Processor Opportunities: Agenda

- Mexico Industry Emissions
- Processing Best Management Practices (BMPs)
- Selected Methane Saving Opportunities
  - Pipe Glycol Dehydrator to Vapor Recovery Unit
  - Acid Gas Removal
  - Convert Gas-Driven Chemical Pumps to Instrument Air
- Project Summaries for Mexico
- Discussion Questions
Mexico Oil and Gas Industry
Methane Emissions in 2000

- Production: 27.8 Bcf
- Distribution: 1.9 Bcf
- Transmission: 5.8 Bcf
- Processing: 2.5 Bcf

Sources: US Natural Gas STAR program success points to global opportunities to cut methane emissions cost-effectively, Oil and Gas Journal, July 12, 2004

Mexico Processing Sector
Methane Emissions (2000)

- Reciprocating Compressors: 1.2 Bcf
- Engines: 0.5 Bcf
- Centrifugal Compressors: 0.4 Bcf
- Blowdowns: 0.2 Bcf
- Plant Fugitives: 0.1 Bcf
- Dehydrators and Pumps: 0.1 Bcf
- Other Sources: 0.1 Bcf

Sources: US Natural Gas STAR program success points to global opportunities to cut methane emissions cost-effectively, Oil and Gas Journal, July 12, 2004
Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2004
Best Management Practices (BMPs)

- Convert Gas Pneumatic Controls to Instrument Air
  - Gas pneumatic controls bleed methane to the atmosphere
- Install Flash Tank Separators in Glycol Dehydrators
  - Glycol regeneration vents methane
- Directed Inspection & Maintenance (DI&M) at Gas Processing Plants and Booster Stations
  - Equipment leaks cause methane emissions

Processor BMPs

- 86% of the processing sector reductions came from PROs
Recommended Technologies and Practices

- Additional valuable information
  - Facilitate technology transfer
  - One page
  - Easy to review
- 29 Partner Reported Opportunities (PROs) apply to Processing sector
  - 17 focused on operating practices
  - 12 focused on technologies
- PRO Fact Sheets are derived from Annual Reports 1994-2003
  - Total 63 posted PRO Fact Sheets at epa.gov/gasstar/pro/index.htm

Overview of Recommended Technologies and Practices

- Sample of Processing PROs
  - Acid Gas Removal
  - Begin DI&M at Remote Facilities
  - Convert Gas-Driven Chemical Pumps to Instrument Air
  - Eliminate Unnecessary Equipment and/or Systems
  - Install Electric Starters
  - Pipe Glycol Dehydrator to Vapor Recovery Unit
  - Recycle Line Recovers Gas During Condensate Loading
  - Replace Ignition – Reduce False Starts
  - Use Inert Gases & Pigs to Perform Pipeline Purges
  - Use of Composite Wrap Repair
Operating Practice PROs

- Pipe glycol dehydrator to vapor recovery unit
- Rerouting of glycol skimmer gas
- Eliminate unnecessary equipment and/or systems
- Inspect and repair compressor station blowdown valves
- Begin DI&M at remote facilities

Pipe Glycol Dehydrator to Vapor Recovery Unit

- What is the problem?
  - Glycol dehydrators use gas assist pumps, which vent methane to the atmosphere
- Partner solution
  - Pipe vented methane to Vapor Recovery Unit (VRU)
- Methane savings
  - Based on a 10 million cubic feet per day dehydrator
- Applicability
  - No limitations when the VRU discharges to a sales line or compressor suction

<table>
<thead>
<tr>
<th>Methane Savings</th>
<th>3,300 Mcf per year</th>
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<tbody>
<tr>
<td>Mcf = Thousand cubic feet</td>
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<table>
<thead>
<tr>
<th>Project Economics</th>
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<tbody>
<tr>
<td>Project Cost</td>
</tr>
<tr>
<td>Annual O&amp;M Costs</td>
</tr>
<tr>
<td>Payback</td>
</tr>
</tbody>
</table>
Pipe Glycol Dehydrator to Vapor Recovery Unit

- Other Benefits
  - Piping glycol dehydrator vent to VRU not only reduces methane but also volatile organic compounds (VOCs) and hazardous air pollutants (HAPs) vented from the reboiler
  - Quick payback and low capital cost of piping
  - At 7.5 cents per kilowatt hour, electrical power cost would be about $340 per million cubic feet (MMcf) per year of gas recovered

Technology PROs

- Acid gas removal
- Install pressurized storage of condensate
- Use ultrasound to identify leaks
- Recycle line recovers gas during condensate loading
- Convert gas-driven chemical pumps to instrument air
Acid Gas Removal

- What is the problem?
  - Diethanol amine (DEA) units absorb CO₂ and H₂S which are corrosive to pipelines, compressors, and other equipment.

- Partner solution
  - Several options with one being to install a Kvaerner membrane where CO₂ is separated from methane.

- Methane Savings
  - Based on emissions saved from average amine unit in the U.S.

- Applicability
  - Can replace any DEA unit but contaminants from feed line must be removed.

<table>
<thead>
<tr>
<th>Methane Savings</th>
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<tbody>
<tr>
<td>6 Mcf per day</td>
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Project Economics

<table>
<thead>
<tr>
<th>Project Cost</th>
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<tr>
<td>&gt;$10,000</td>
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<table>
<thead>
<tr>
<th>Annual O&amp;M Costs</th>
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<tbody>
<tr>
<td>&gt;$10,000</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Payback</th>
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<tbody>
<tr>
<td>3-10 years</td>
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</table>

Acid Gas Removal (Kvaerner Process)

Adapted from "Trimming Residue CO₂ with Membrane Technology," 2005
Acid Gas Removal

- Duke Energy Experience
  - Kvaerner process installed at Mewborn processing plant in Colorado, 2003
  - Membrane chosen for other advantages; zero emissions is added benefit
    - 65% less capital cost than amine unit
    - <10% less operating cost
    - <10% less operator man hours
    - 1/3 footprint of amine unit
    - Less process upsets
    - Less noise
    - Less additional infrastructure construction

- Costs
  - Conventional DEA Acid Gas removal would cost $4.5 to $5 million capital, $0.5 million in operating and maintenance (O&M)
  - Kvaerner Membrane process cost $1.5 to $1.7 million capital, $0.02 to $0.05 million O&M

Convert Gas-Driven Chemical Pumps to Instrument Air

- What is the problem?
  - As part of normal operations, pneumatic devices release natural gas into the atmosphere (more than 6 cubic feet per hour)

- Partner solution
  - Replace High-bleed devices with devices that run on instrument air

- Methane Savings
  - Based on average savings from converting devices from one facility to instrument air

- Applicability
  - Must install compressors, power source, dehydrators and volume tanks to convert to instrument air

Methane Savings

<table>
<thead>
<tr>
<th>Methane Savings</th>
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<tbody>
<tr>
<td>20,000 Mcf/year</td>
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Project Economics

<table>
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<tr>
<th>Project Cost</th>
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<tbody>
<tr>
<td>Annual O&amp;M Costs</td>
<td>&gt;$10,000</td>
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<tr>
<td>Payback</td>
<td>0-1 years</td>
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</tbody>
</table>
Convert Gas-Driven Chemical Pumps to Instrument Air - Schematic

- Installed compressed air system to drive pneumatic devices in ten South Louisiana, U.S. facilities
- Project Cost = $40,000
- Emissions Reductions = 23,000 Mcf/year
- Savings = $161,000 / year
- Payback Period ~ 3 months
New PROs

- Broad dissemination of PROs is key to program success and effective peer-based technology transfer
  - Zero Emission Dehydrators
  - Recover Gas from Pipeline Pigging Operations
  - Nitrogen Rejection Unit Optimization

Project Summary for Mexico

- Pipe Glycol Dehydrator to Vapor Recovery Unit

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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Project Description:</td>
<td>Pipe methane from 10 MMcf per day dehydrator to Vapor recovery unit</td>
</tr>
<tr>
<td>Methane Saved:</td>
<td>$3,300 Mcf per year (93 thousand cubic meters per year)</td>
</tr>
<tr>
<td>Sales Value:</td>
<td>$17,300 ($5.25 per Mcf gas)</td>
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<tr>
<td>Capital and Installation Cost:</td>
<td>($1,000)</td>
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<tr>
<td>Operating and Maintenance Cost:</td>
<td>($0) Negligible</td>
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<tr>
<td>Payback Period:</td>
<td>Less than 1 month</td>
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<tr>
<td>Additional Carbon Market Value:</td>
<td>$40,000 ($30 per tonne of CO$_2$e)</td>
</tr>
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</table>
## Project Summary for Mexico

### Acid Gas Removal

**Project Description:** Replace DEA unit with Kvaerner membrane unit

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
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<tbody>
<tr>
<td>Methane Saved:</td>
<td>2,190 Mcf per year (62 thousand cubic meters per year)</td>
</tr>
<tr>
<td>Sales Value:</td>
<td>$11,500 ($5.25 per Mcf gas)</td>
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<tr>
<td>Capital and Installation Cost¹:</td>
<td>($1,700,000)</td>
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<tr>
<td>Operating and Maintenance Cost²:</td>
<td>($13,000)</td>
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<td>Payback Period:</td>
<td>4 years</td>
</tr>
<tr>
<td>Additional Carbon Market Value:</td>
<td>$26,500 ($30 per tonne of CO₂e)</td>
</tr>
</tbody>
</table>

¹ - A $3,300,000 cost savings over typical DEA unit
² - A $450,000 operating cost savings over typical DEA unit

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### Convert Gas-Driven Chemical Pumps to Instrument Air

**Project Description:** Converting high-bleed pneumatic devices at one facility to instrument air

<table>
<thead>
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<tbody>
<tr>
<td>Methane Saved:</td>
<td>20,000 Mcf per year (565 thousand cubic meters per year)</td>
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<tr>
<td>Sales Value:</td>
<td>$105,000 ($5.25 per Mcf gas)</td>
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<td>Capital and Installation Cost:</td>
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<td>Operating and Maintenance Cost:</td>
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<td>Payback Period:</td>
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<tr>
<td>Additional Carbon Market Value:</td>
<td>$240,000 ($30 per tonne of CO₂e)</td>
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Discussion Questions

- To what extent are you implementing any of these PROs?

- What are the barriers (technological, economic, lack of information, regulatory, etc.) that are preventing you from implementing any of these technologies?

Reference: Unit Conversions

<table>
<thead>
<tr>
<th>Conversion</th>
<th>Unit Conversion</th>
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<tbody>
<tr>
<td>1 cubic foot</td>
<td>0.02832 cubic meters</td>
</tr>
<tr>
<td>Degrees Fahrenheit</td>
<td>(°F – 32) * 5/9 degrees Celsius</td>
</tr>
<tr>
<td>1 inch</td>
<td>2.54 centimeters</td>
</tr>
<tr>
<td>1 mile</td>
<td>1.6 kilometers</td>
</tr>
<tr>
<td>14.7 pounds per square foot</td>
<td>1 atmosphere</td>
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</table>