Process Output Improved through Online Monitoring of Hydrogen Reciprocating Compressor

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Problem

- Refinery Diesel Fuel Production limited by Hydrogen make-up compressor (106-K-2A) discharge pressure.
- Maintain eventual improvements, i.e. keep new discharge pressure levels at the allowable reactor pressure reliably.
- Maximize run time of motor driven compressor due to lower operational costs as compared to the steam turbine driven compressor.
Typical HDT Flowchart

- **Furnace**
- **Reactor**
- **High Pressure Separator**
- **Purge Fuel Gas**
- **Diesel Fuel Final Product**
- **Hydrogen Recycle**

- Diesel Fuel feed
- Hydrogen Make-up

- "106-K-02"
# 106-K-02A Specs

<table>
<thead>
<tr>
<th></th>
<th>Compressor</th>
<th>1st Stage</th>
<th>2nd Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>Worthington BDC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HP</td>
<td>805</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RPM</td>
<td>595</td>
<td></td>
<td></td>
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<tr>
<td>Service</td>
<td>Hydrogen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow</td>
<td>216.000 Nm³ / dia</td>
<td>9.000 Nm³ / h</td>
<td></td>
</tr>
<tr>
<td>Suction Pressure (psig)</td>
<td>-</td>
<td>198</td>
<td>465</td>
</tr>
<tr>
<td>Discharge Pressure (psig)</td>
<td>-</td>
<td>482</td>
<td>796</td>
</tr>
<tr>
<td>Suction Temperature (°F)</td>
<td>-</td>
<td>95.4</td>
<td>110</td>
</tr>
<tr>
<td>Discharge Temperature (°F)</td>
<td>-</td>
<td>247.3</td>
<td>202</td>
</tr>
<tr>
<td>Cylinder Diameter (inches)</td>
<td>-</td>
<td>11 1/2</td>
<td>7 1/2</td>
</tr>
<tr>
<td>Suction Valves</td>
<td>4</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Discharge Valves</td>
<td>4</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Unloaders</td>
<td>4</td>
<td>2</td>
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</table>
Solution

- Reciprocating Compressor Dynamic Analysis to diagnose causes of discharge pressure limitation.
- Online monitoring including analysis capabilities to maintain compressor at new discharge pressure levels.
- Online diagnose to minimize downtime of motor driven compressor.
Pressure Ports

- Compressor is not equipped with cylinder internal pressure ports necessary for Dynamic Analysis
- Modified discharge valves and covers were installed to provide cylinder internal pressure ports
Monitoring Scheme

Control Room

DCS

SERVER

Field

Ethernet

Workstations

Monitoring

email

FTP

Internet

Remote Diagnose

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Monitoring Scheme Details

- 2 Smart Transmitters
- 4 Temperature Transmitters
  1st and 2nd Stage
  Suction and Discharge
- 4 Pressure Transducers
  1st and 2nd Stage
- 2 Frame Accelerometers
- 1 Phase sensor
- 2 Rod Drop Sensors
Remote diagnose:

- Severe 2\textsuperscript{nd} Stage Suction Valves’ Leak
- Quantitative evaluation of leak indicated unloader fingers’ partially opening the valves

Recommendations:

- Replace 2\textsuperscript{nd} Stage Suction Valves
- Check and correct unloader fingers
UN-REGAP - 106-K-2A - After

IDEAL

ACTUAL

PERCENT SWEEP VOLUME

1> HE 2 - Fri Feb 14 14:27:12 2003
2> CE 2 - Fri Feb 14 14:27:12 2003

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Reactor Inlet Pressure

Data

kgf/cm²

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Added Value

- Incorporation of lower value streams to produce Diesel fuel.
- Additional margin of $10.00 for each m$^3$ of lower value streams incorporated to Diesel fuel for Reactor Inlet Pressure increment of 57 psi.
- Average daily production increase, 100 m$^3$/day.
- Added value $1,000.00/day
- Pay-off < 3 months
Lessons Learned

- Monitoring justification is easier when process gains are involved.
- Remote diagnosis is possible and greatly reduces monitoring costs.
- Maintaining the gains is key for justification.