Compressor and Driver Selection Roundtable
Gas Electric Conference
Scott Schubring – Rotating Equipment
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Houston, TX
Why do we need this compression?

• We have to Recover Pressure drop

• Pressure drop is caused by:
  - Pipeline friction
  - Gas filters / dehy / coolers / valves, elbows, etc…
  - Pulsation bottles and unit piping
  - Suction pressure controllers

• Because the purpose of compression is to recover pressure drop, shouldn’t our focus when selecting and installing equipment take that into consideration?
Design Conditions?
Gas Turbine Driven Centrifugal Compressor

- Fairly Simple
- Low capital
- High O&M
- High fuel costs
Variable speed EMD Centrifugal Compression w/ VFD

- Fairly Simple
- Low capital (if power available)
- Low O&M
- Very High power costs
Constant speed EMD / Voith transmission / Centrifugal Compression

• Fairly Simple
• Low capital (if power available)
• Low O&M
• High power costs
Slow Speed Integral Reciprocating Compression / Gas Engine

- More Complex
- High capital
- Lowest O&M
- Lowest fuel costs
Constant Speed EMD Separable Slow Speed Reciprocating Compression (No VFD)

- Very Simple
- Low capital (if power available)
- Low O&M
- High power costs
Constant Speed EMD Separable High Speed Reciprocating Compression (No VFD)

- Simple
- Low capital (if power available)
- High O&M
- High power costs
Separable High Speed Reciprocating Compression / Gas Engine

- Very Complex
- Mid range capital
- Very High O&M
- Low fuel costs
Electric Compression Considerations

- Your economic model needs to factor in all the losses from the substation meter (where you are billed) to the motor shaft.

  - There is typically around 9~10% power loss from the substation meter to the shaft.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>% Power Loss</th>
<th>% Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substation</td>
<td>-1.5%</td>
<td>98.5%</td>
</tr>
<tr>
<td>Isolation Transformer</td>
<td>-1.2%</td>
<td>98.8%</td>
</tr>
<tr>
<td>VFD</td>
<td>-3.2%</td>
<td>96.8%</td>
</tr>
<tr>
<td>Motor</td>
<td>-2.5%</td>
<td>97.5%</td>
</tr>
<tr>
<td>Gearbox</td>
<td>-2.0%</td>
<td>98.0%</td>
</tr>
<tr>
<td>Totals to compr shaft</td>
<td>-10.0%</td>
<td>90.0%</td>
</tr>
</tbody>
</table>
Going “Green” by using electric?

- More fuel is burned when using electric power.
- Eventually (~2018), the government will start to penalize us for using compression electricity.
- The “greenest” compression option will be to burn natural gas locally – but hard to convince public.
Electric Rates

• What do you really pay?

• How do you stay competitive in the long run?

A rate of $0.055 translates to $0.10+actual cost?
Equipment Selection Drivers
O&M Costs

• Operation and Maintenance costs can be significant and are a key driver for equipment selection

• These costs need to be projected out for 20+ years to fully understand the economic effect to the bottom line profit

• Some equipment types might seem inexpensive due to long intervals between maintenance, but look at the cost of that overhaul or replacement
<table>
<thead>
<tr>
<th>Unit Type</th>
<th>Total O&amp;M Cost Over 20 Years</th>
<th>Average O&amp;M Cost per Horsepower-Hour (Over 20 Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas Turbine / Centrifugal Compressor (w/out Dry Gas Seal Replacements or Catalyst)</td>
<td>$6,305,000</td>
<td>$0.0044</td>
</tr>
<tr>
<td>Gas Turbine / Centrifugal Compressor (w/ Dry Gas Seal Replacements and Catalyst)</td>
<td>$8,449,000</td>
<td>$0.0059</td>
</tr>
<tr>
<td>High Speed Reciprocating Engine</td>
<td>$5,561,000</td>
<td>$0.0077</td>
</tr>
<tr>
<td>Slow Speed Reciprocating Engine</td>
<td>$2,713,700</td>
<td>$0.0019</td>
</tr>
<tr>
<td>Constant Speed Electric Motor / Slow Speed Recip Compressors</td>
<td>$1,393,700</td>
<td>$0.0010</td>
</tr>
<tr>
<td>Constant Speed Electric Motor / High Speed Recip Compressors</td>
<td>$2,252,000</td>
<td>$0.0016</td>
</tr>
<tr>
<td>Constant Speed Electric Motor w/ Voith Gearbox / Centrifugal Compressor (w/out Dry Gas Seal Replacements)</td>
<td>$1,732,700</td>
<td>$0.0012</td>
</tr>
<tr>
<td>Constant Speed Electric Motor w/ Voith Gearbox / Centrifugal Compressor (w/ Dry Gas Seal Replacements)</td>
<td>$2,172,700</td>
<td>$0.0015</td>
</tr>
<tr>
<td>Variable Speed Electric Motor, VFD w/ Standard Gearbox / Centrifugal Compressor (w/out Dry Gas Seal Replacements)</td>
<td>$2,986,000</td>
<td>$0.0021</td>
</tr>
<tr>
<td>Variable Speed Electric Motor, VFD w/ Standard Gearbox / Centrifugal Compressor (w/ Dry Gas Seal Replacements)</td>
<td>$3,426,000</td>
<td>$0.0024</td>
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