IMPROVED MECHANICAL SEAL DESIGN FOR HIGH TEMPERATURE /LIGHT SLURRY APPLICATIONS

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Author Biographies

Jose Martin is an engineer with the Applied Technical Solutions group of Flowserve Seals in Temecula, CA. He has over 20 years experience in mechanical seals including design and troubleshooting. He has held on-site positions at various refineries, serving as a sealing expert. He is currently assisting the field sales force in Latin America and western Canada. He received his BS in mechanical engineering from University of Guadalajara.

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Abstract

Extracting hydrocarbon products in oil sand formations requires high pressure to drive fluid out of the formation and to move the products out to production. The pump models that fit this operating envelope are not common in abrasive services. Mechanical seals that are normally installed in these pumps types are commonly API 682 type designs and are not well suited to handle abrasives.

This case study reviews an application where a bad actor conventional seal was replaced by a hybrid seal design to handle a high temperature, light slurry process while still providing low barrier fluid consumption.
Agenda

• Application description
• Challenges
• Review of previous solutions
• Description of developed solution
• Field results
• Lessons learned
Application Description

• Fluid: Hot bitumen with solids (sand, pipe debris) + H₂S
• Temperature: 275° – 302 °F (135° – 150° C)
• Pressure: 4.3 – 25.9 psig (29.6 – 178.6 kPag )
• Shaft Speed: 1190 RPM
• Shaft Size: 3.740” (95 mm)
• API Plan 53B
Challenges

- High temperature
- Solids in process
- Limited barrier reservoir capacity

API Plan 53A

API Plan 53B
Review of Previous Solution

- Proven design - API 682 Type A
- High pressure capability
- Faces exposed to barrier fluid
- Prone to clogging
- Insufficient materials
- Mechanical face retention

Average seal life less than one month
Review of Previous Solution
Review of Previous Solution

Inner Seal Failure - Excessive Leakage

- Rolled Dynamic Gasket
  - Pressure Reversal
- Gasket Extrusion
  - Soft Gaskets at High Temp
  - High Temperature Barrier Fluid
- Face Hang Up
  - Process Buildup Under Inner Seal
  - Thermal Expansion of Adaptive Hardware
Description of Developed Solution

- Low Expansion – High Durability Materials
- Line-on-Line Faces
- Large Cross-Section Dynamic Gasket
- Thermal Management Features
- API 682 Type A Outer Seal
- Hydraulically Loaded Faces
- Barrier on ID
- Outer Seal on ID Line - OD Barrier on ID Faces
Field Results

• Seal installed in June 2015
• Very low barrier fluid consumption
• Removed in April 2016 due to reverse rotation
• Examination of seal faces showed no damage or wear
Field Results
Lessons Learned

• Thermal expansion considerations
• Barrier temperature management
• Dynamic gasket sizing
Recommendations

• Seal faces must place process on OD
  – Slurry design features
  – High ID pressure capability
• Materials should be selected to reduce differential thermal expansion
• Review barrier system design for cooling capacity
• Select low leakage outer seals