Natural Gas Dehydration
Lessons Learned from the Natural Gas STAR Program

Producers Technology Transfer Workshop

ConocoPhillips Petroleum Company,
New Mexico Environment Department,
New Mexico Oil & Gas Association

Farmington, New Mexico
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Natural Gas Dehydration: Agenda

- Methane Losses
- Methane Recovery
- Is Recovery Profitable?
- Industry Experience
- Discussion
U.S. Production Sector Methane Emissions (2007)

Note: Bcf = billion cubic feet

Storage Tank Venting 27 Bcf
Other Sources 5 Bcf
Well Venting and Flaring 86 Bcf
Pneumatic Devices 79 Bcf
Dehydrators and Pumps 3 Bcf
Offshore Operations 29 Bcf
Compressors 12 Bcf
Meters and Pipeline Leaks 8 Bcf


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
  - 41,800 dehydration units in natural gas production, gathering, and boosting
  - Most use triethylene glycol (TEG)
- Glycol dehydrators create emissions
  - Methane, Volatile Organic Compounds (VOCs), Hazardous Air Pollutants (HAPs) from reboiler vent
  - Methane from pneumatic pump and valves
Basic Glycol Dehydrator System Process Diagram

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

1 cubic foot gas per 1 gallon TEG
2 cubic feet gas per 1 gallon TEG

Methane Recovery

- Optimize glycol circulation rates
- Flash tank separator (FTS) installation
- Electric pump installation
- 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 rate
- 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 small units are not using an FTS

Glycol MACT applies to all large and ~half medium sized dehydrators.

<table>
<thead>
<tr>
<th>MMcf/day processed</th>
<th>With FTS</th>
<th>Without FTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1</td>
<td>1-5</td>
<td>&gt;5</td>
</tr>
</tbody>
</table>

Source: API

MMcf = Million cubic feet
Methane Recovery

- Recovers about 90% of methane emissions
- Reduces VOCs by 10 to 40%
- Must have an outlet for low pressure gas
  - Fuel
  - Compressor suction
  - Vapor recovery unit

Flash Tank Costs

- Lessons Learned study provides guidelines for scoping costs, savings and economics
- Capital and installation costs:
  - Capital costs range from ~$3,375 to $6,750 per flash tank
  - Installation costs range from ~$1,650 to $3,050 per flash tank
- Negligible operating and maintenance (O&M) costs
Installing 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 often 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

Electric Pump Eliminates Motive Gas

Diagram showing the process flow for installing an electric pump to eliminate motive gas, with labels for various components and flow paths.
Overall Benefits

- Financial return on investment through gas savings
- Increased operational efficiency
- Reduced O&M costs
- Reduced compliance costs (HAPs, BTEX¹)
- Limitation: must have electric power source

¹ – Benzene, toluene, ethylbenzene, xylene

Is Recovery Profitable?

Three Options for Minimizing Glycol Dehydrator Emissions

<table>
<thead>
<tr>
<th>Option</th>
<th>Capital Costs</th>
<th>Annual O&amp;M Costs</th>
<th>Emissions Savings</th>
<th>Payback Period¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimize Circulation Rate</td>
<td>Negligible</td>
<td>Negligible</td>
<td>394 to 39,420 Mcf/year</td>
<td>Immediate</td>
</tr>
<tr>
<td>Install Flash Tank</td>
<td>$6,500 to $18,800</td>
<td>Negligible</td>
<td>1,191 to 10,717 Mcf/year</td>
<td>4 to 11 months</td>
</tr>
<tr>
<td>Install Electric Pump</td>
<td>$1,400 to $13,000</td>
<td>$165 to $6,500</td>
<td>360 to 36,000 Mcf/year</td>
<td>&lt; 1 month to several years</td>
</tr>
</tbody>
</table>

¹ – Gas price of $7/Mcf
Additional Dehydration Opportunities

- **Desiccant dehydrators**
  - Use packed column of desiccant salts to remove water instead of using glycol

- **Zero emission dehydrators**
  - Combine several dehydration technologies (flash tanks, electric pumps, reroute skimmer gas, electric control valves) to virtually eliminate methane emissions

- **JATCO venturi system**
  - Use high pressure motive gas to capture still gas and reroute to facility suction to create a closed loop system

- **Re-route glycol skimmer gas**
  - Non-condensable skimmer gas from the condensate separators in glycol dehydrators can be re-routed to:
    - Reboiler for fuel use
    - Low pressure fuel systems for fuel use

Other Partner Reported Opportunities

- **Pipe glycol dehydrator to vapor recovery unit (VRU)**
- **Replace glycol dehydration units with methanol injection**
- **Flare regenerator off-gas (no economics)**
- **Replace glycol dehydrator with desiccant dehydrator (see Lessons Learned study)**
- **With a vent condenser,**
  - Route skimmer gas to firebox
  - Route skimmer gas to tank with VRU
- **Instrument air for controllers and glycol pump**
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
- Additional methane emissions reduction technologies and practices available on the Natural Gas STAR website

Discussion

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