Convert Gas Pneumatic Controls to Instrument Air
Lessons Learned from Natural Gas STAR Partners

EPA’s Natural Gas STAR Program,
Pioneer Natural Resources USA, Inc., and
The Gas Processors Association

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Air Pneumatic Devices

- Methane Losses
- Methane Recovery
- Is Recovery Profitable?
- Spreadsheet-based Analytical Tools
- Industry Experience
- Discussion Questions
Natural Gas Pneumatic System

- Natural Gas from Plant
- Inlet Fluids
- Pressure Controller
- Gas Out
- LLC: Liquid Level Controller
- Liquid Out
- 20-30 PSI Network
- Instrumentation and Control Systems Piping Network
- Utility Services

Reducing Emissions, Increasing Efficiency, Maximizing Profits
Sources of Methane Losses

- As part of normal operations, pneumatic devices release natural gas into the atmosphere.
- High-bleed devices bleed in excess of 6 scf per hour:
  - Equates to >50 Mcf/year
  - Typical high-bleed pneumatic devices bleed an average of 140 Mcf/year.
Magnitude of Methane Losses

- Major source of methane losses from the natural gas industry
- Pneumatic devices are used throughout the natural gas industry
  - Over 13,000 in the processing sector
  - Estimated methane loss of 16 Bcf/year = $48 million!
Convert to Instrument Air devices

- Most applicable to:
  - Large facility with high bleed pneumatic devices and has access to electricity

- Major components of instrument air system
  - Compressor
  - Power Source
  - Air Drier
  - Volume Tank
Instrument Air Decision Process

- Identify possible locations for system installations
- Determine optimal system capacity
- Estimate project costs
- Estimate gas savings
- Evaluate economics
- Develop an implementation plan
Determine Optimal System Capacity

- **Instrument Air Requirements**
  - Volume of the compressed air
    - Meter pneumatic gas supply
    - Rule of Thumb: 1 cfm air/control loop
  - Adjust for air losses
    - 17% of air input is bypassed in drier

- **Utility Air Requirements**
  - Rule of Thumb for pneumatic air systems:
    - 1/3 for instrument air
    - 2/3 for utility air
Calculate Gas Savings

- Determine the Gas Value Saved
  - Value of Gas = \((IA_u + UA_u) \times M \times P/1000\)
    - \(IA_u\) = Instrument Air Use: e.g. 35 control loops
    - \(UA_u\) = Utility Air Use: e.g. assume 10 cfm utility gas
    - \(M\) = Minutes in a year (525,600)
    - \(P\) = Price of Gas: assume $3.00/Mcf
  - Value of Gas = \((35 \times 1 + 10) \times 525,600 \times 3.00 / 1,000\)
    - Value of Gas Saved = $ 71,000/year
Calculate Compressor Size

Determine Air Compressor Capacity

- Air Compressor Capacity = $IA_S + UA_S$
  - $IA_S = \text{Instrument Air Supply}$
    - $= IA_U / (100\% - \% \text{ air bypassed in drier})$
  - $UA_S = \text{Utility Air Supply}$
    - $= IA_U \times (\text{fraction of utility air use}) / (\text{fraction of instrument air use})$

- Air Compressor Capacity
  - $= [(35/\text{(100\% - 17\%)}) + ((35 \times (2/3))/(1/3))] = 112 \text{ cfm}$
## Determine Compressor Costs

<table>
<thead>
<tr>
<th>Service Size</th>
<th>Air Volume (cfm)</th>
<th>Compressor Type</th>
<th>Horsepower</th>
<th>Equipment Costs ($)</th>
<th>Annual Service Costs ($/yr)</th>
<th>Service Life (yrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>30</td>
<td>Reciprocating</td>
<td>10</td>
<td>2,500$1</td>
<td>300</td>
<td>1</td>
</tr>
<tr>
<td>Medium</td>
<td>125</td>
<td>Screw</td>
<td>30</td>
<td>12,500</td>
<td>600</td>
<td>5-6$2</td>
</tr>
<tr>
<td>Large</td>
<td>350</td>
<td>Screw</td>
<td>75</td>
<td>22,000</td>
<td>600</td>
<td>5-6$2</td>
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</tbody>
</table>

1 Cost included package compressor with a volume tank.

2 Rebuilt compressor costs $3,000 plus $500 labor minus $500 core exchange credit.
Determine Cost of Tank

<table>
<thead>
<tr>
<th>Service Size</th>
<th>Air Volume (gallons)</th>
<th>Equipment Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>80</td>
<td>500</td>
</tr>
<tr>
<td>Medium</td>
<td>400</td>
<td>1,500</td>
</tr>
<tr>
<td>Large</td>
<td>1,000</td>
<td>3,000</td>
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</table>

Small reciprocating air compressors, 10 horsepower and less, are commonly supplied with a volume tank.
## Determine Cost of Drier

<table>
<thead>
<tr>
<th>Service Size</th>
<th>Air Volume (cfm)</th>
<th>Drier Type</th>
<th>Equipment Cost ($)</th>
<th>Annual Service ($/yr)</th>
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</thead>
<tbody>
<tr>
<td>Small</td>
<td>30</td>
<td>membrane</td>
<td>1,500</td>
<td>500</td>
</tr>
<tr>
<td>Medium</td>
<td>60</td>
<td>membrane</td>
<td>4,500</td>
<td>2,000</td>
</tr>
<tr>
<td>Large</td>
<td>350</td>
<td>alumina</td>
<td>10,000</td>
<td>3,000</td>
</tr>
</tbody>
</table>

1 Largest membrane size; use multiple units larger volumes.
Calculate Capital and Operating Costs

- **Determine Capital Cost**
  - Equipment Cost = Compressors Cost (2) + Tank Cost (2) + Dryer Cost
    \[= 2 \times $12,500 + 2 \times $500 + 1 \times $4,500\]
  - Equipment Cost * Installation Cost Factor
    Total Capital Cost = $30,500 \times 1.5 = $45,750

- **Determine Operating Cost**
  - Electrical Power = $13,140
  - Engine Power * Operating Factor * Electricity Cost
### Economics of Replacement

<table>
<thead>
<tr>
<th></th>
<th>Year 0</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation Cost ($)</td>
<td>(45,750)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>O&amp;M Cost ($)</td>
<td>0</td>
<td>(13,140)²</td>
<td>(13,140)</td>
<td>(13,140)</td>
<td>(13,140)</td>
<td>(13,140)</td>
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<tr>
<td></td>
<td>(3,200)²</td>
<td>(3,200)</td>
<td>(3,200)</td>
<td>(3,200)</td>
<td>(3,200)</td>
<td>(3,200)</td>
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<tr>
<td>Overhaul Cost ($)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(4,800)³</td>
</tr>
<tr>
<td>Total Cost ($)</td>
<td>(45,750)</td>
<td>(16,340)</td>
<td>(16,340)</td>
<td>(16,340)</td>
<td>(16,340)</td>
<td>(21,140)</td>
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<tr>
<td>Gas Savings ($)</td>
<td>0</td>
<td>71,000⁴</td>
<td>71,000</td>
<td>71,000</td>
<td>71,000</td>
<td>71,000</td>
</tr>
<tr>
<td>Annual Cash Flow ($)</td>
<td>(45,750)</td>
<td>54,660</td>
<td>54,660</td>
<td>54,660</td>
<td>54,660</td>
<td>49,860</td>
</tr>
<tr>
<td>Cumulative Cash Flow ($)</td>
<td>(45,750)</td>
<td>8,910</td>
<td>63,570</td>
<td>118,230</td>
<td>172,890</td>
<td>222,750</td>
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<tr>
<td>Payback Period (months)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>IRR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>117 %</td>
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<tr>
<td>NPV ⁵</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$158,454</td>
</tr>
</tbody>
</table>

¹ Electrical Power at 7.5 cents/kWh.
² Maintenance costs include $1,200 compressor service and $2,000 air drier membrane replacement
³ Compressor overhaul cost of $3,000, inflated at 10% per year
⁴ Value of gas = $3.00/Mcf
⁵ Net Present Value (NPV) based on 10% discount rate for 5 years
Partner Experience: Spirit Energy ‘76

- Installed air compression system in its Fresh Water Bayou facility
- Project Cost = $60,000
- Emissions Reductions = 69,350 Mcf/year
- Savings = $208,050 /year
- Payback Period < 4 months
Partner Experience : Texaco

- Installed compressed air system to drive pneumatic devices in 10 South Louisiana facilities
- Project Cost = $40,000
- Emissions Reductions = 23,000 Mcf/year
- Savings = $69,000 / year
- Payback Period ~ 7 months
Lessons Learned

- Instrument air system has potential to increase revenue and cut methane emissions
- It may extend the life of system equipment
- Installing low-bleed devices in conjunction with switch to instrument air is economical
- Existing infrastructure can be used
- Rotary air compressors lubricated with oil must be filtered ahead of membrane dryer
Other Technologies

- Liquid nitrogen system
  - Expensive and potential safety hazard
- Mechanical controls and instrumentation system
  - No power source needed
  - Limited application, frequent calibration required
- Electric and electro-pneumatic devices
Discussion Questions

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