Sealing Systems For Pumps
Part I

Presented by:
Shelby Scott
Western Region
John Crane, Inc
Packing

Mechanical Seal Basics

Pros & Cons: Packing & Seals

Mechanical Seal Elements

Basic Seal Designs

Materials of Construction
Note: Leakage occurs in a direction parallel to the shaft.
Clean Process Fluid Acts as Lubricant Between Packing & Sleeve

Target Leakage: 30 - 60 drops per minute

Atmosphere
Typical Packing Support

Flush Water Pressure Higher Than "A"

Atmosphere

Target Leakage: 30 - 60 drops per minute

Often, Clean Flush Is Used To Cool & Lubricate Inboard & Outboard Packing Rings
Alternate Sealing Methods & Support
Die-Formed Packing Ring Sets

❖ Pre-Consolidated In Die Press To Final Shape
  - Fast installation, minimal leakage at start-up
  - Rings Cut With Bevel Seams
    ❖ Eliminates leak path

❖ Cut To Exact Shaft Diameter
  - Ensures maximum performance
  - Minimal leakage

❖ Packaged In Complete 5 Or 6 Ring Sets
  - Ensures all old rings are removed – no left overs
Minimize Packing Water Use

Staggered Seam Locations

Start at one o'clock, stagger joints 90 degrees, and set firmly.
No Support
Packing Combination

1625G / G57

- Mixed set for no water support applications
- G57 - flexible graphite with corners of carbon yarn, provide sealability, self lubricating
- 1625G - graphite yarn with PTFE, act as bull rings to keep flexible graphite from extruding
Packing vs. Mechanical Seals

- Is not a seal but rather a restricting device. Requires leakage or it will burn.
- Will groove and wear shafts and sleeves.
- High horsepower load to overcome friction.
- Product loss.
- Requires large amounts of water for cooling.
- Requires maintenance time and downtime for installations and packing adjustments.
- Equipment damaged and destroyed from leakage.

- Will seal with invisible leakage. On difficult applications the leakage ratio between seals and packing is 1 to 100 or better.
- Seals have been known to run 8 to 10 years without failure.
- Monetary savings from little to no product loss, water savings and energy savings.
- Little maintenance required after initial installation.
- Seals offer better safety when sealing potentially hazardous materials.
Leakage

Atmosphere

Process Fluid

Shaft

Pump Housing

Leakage perpendicular to shaft centerline
Mechanical Seal Face Lubrication

- Surfaces in Contact
  - Fluid Migrates Through ‘Low’ Areas
    - Provides Lubrication to Reduce Heat
    - Absorbs Heat Generated
  - Surface Wears as ‘Peaks’ Broken Off
Minimizing Leakage

- Close clearance = less leakage and increased wear
- Greater clearance = more leakage and less wear.

Typical seal face film thickness is 10-50 μ-in (micro-inches).

A typical piece of paper is 5,000 μ-in thick!
Without Lubrication, Seal Faces Run Dry And Overheat

Lack Of Lubrication Causes, Contact, Heat Generation & Wear
Seal Face Damage: Heat Checking

Wear Groove

Seal Face Front View

Cracks Due To Inadequate Cooling
Mechanical Seal Elements

1. Primary sealing elements
2. Secondary sealing elements
3. Drive elements
4. Load elements
5. Adaptive hardware elements
Two Basic Seal Designs Exist:

- Bellows seals: more flexible, no dynamic O-ring, clog-resistant bellows made from rubber, metal or PTFE
- O-ring seals: compact, higher pressures, wide chemical range
The Ideal Material for Mechanical Seals:

- corrosion resistant
- wear resistant
- rugged design – non deflecting

Waste Water Seal: Silicon Carbide / Silicon Carbide or Tungsten Carbide / Tungsten Carbide

Clean Water Seal: Carbon / Silicon Carbide or Carbon / Tungsten Carbide
Optimum Materials for Efficient Sealing

- **Hard Face**
  - Silicon Carbide
  - Ceramic (Al-Oxide)
  - Tungsten Carbide

- **Soft Face**
  - Carbon

- **Bellows**
  - Viton
  - Buna
  - EPDM

- **Metal Parts and Spring**
  - 304 SS (18-8) or 316 Stainless Steel
Self-Cleaning Effect of Rotating Seal

- Resistance to packing and adhesion by the product to the rotating member
Seal Survival Depends on Cooling / Lubrication

- Heat Generated at Faces due to Friction
- Liquid Around Seal Provides Lubrication
- Liquid Also Removes Heat
- Dry-Running Will Result in Quick Failure
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Part I - The End!!!

Questions???

Tom Nowak – West Region Engineering Manager
Office # 562-802-2555
THNowak@JohnCrane.com

Roger Chavez – Sales Rep.
Mobile # 562.547.6431
RChavez@JohnCrane.com
Sealing Systems For Pumps
Part II

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- Seal Types
- Causes of Seal Failure
- Piping Plans
- Sealing Water Usage
- Safeunit Flowmeters
Pump Types

Submersible Pump

Sewage Pump
Dual Seal Arrangement

- Inboard Seal
  - Prevents Leakage of Process Water

- Outboard Seal
  - Prevents Leakage Into Motor

- Oil Between Seals
  - Provides Outboard Seal Support
Waste Water Applications
Waste-water pump
Mechanical Seals for Waste Water Applications

- Mainly Single Springs
- Self-Cleaning Effect Due to Rotating Spring
- Face Materials Need High Resistance
  - Chemicals
  - Abrasion
- Elastomers to be Chemical Resistant
Factors influencing leakage

- Seal face condition
- Running-in process
- Process influences
- Stability of seal face
- Condition of the secondary seals
- Face deformation caused by temperature and pressure
- Vibration and stability of the machine
- Operating mode of the plant
- Characteristics of the sealed fluids
- Accuracy of the seal mounting and assembly
- Condition of the equipment
Failure Causes at Mechanical Seal

- Insufficient venting at Mechanical Seal
- Vaporization of media in seal gap
- Negative pressure in stuffing box
- Air bubbles in piping system of pump or buffer fluid system

Hindered heat transfer due to gas ring
Failure of Mechanical Seal

**Cause of failure:**
Dry running at start up of pump, insufficient venting

**Observations:**
Faces are dull and slightly shiny,
Bellows at seal face melted and with cracks

**Solution:**
- Vent pump sufficient
- Checklist for start up
- Train staff

<table>
<thead>
<tr>
<th>Media</th>
<th>Waste water</th>
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<tbody>
<tr>
<td>Pressure</td>
<td>10 PSI</td>
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<tr>
<td>Speed</td>
<td>1750 RPM</td>
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<tr>
<td>Temperature</td>
<td>90 F</td>
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</table>
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Failure of Mechanical Seal

**Cause of failure:**
Dry running at start up of pump, insufficient venting

**Observations:**
Faces dull and with traces, selective corrosion

**Solution:**
- Fill and vent Pump before start up
- Check material selection, at pH-Value <7 use SiC

<table>
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<tr>
<th>Media</th>
<th>Waste Water with 3% Solids</th>
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<td>Pressure</td>
<td>45 PSI</td>
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<tr>
<td>Speed</td>
<td>1780 RPM</td>
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<tr>
<td>Temperature</td>
<td>75 - 90 ºF</td>
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Failure of Mechanical Seal

Cause of failure:
Thermal overload of faces due to vaporization of media in seal gap, Operation near boiling point

Observations:
Faces dull and with clear running traces and blistering. Elastomers brittle.

Solution:
➢ increase pressure
➢ lower temperature

<table>
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<tr>
<th>Media</th>
<th>Wastewater</th>
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<tbody>
<tr>
<td>Pressure</td>
<td>Approx 25 PSI</td>
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<tr>
<td>Speed</td>
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<td>Temperature</td>
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Flush Plan 11 - Circulation from Discharge

Discharge

Circulation Pipe From Discharge to Seal Chamber

Suction

Single Mechanical Seal
Flush Plan 13 - Circulation to Suction

- Discharge
- Circulation Pipe From Seal Chamber to Suction
- Suction
- Single Mechanical Seal
Plan 31 – Cyclone Separator

Discharge

Clean fluid to seal Abrasives back to suction

Suction

Single Mechanical Seal
Plan 32 - External Source Flush

Minimum Pressure
5 psi / .3 bar
Above “A”

Discharge

Seal Water Flow

Higher Pressure Seal Water Is The Seal Face Lubricant

Single Mechanical Seal
Sealing Water Usage

- Packing / Seals Typically Supplied 5 - 10 gpm
- Packing Typically Needs Only 1 gpm
- Seals Typically Need Only ½ gpm
- Supply Only The Amount That’s Needed!
Safeunit Sealing Water System

- Complete System To Control Sealing Water Flow & Pressure
- Monitors Water Supply & Indicates Trouble
- Used With:
  - Packing
  - Single seals
  - Quench seals
  - Double seals
- Quick Cleaning Without Interrupting Water Flow
- Optional Alarm
Safeunit Types

- **SFP**
  Packing or Single Seal Flush

- **SFQ**
  Quench Seals

- **SFD**
  Double Seals
Plan 32 - External Source Flush

Minimum Pressure
5 psi / .3 bar
Above “A”

Discharge

Safeunit To
Reduce Use To ½ gpm

Seal Water Flow

Type SFP
Safeunit

Suction

A

Single
Mechanical Seal
Plan 54 - External Source Barrier

Minimum Pressure
20 psi / 1.2 bar
Above “A”

Discharge

Hot Barrier Out (Top)

Type SFD Safeunit

Seal Water Flow

Double Mechanical Seal

Cool Barrier In (Bottom)

Suction
O-Ring Style Split Seal

- Fast, Easy Installation
- Cartridge Split Seal
- Downtime Reduced To A Minimum
- For Typical Pumps
- Non-clog Finger Springs
- Preinstalled O-rings
- Vacuum To 200 psi
- Pressure Range
- Up To 3600 rpm
Bellows Style Split Seal

- Bellows accommodates large shaft runout (~0.125”)
- No o-rings or metal springs to clog or hang up.
Part II - The End!!!

Questions???

Roger Chavez – Western Region
Office # 562-802-2555
Cell # 562-547-6431
RChavez@JohnCrane.com