Mechanical Seals in Decoker Units
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2007 Coking.com Safety Seminar
May 7 – 10, 2007
League City, Texas

Agenda

- Decoker Unit Application Overview
- Critical Applications
- Support Systems
- Troubleshooting
- Open Discussion
Decoker Unit Application Overview

- What makes a mechanical seal application challenging?
  - High temperature
  - Coking
  - High pressure
  - Solids
  - Poor system performance

High Temperature Sealing

- Basic Seal Design Criteria
  - Materials must withstand maximum temperatures, typically up to 800 F (427 C)
  - Components must tolerate thermal expansion differences
  - Outboard seal must prevent atmospheric coking or solidification
  - Assembly must accommodate high axial shaft movement during warm-up
Typical High Temperature Seal

- BXRH
- Single seal
- Welded metal bellows
- Flexible stator
- Plan 62 steam quench

Material Selection

- Welded metal bellows: Alloy 718
  - Excellent HT physical properties
  - Good corrosion resistance including H₂S
- Flexible graphite gaskets
  - Excellent HT properties and corrosion resistance
  - No memory, requires mechanical loading
**Material Selection**

- Silicon Carbide and Carbon seal faces
  - Excellent HT properties and corrosion resistance
  - Use two hard faces with abrasive media
- Alloy metals or 316 SS for all other metal components
  - Maximize corrosion resistance
  - Don’t compromise with “cheap” bolts/screws

**Tolerating Thermal Expansion**

- Match thermal expansion in shrink fit
  - Carbon or silicon carbide seal face requires a low expansion bellows flange
  - High Chrome alloy is required with high Sulfur or Hydrogen Sulfide content
Thermal Expansion Rates

- Approximate rates of thermal expansion
  - AM-350    7 E-6 in/in °F
  - Alloy C-276 6 E-6 in/in °F
  - Alloy 718  7 E-6 in/in °F
  - 316 SS    9.5 E-6 in/in °F
  - Alloy 42  3 E-6 in/in °F
  - Carbon    3 E-6 in/in °F
  - SiC        3 E-6 in/in °F

Tolerating Thermal Expansion

- At ambient temp., the seal face is lapped flat
- As temp. increases, the bellows diaphragms expand faster than the bellows flange & face
- Expansion is absorbed in the hinge
- Seal face remains flat
Prevent Coking

- Use anti-coke device and throttle bushing with Plan 62 quench
  - Direct Plan 62 steam quench from gland toward seal faces to purge oxygen

Prevent Coking with Plan 62

- Quench atmospheric side of seal with steam
- Inlet at top of gland, outlet at bottom
- Use throttle bushing to direct flow to drain
- Minimal steam supply required, 3 psi (0.2 bar) typical maximum
Prevent Vacuum-Induced Dry Run

- Add Plan 11, 21, or 32 flush with a throat bushing to boost seal pressure
  - Positive pressure at the seal eliminates air ingestion and keeps the faces running wet
Plan 11 & 32 Flush

- Plan 11: bypass flush from discharge through orifice
  - Simplest flush that adds seal pressure

- Plan 32: flush from an external clean source
  - Best flush for a clean, isolated seal area

Plan 21 & 23 Flush

- Plan 21: bypass flush from discharge through orifice & cooler
  - Useful to lower flush temperature while adding pressure

- Plan 23: flush from internal pumping ring through cooler
  - Most efficient flush but provides too much cooling for coker unit applications
Accommodate Axial Growth

- Metal bellows allow long axial travel
  - During pump warm-up, the shaft may have faster axial growth relative to the casing
  - Bellows absorb transient shaft movement

Starting Hot Pumps

- Slow warm-up is essential for the shaft and housing to grow together
  - Rapid warm-up increases stresses on pump parts, alignment, piping, and seals
High Temperature Rotating Design

- BXH
- Single seal
- Welded metal bellows
- Flexible rotor
- Plan 62 steam quench

Rotating vs. Stationary Bellows

- Stationary Bellows
  - Allows higher speeds
  - Absorbs shaft misalignment
  - Steam quench keeps bellows ID clean
- Rotating Bellows
  - Self-cleaning bellows OD
  - Generally shorter, used in dual seals
High Temperature Dual Seals

• Dual seals offer some advantages in high temperature applications
  ➢ Eliminate coking conditions on atmospheric side
  ➢ Operate under vacuum conditions
  ➢ Add safety measure
  ➢ Assist monitoring requirements

HT Dual Seal Considerations

• Wet barrier seals
  ➢ Barrier fluid must be suitable for sustained high temperature condition
  ➢ Reservoir must be larger than normal and cooling coils are mandatory
  ➢ Design must allow room for barrier fluid to circulate under IB seal
  ➢ How to rectify up to 800 F (427 C) pump with 200 F (93 C) maximum barrier fluid?
Plan 32 Flush for Dual Seals

- Flush isolates, cools, and protects inboard seal
  - Turn on flush before starting and leave it on after stopping pump
  - Flush fluid must be compatible with process, may come from similar process
  - Flow rate is low, use throat bushing to isolate seal area
  - Flush source must be reliable

Dual Seal Plan 52 & 53A

- Plan 52: unpressurized, with orifice in vent
- Plan 53A: pressurized
- Safety backup
- Prevents coking
- Provides some cooling to the inboard seal
- Can protect against pressure fluctuations
Good Piping Practices

- Minimize line losses
- Use large diameter tubing
- Only upward sloping lines
- Use long radius bends
- Minimize component losses
- Optimize for thermal siphon
- Check rotation direction
- Test for leaks

Bad Piping Practices

- Hard piping
- Fittings
- Valves
- Long runs
- Excess elevation
- Vapor traps
- Not self-venting
HT Dual Seal Considerations

- Dry containment (outboard) seals
  - Plan 72 steam purge must flow between seals to prevent inboard seal coking
  - Dual seal must drain condensate and process leakage to Plan 75 collection vessel
  - Containment seal does not protect inboard seal from running dry under heavy vacuum
    - Low pressure steam may leak into process
  - Most applications still require inboard flush

HT Containment Seal

- Containment seals were introduced in the 2nd Edition of API 682
  - No applications in decoker units were found but could be viable alternative
Jet Pump Seal

- With clean Plan 32 flush, coke fines in process won't affect seal faces
  - Lose the flush and suffer abrasive wear
- High pressure jet pump for the decoker tool uses QBR pusher seal
  - Flexible stator provides good face tracking

Conclusions

- Decoker unit seal applications are not so different from other parts of the refinery - focus on fundamental seal practices
- High temperature coker feed/charge pump seals require careful attention to seal design and system operation
- Jet pump seals achieve long life when coke fine-induced abrasion is prevented