User/Vendor Collaborative Seal Selection

From Problem Evaluation to Commissioning
Problem Statement

- Problematic dual seals in Ethylene Service
  - Vertical 16 stage pump
  - 1485 psig discharge

- High Maintenance costs

- MTBF of 2 to 6 months
  - Residue build up on ID of primary
  - Heavy wear on secondary
Assessment Criteria

- Team effort with seal/pump vendor and end user.
- Selection based on Life Cycle Cost
- Minimize engineering changes in the field
- Quick implementation and validation
- Reuse the existing support systems
- 60 month MTBF Target
Original Seal Design

Primary – Wet contacting Pusher seal with hydropads

Secondary – Dry Running Contacting Seal with N2 sweep

Plan 13 through a triple orifice with flush supply from 9th stage

Balance Ratio of 85.6%

Stuffing box press. 780 psig (super critical state)
Analysis of Original Seal

- Field testing of secondary seals
- Trending of primary leakage
- Samples of residue from primary seal
- Review of the flush plans
- Literature Searches/Consultation
Analysis (Detailed Analysis)

- Face distortion
- Heat generation (face temperature)
- Liquid fraction
- Seal Leakage
- Face Contact pressure
- PV numbers

Pre Startup

3600 RPM
Alternative Selection

- Plan 53 Wet Contacting (dual seal - pressurized barrier from accumulator)
- Plan 54 Wet Contacting (dual seal - pressurized barrier from external pump)
- Tandem Vaporizing Non Contacting (Plan 13/76)
- Optimized Existing Wet Primary and Containment seal.
Evaluate Options Against Assessment Criteria

- Selection based on Life Cycle Cost
- Minimize engineering changes in the field
- Quick implementation and validation
- Reuse the existing support systems
- 60 month MTBF Target
- Targeted the optimization of the existing seal configuration for detailed analysis.
Optimization Process

- Seal performance parameters
  - Changes in flush configuration
  - Balance ratio changes
  - Stuffing box pressure changes
  - Flush flow modifications
  - Face geometry changes
  - Additional FEA analysis to validate heat generation and face distortion
Proposed Solution

- Primary seal
  - Face Geometry Change
  - Balance ratio reduction
  - Optimized flush distribution for cooling
- Non Contacting Secondary seal
- Intermediate bushing
- Changed Flush Plan
  - Reduced stuffing box pressure by orifice change in Plan 13 (seal gland to suction)
  - Added Plan 11 to increase flow
  - Incorporated Pressure reducing coils
NEW SEAL DESIGN
Performance Parameter Comparison: Old/New Seal

**SEAL DESIGN ANALYSIS SUMMARY**
*(Steady state- hydropadded area)*

<table>
<thead>
<tr>
<th></th>
<th>Avg. Face Temp. F</th>
<th>PVnet (based on average contact pressure) psi-ft/min</th>
<th>Vapor Pressure psig</th>
<th>Face pressure psi</th>
<th>Balance %</th>
<th>Friction heat BTU/h</th>
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<tbody>
<tr>
<td>Old Seal</td>
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Implementation Plan

- Staged installation
- Validation testing
  - Leakage Verification
  - Secondary seal tests
  - Stuffing Box measurements
  - Flush flow verification
Implementation results

- Test results on secondary seals
- MTBF to date on the pumps
  - 3 pumps modified
  - No removals to date
  - Lead pump has 28 months
- Trending of leakages.
- Cost was 1/3 of the alternative
- Implementation was fast
- No added complexity
Learnings

- Detailed Engineering Review allowed for a fast, low cost, reliable alternative.