47°F 440 psig</td>
<td>Least expensive</td>
</tr>
<tr>
<td>Lithium chloride</td>
<td>60°F 250 psig</td>
<td>More expensive</td>
</tr>
</tbody>
</table>
Desiccant Performance

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

Max Spec Line for CaCl₂

Max Spec Line for LiCl₂
Desiccant Dehydrator Schematic

- Filler Hatch
- Maximum Desiccant Level
- Minimum Desiccant Level
- Dry Sales Gas
- Desiccant Tablets
- Support Grid
- Inlet Wet Gas
- Brine
- Drain Valve

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Economic and Environmental Benefits

- Reduce capital cost
  - Only capital cost is the vessel
  - Desiccant dehydrators do not use pumps or fired reboiler/regenotador
- 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
Reducing Emissions, Increasing Efficiency, Maximizing Profits

Five Steps for Implementing a Desiccant Dehydrator

1. **IDENTIFY** possible locations for desiccant dehydrators
2. **DETERMINE** dehydrator capacity
3. **ESTIMATE** capital and operating costs
4. **ESTIMATE** savings
5. **CONDUCT** economic analysis
Optimum Operating Conditions

- Works best in high pressure and low temperature conditions

<table>
<thead>
<tr>
<th></th>
<th>Low Pressure (&lt;300 psig)</th>
<th>High Pressure (&gt;300 psig)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Temperature</td>
<td>Desiccant/Glycol(^1)</td>
<td>Desiccant</td>
</tr>
<tr>
<td>(&lt;70 °F)</td>
<td>Glycol(^1)</td>
<td></td>
</tr>
<tr>
<td>High Temperature</td>
<td>Glycol</td>
<td>Glycol/Desiccant(^2)</td>
</tr>
<tr>
<td>(&gt;70 °F)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) 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

Calculate:
D = F * (I - O) * B
D = 1 * (21 - 7) * 1/3
D = 4.7 lb desiccant/d

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

Source: Van Air
Calculate Vessel Inside Diameter

Example:

<table>
<thead>
<tr>
<th>ID</th>
<th>D</th>
<th>T</th>
<th>B</th>
<th>H</th>
<th>Calculate:</th>
</tr>
</thead>
<tbody>
<tr>
<td>?</td>
<td>4.7</td>
<td>7</td>
<td>55</td>
<td>5</td>
<td>ID = 12* √(4<em>D</em>T<em>12 / H</em>B*11) = 16.2 in</td>
</tr>
</tbody>
</table>

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)

Commerically 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

Calculate:
GV = \( \frac{F \times W \times R \times OC \times G \times 365 \text{ days/yr}}{1,000 \text{ cf/Mcf}} \)
GV = 69 Mcf/yr

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)

Glycol Dehydrator Unit
Source: GasTech
Gas Vented from Pneumatic Controllers

Example:

Where:

GE = ?
PD = 4
EF = 126 Mcf/device/yr

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

Source: www.norriseal.com

Norriseal Pneumatic Liquid Level Controller
Example:

GLD = ?
ID = 20 in (1.7 ft)
H = 76.75 in (6.4 ft)
%G = 45%
P₁ = 15 Psia
P₂ = 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
P₁ = Atmospheric pressure (Psia)
P₂ = Gas pressure (Psig)
T = Time between refilling (days)

Calculate:

GLD = \frac{H \times ID^2 \times \pi \times P₂ \times %G \times 365 \text{ days/yr}}{4 \times P₁ \times T \times 1,000 \text{ cf/Mcf}}

GLD = 10 Mcf.yr

Desiccant Dehydrator Unit
Source: www.usedcompressors.com

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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?