- PUMP PIPING SYSTEM CASE STUDY -

INSUFFICIENT DAMPENERS

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Agenda

 Introduce System and Problem

 Steps Used to Solve Problem

 Summary and Lesson Learned
Two-Plunger Existing Methanol Units A & B

Motor

Dampener

Dampener

Duplex Pump

Duplex Pump
Problem: Piping Failures and High Vibrations

- Duplex methanol pump discharge piping system
- Small piping connections experiencing failures
- High vibrations even with dampeners installed
Methanol Piping Recycle Line Failures

- Failure on different methanol pump operating in parallel
- Location and type typical of failures of subject duplex pump
Field Data: Unit B Discharge Pulsation

- Unclear if dampener is correctly pre-charged
- High 1x = possible valve leakage
- Unclear operating conditions

Approximately 1,000 lbs shaking force in 2” line
## Pump System Description

<table>
<thead>
<tr>
<th>Existing Duplex Pumps</th>
<th>Future Triplex Pumps</th>
</tr>
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<tbody>
<tr>
<td>1.65” bore (4.19 cm)</td>
<td>1.75” bore (4.45 cm)</td>
</tr>
<tr>
<td>4.72” stroke (12.0 cm)</td>
<td>2.95” stroke (7.50 cm)</td>
</tr>
<tr>
<td>170 rpm</td>
<td>140 rpm</td>
</tr>
<tr>
<td>10.27 gpm (2.33 m³/hr)</td>
<td>11 gpm (3.0 m³/hr)</td>
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36 psia (2.48 bara) suction pressure

700-4550 psig (48-314 barg) discharge pressure
Existing & Proposed Dampeneners

- **Duplex Pumps** (existing)
  - 2 L Pre-charged to 80% of 4000 psig
  - *Ineffective for most of pressure range*

- **Triplex Pumps** (proposed)
  - 1 L Pre-charged to 80% of 4550 psig
  - *Ineffective for most of pressure range*
General Comments: Gas-Liquid Dampeners

- Pre charge gas filled bladder to fixed percentage of line pressure
- Pre-charged gas creates relatively large effective liquid volume to absorb pulsations
- Gas volume acts as spring compressing and expanding with line pressure changes
Dampener Pre-Charge vs. Line Pressure

- **If pre-charge pressure ≥ line pressure**
  - Gas volume of a dampener is largest
  - However, not effective because not opened/active

- **When pre-charge pressure < line pressure**
  - Pressure compresses bladder in dampener
  - Gas volume, and therefore effective volume, is decreased
  - Decrease of volume is directly proportion to increase in line pressure --- per ideal gas law
Dampener Size as Line Pressure Increases

- Operating dampener over large pressure range
  - Larger volume needed for low pressure because
  - Decreased gas volume at high pressure

- Examples:
  - 3.0 L gas volume at 700 psig becomes 1.0 L gas when line pressure reaches 2100 psig
  - 5.0 L gas volume at 2100 psig becomes 2.5 L gas when line doubles (4200 psig)
Reasoning Leading to Solution

- Space not available for all liquid filter
- Orifices alone not effective enough
- If ratio of pre-charge pressure to line pressure to high, bladder may fail
- Large discharge pressure operating range requires multiple dampeners
Solution

- Due to wide pressure range for this application, **two** dampeneners recommended
  - One pre-charged to 80% of low operating pressure (then it closes off, or is protected to prevent bladder failure)
  - Other pre-charged to 80% of medium line pressure so it operates over higher pressure range
Two Dampener Installation

- Two gas-liquid dampeners recommended for discharge system
- Dampeners recommended for each pump

Recommended dampeners located near pump plunger manifold
Pump Discharge Piping System

Location of test point for data on next slide

1-D Pulsation Model Schematic Developed
Pulsation Reduction Data: New Triplex

- **Single Dampener**
- **Two Dampeneners**

- X-axis – Hz
- Y-axis – psi pk-pk
Summary

• Only 1 dampener not sufficient for existing or new pumps

• Install 2 or more dampeneners for system with large pressure range
  • 1 for lower end of pressure range
  • 1 for upper end of pressure range
QUESTIONS OR COMMENTS?