Mechanical Seals in Decoker Units

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Agenda

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

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Decoker Unit Application Overview

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

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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

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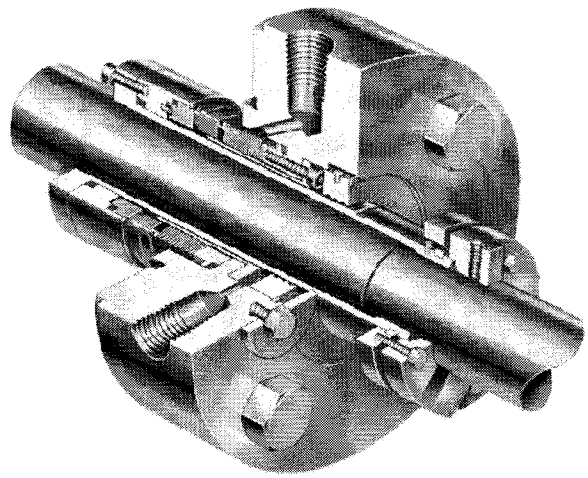
Typical High Temperature Seal

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



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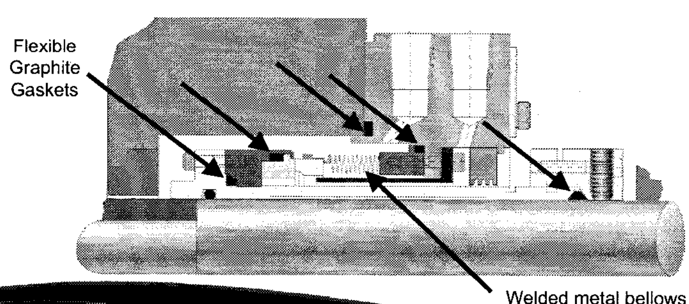
Material Selection

- Welded metal bellows: Alloy 718
  - Excellent HT physical properties
  - Good corrosion resistance including H_2S
- Flexible graphite gaskets
  - Excellent HT properties and corrosion resistance
  - No memory, requires mechanical loading



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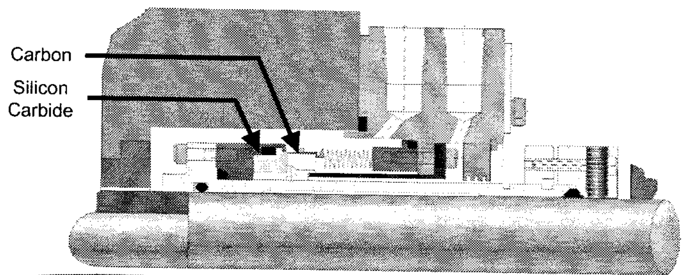
Material Selection

- 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



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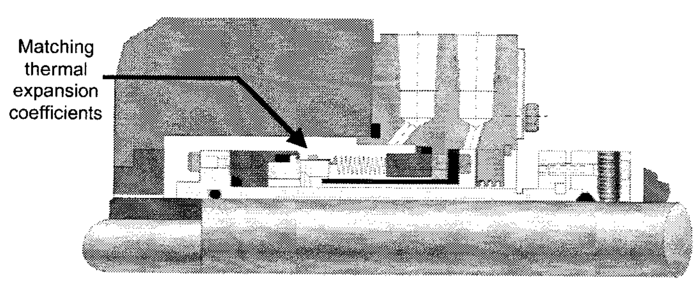
Tolerating Thermal Expansion

- 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



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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

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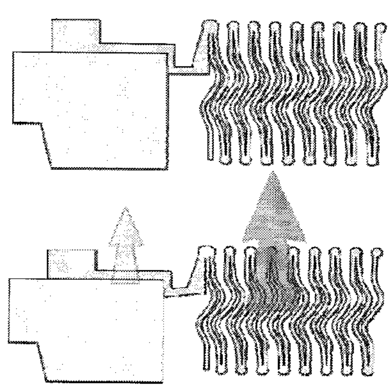
Tolerating Thermal Expansion



- 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

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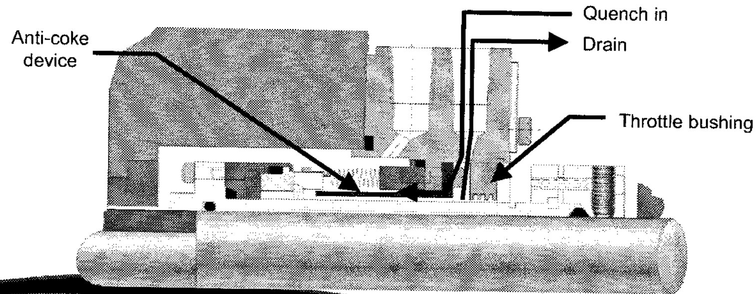
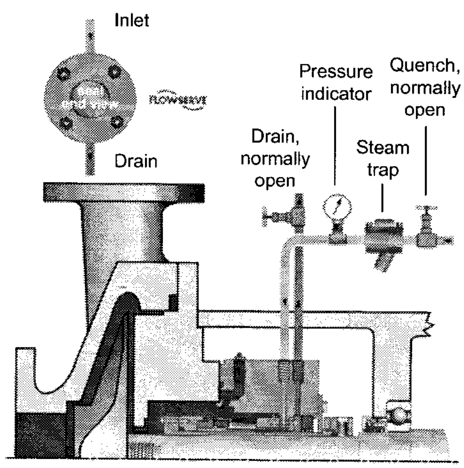
Prevent Coking

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



Experience In Motion

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

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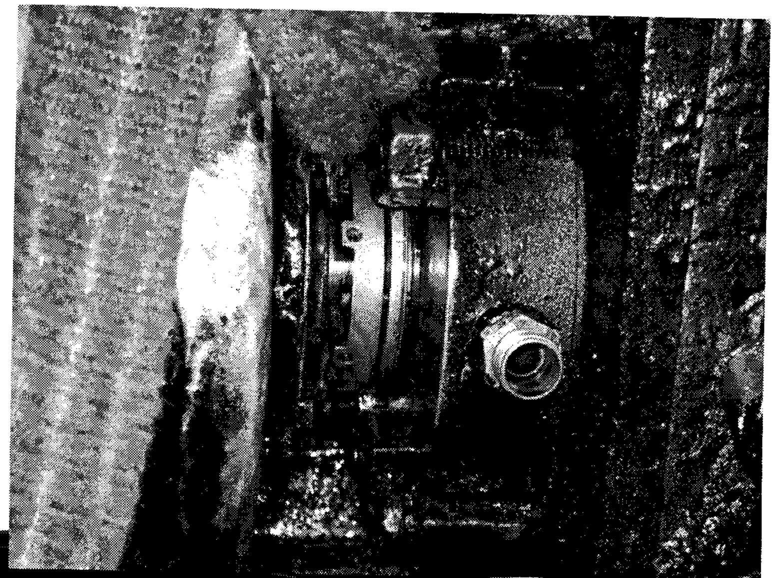
Common Outside View of Seal



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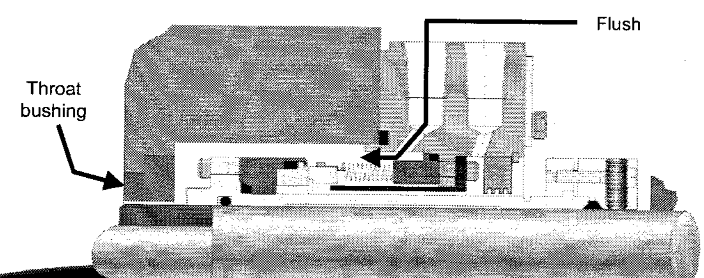
Prevent Vacuum-Induced Dry Run

- 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



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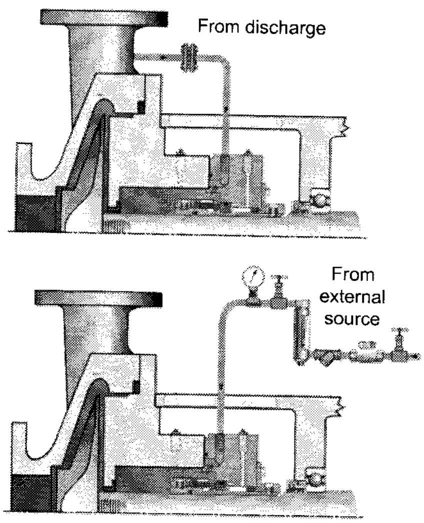
Plan 11 & 32 Flush



- 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

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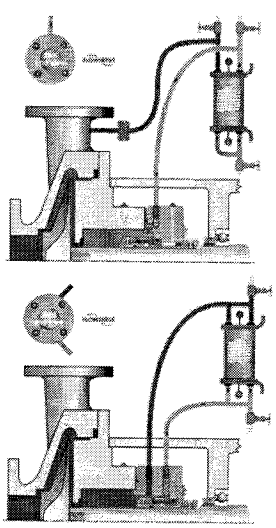
Plan 21 & 23 Flush



- 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

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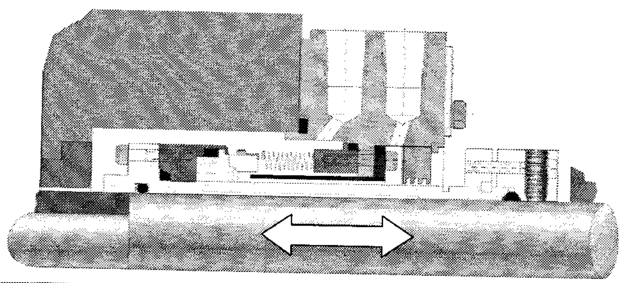
Accommodate Axial Growth

- 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



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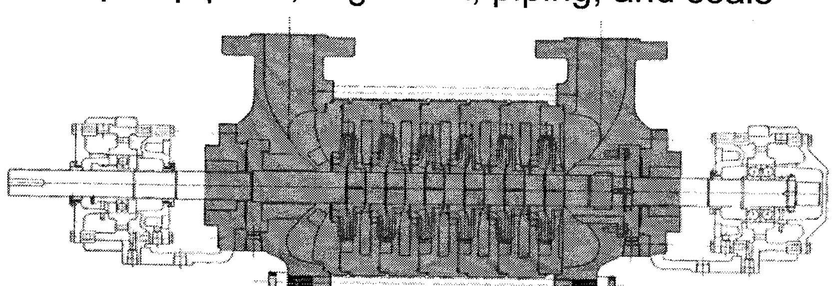
Starting Hot Pumps

- 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



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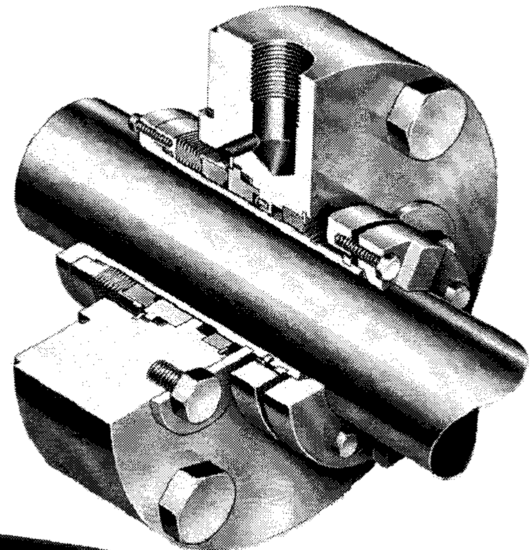
High Temperature Rotating Design

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



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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

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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

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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?

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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

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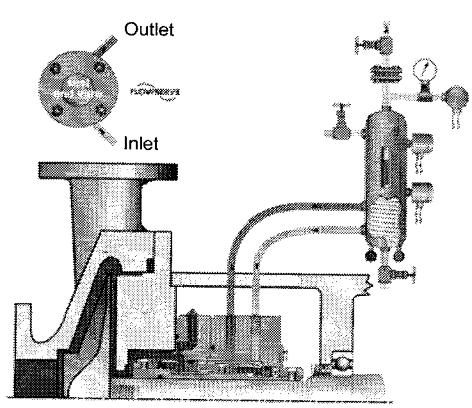
Dual Seal Plan 52 & 53A



- 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

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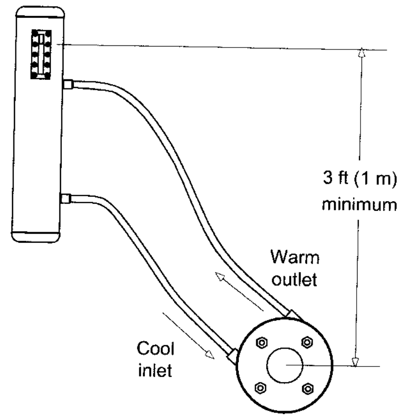
Good Piping Practices

- 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



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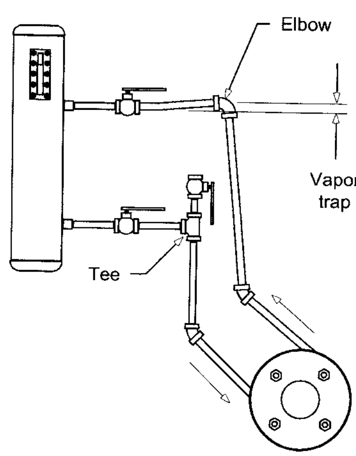
Bad Piping Practices

- Hard piping
- Fittings
- Valves
- Long runs
- Excess elevation
- Vapor traps
- Not self-venting



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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

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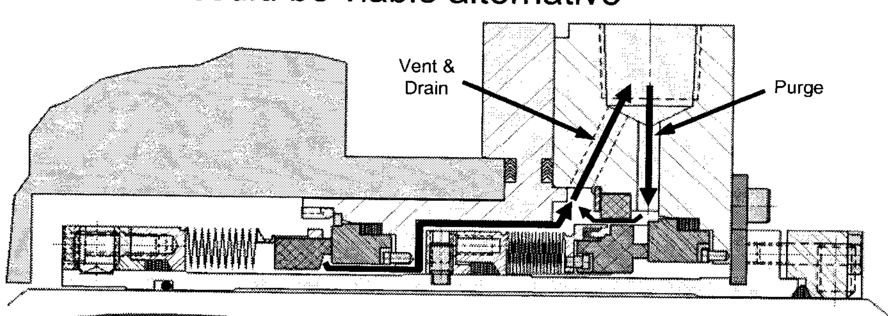
HT Containment Seal

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



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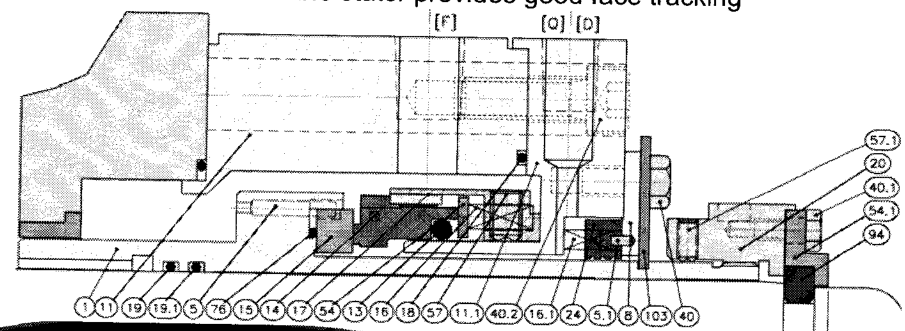
Jet Pump Seal

- 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



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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

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