MECHANICAL SEAL TROUBLESHOOTING GUIDE

DISASSEMBLY I INSPECTIONS I SEAL TRACKING DATABASE

CHESTERTON®
Global Solutions, Local Service.

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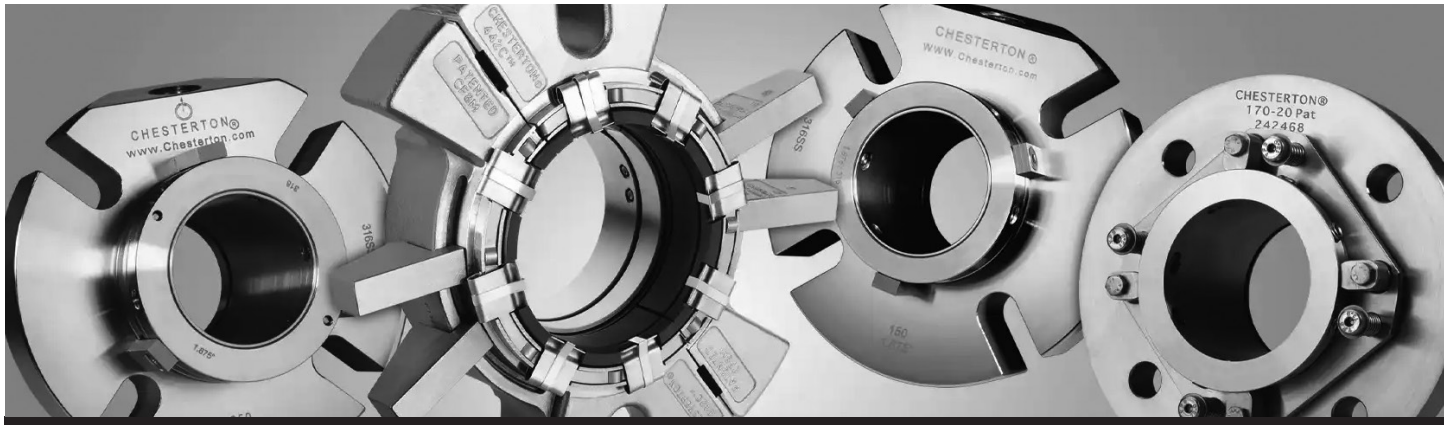


Introduction

Systematic failure analysis or troubleshooting is the key to improving product reliability. This statement is true in any industry and when you are dealing with any product. Troubleshooting the failure of a mechanical seal does not have to be a time consuming process. The best time to troubleshoot a failed mechanical seal is immediately after failure. This is when the information or facts will be clear in your mind. It is also extremely beneficial to have the seal stop operating immediately after the failure has taken place as this will reduce the chance of further damage to the seal and increase the chances of a successful analysis.

Troubleshooting the failure of a mechanical seal should be done in a way consistent with the seven basic steps of problem solving.

These seven steps are:

1. **Identify or Select the Problem**
2. **Collect the Data**
3. **Analyze the Problem**
4. **Generate the Solution**
5. **Implement the Solution**
6. **Evaluate**
7. **Standardize**

By using these seven steps as a guide you can perform a failure analysis of any product or system to improve product performance and increase mechanical seal reliability.

Troubleshooting Process

There are three main parts involved in the process of troubleshooting mechanical seal failures. These three parts correspond to steps ***1.*** through ***4.*** in problem solving. Steps ***5.*** through ***7.*** in the problem solving process will require experience, data evaluation, and retained knowledge to apply them towards mechanical seal troubleshooting.

The three main parts of seal troubleshooting are listed below:

1. *Gathering all of the **ACCURATE APPLICATION DATA** available*
2. *Gathering all of the **SYSTEM INFORMATION** available*
3. *Making notations of the **PHYSICAL EVIDENCE** as you are inspecting each individual seal component during disassembly*

The key to quick, accurate, and effective seal failure analysis is to be able to inspect the physical evidence (seal and rotating equipment) and relate the physical evidence to the application and/or system data. It is very important that all three parts of the information be available in order to make the proper recommendation to solve the problem.

There is no better place to perform a failure analysis than at the site the failure took place. The physical evidence and the application and system operation data is fresh in everybody's mind. Troubleshooting mechanical seal failures is not a simple process, but with experience, product knowledge, and confidence you can be providing solutions to your customer and improving product reliability, thereby reducing plant downtime.

Be aware that there are often factors other than the mechanical seal that contribute to premature seal failure.

Some of the other factors that should be considered are:

- **Fluid Characteristics**
- **Equipment Conditions**
- **System Operation**
- **System/Equipment Design**
- **Environmental Controls**
- **Maintenance Practices**

Listed below are common factors that contribute to early seal failure along with some helpful questions that will improve your troubleshooting skills.

Fluid Characteristics

- Does it crystallize?
- Does it coke?
- Does it harden or setup?
- Does it contain solids?
- What is the flash/vapor point?
- Is it a lubricating or non-lubricating fluid?

Equipment Conditions

- What is the radial and axial movement?
- What is the condition of the bearings?
- Are there alignment problems?
- Is the impeller balanced and positioned properly?

System Operation

- Does the system run dry?
- Is thermal shock an issue for the seal?
- What are the system cleaning procedures?
- Is it a continuous or cyclic process?
- Is there water hammer?
- Is cavitation a problem?
- Where is the pump operating on the curve?

System/Equipment Design

- What is the shaft L/D ratio?
- What is the valve/piping arrangement?
- Have there been any piping changes?
- Are filters or strainers being used?

Environmental Controls

- What is the flush pressure? Is it reliable?
- Are there any shutoffs in the environmental control lines?
- Do you need a dual seal?
- Do you need to consider a steam quench?
- Is there a cooling jacket?

Maintenance Practices

- What are the seal installation practices?
- Do the maintenance personnel require product training?
- Is the pump repaired when the seal is installed?
- Who installed the seal—internal maintenance personnel or outside contractors?

Using this Guide

This guide has been written to identify some common failure modes of mechanical seals. It includes the major symptoms of the failure modes for seal faces, wear tracks, elastomers, and metal components.

This guide is set up in a symptoms, causes, failure modes and solutions format.

SYMPTOMS

Are identified in the photographs at the top of each page.

FAILURE MODES

Are a description of the type of failure associated with the symptom.

CAUSES

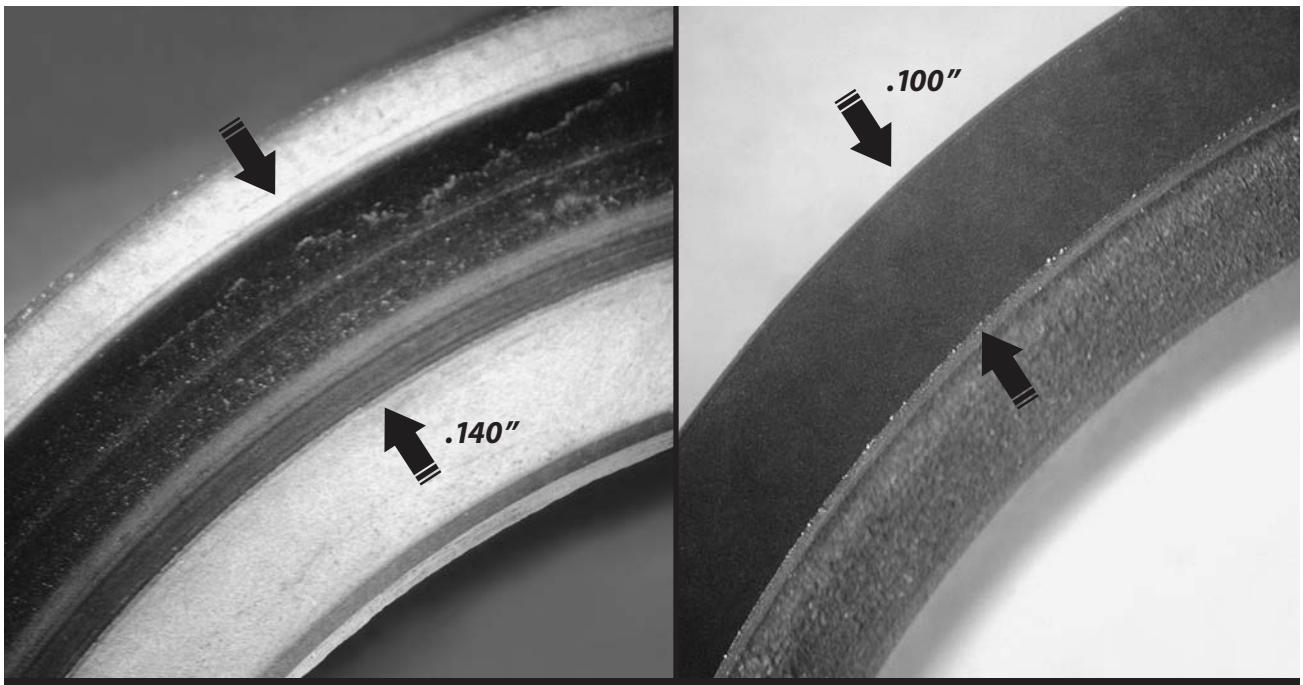
Give the user other places to look for information or ask questions.

SOLUTIONS

Are recommended to enhance product performance.

This guide has been written to help improve the accuracy of troubleshooting the failure of mechanical seals in the field. During the inspection process of a failed seal the components can be compared to the photographs in the guide for easy identification. This guide can be used alone or in combination with the Chesterton Seal Reliability Tracking Database Program. The terminology used in this guide is the same as that used in the Tracking Program. The Tracking Program is a computer program that will allow you to develop a database and store valuable seal reliability information. For further information about the Tracking Program please contact a Chesterton Customer Service Team member.

Wear Track Symptoms



ROTARY SEAL FACE – WIDE TRACK

STATIONARY SEAL FACE – NARROW

SYMPTOMS

- Wear track wider than narrow seal face width

CAUSES

- Miscentering of stationary type seal
- Radial shaft runout (bearing problem)
- Shaft deflection/wobble during operation

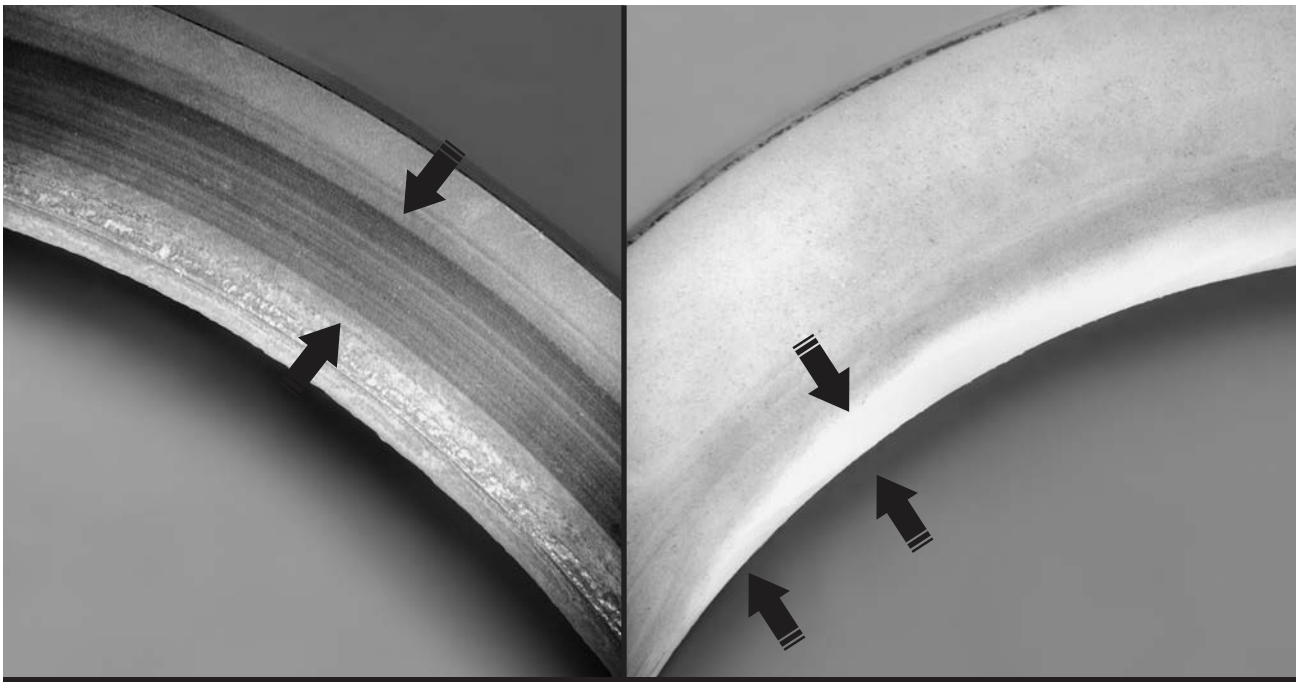
FAILURE MODES

- Misinstallation
- Equipment conditions
- Equipment design

SOLUTIONS

- Check bearings for radial runout exceeding limit of seal type
- Review installation techniques/instructions
- Calculate L/D ratio for equipment – Upgrade if necessary

Wear Track Symptoms Continued



STATIONARY (TYPE SEAL) – CENTERED

ROTARY (TYPE SEAL) – MISCENTERED

SYMPTOMS

- Centered or miscentered

CAUSES

Centered seal face wear track indicates:

- Properly centered seal and good equipment operation

Miscentered seal face wear track indicates:

- Miscentered seal (rotary type) during installation
- Equipment condition – Radial runout
- Equipment operation – Off curve, vibration

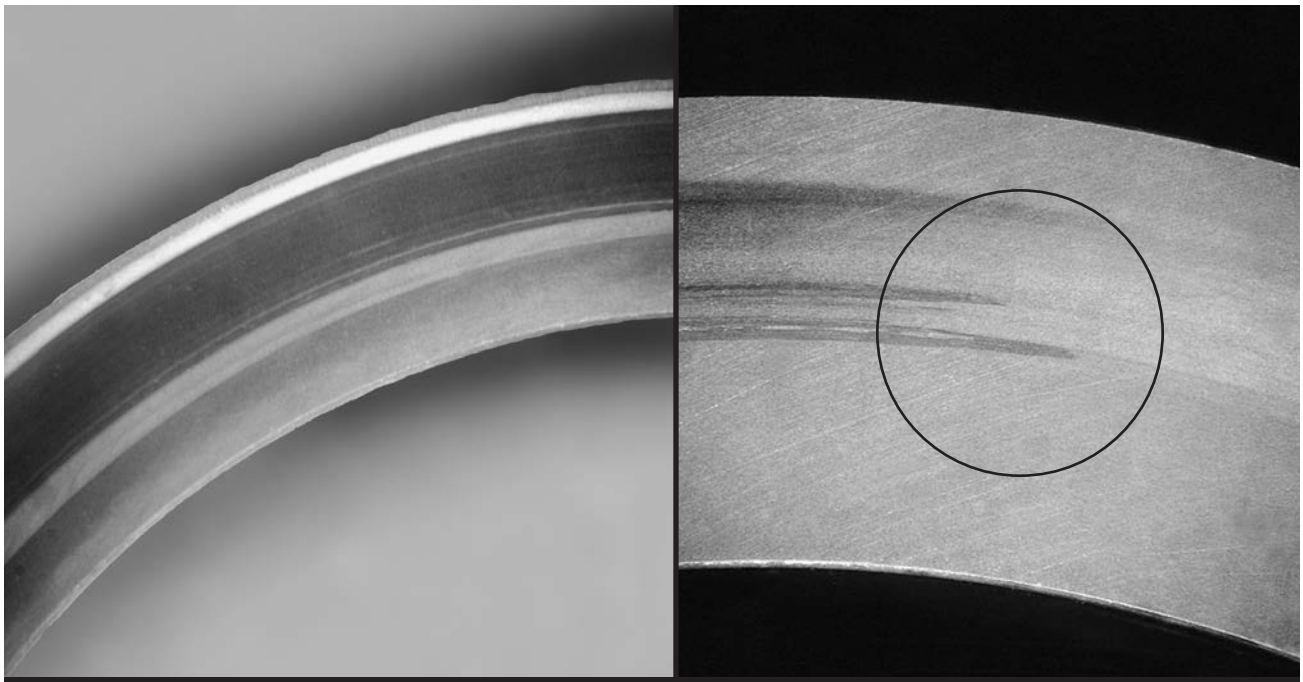
SOLUTIONS

- Check bearings for radial runout exceeding limit of seal type
- Review installation techniques/instructions
- Check equipment for shaft – Seal chamber concentricity

FAILURE MODES

- Misinstallation
- Equipment conditions

Wear Track Symptoms Continued



EVEN WEAR TRACK

UNEVEN WEAR TRACK

SYMPTOMS

- Even/uneven wear track

CAUSES

Even wear on a seal face usually indicates:

- Good contact between the mating seal rings

Uneven wear on a seal face indicates:

- Distortion of the seal ring due to over tightening, clamping, or excessive pressure
- Distortion due to insufficient gland support
- Misaligned seal rings in a split seal
- Improperly stress relieved component

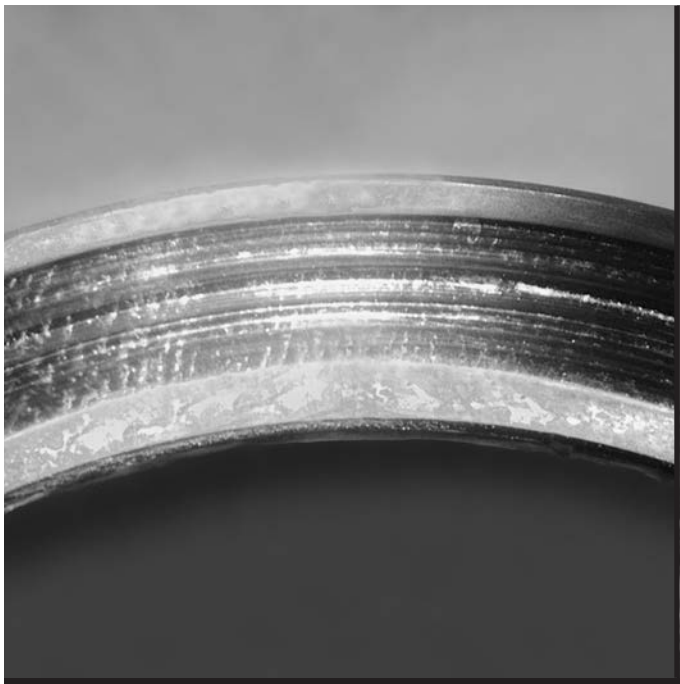
SOLUTIONS

- Review installation techniques/instructions
- Check/reduce torque and evenly tighten gland bolts
- Review operating conditions
- Reduce torque and evenly tighten gland bolts

FAILURE MODES

- Misinstallation
- Quality/design related issue

Seal Face Symptoms



SEAL FACE SCORING

SEAL FACE EROSION

SYMPTOMS

- Scoring or erosion

CAUSES

- Rebuilding seal in dirty environment
- Faces opening/flashing/vibration/distortion of the seal face due to temperature and pressure
- Minerals or particles found in the fluid film between the seal faces

SOLUTIONS

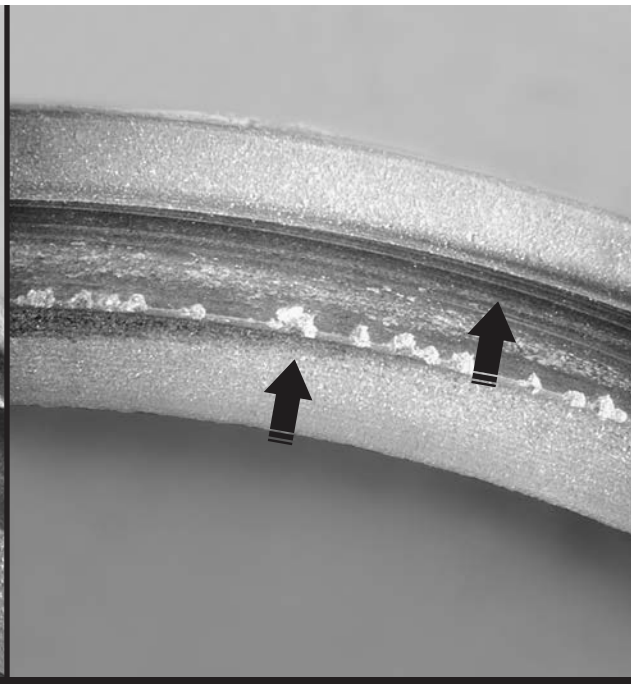
- Maintain seal face flatness
- Eliminate dry running, flashing and vibration
- Use clean flush source with bushing
- Use suction recirculation control
- Use harder seal face materials

FAILURE MODES

- Abrasive particles between the seal faces
- Lack of seal face lubrication

Seal Face Symptoms Continued

SEAL FACE – CHIPPING O.D.



SEAL FACE – CHIPPING I.D.

SYMPTOMS

- Chipping on outside/inside diameter

CAUSES

- Faces opening/flashing – Operating near vapor point
- Vibration
- Cavitation – Equipment operation
- Products hardening and setting-up
- Over pressurization

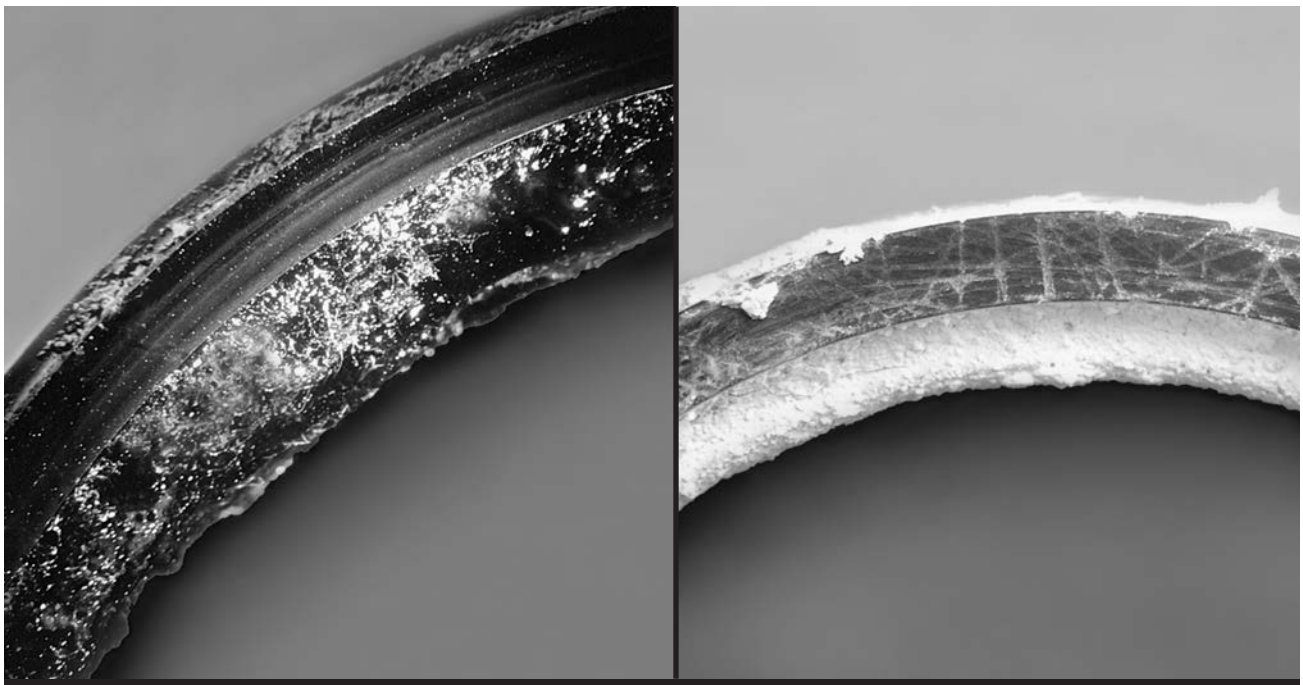
SOLUTIONS

- Proper environmental controls
- Check equipment operating conditions
- Insure the product is not flashing between the seal faces
- Operating seal within design parameters

FAILURE MODES

- Inadequate environmental controls
- Misapplication
- Product harden, set-up
- Exceed limits (speed, temperature, pressure)
- Equipment operation
- Lack of seal face lubrication

Seal Face Symptoms Continued



SEAL FACE – COKING

SEAL FACE – CRYSTALLIZED

SYMPTOMS

- Coking or crystallized product

CAUSES

- Excessive temperatures (both)
- Dirty or contaminated fluid (coking)
- Operating outside of the temperature envelope of the fluid (both)
- Small clearances in the seal chamber
- Pump cooling jacket not efficient
- Fluid evaporation between the seal faces (crystallization)

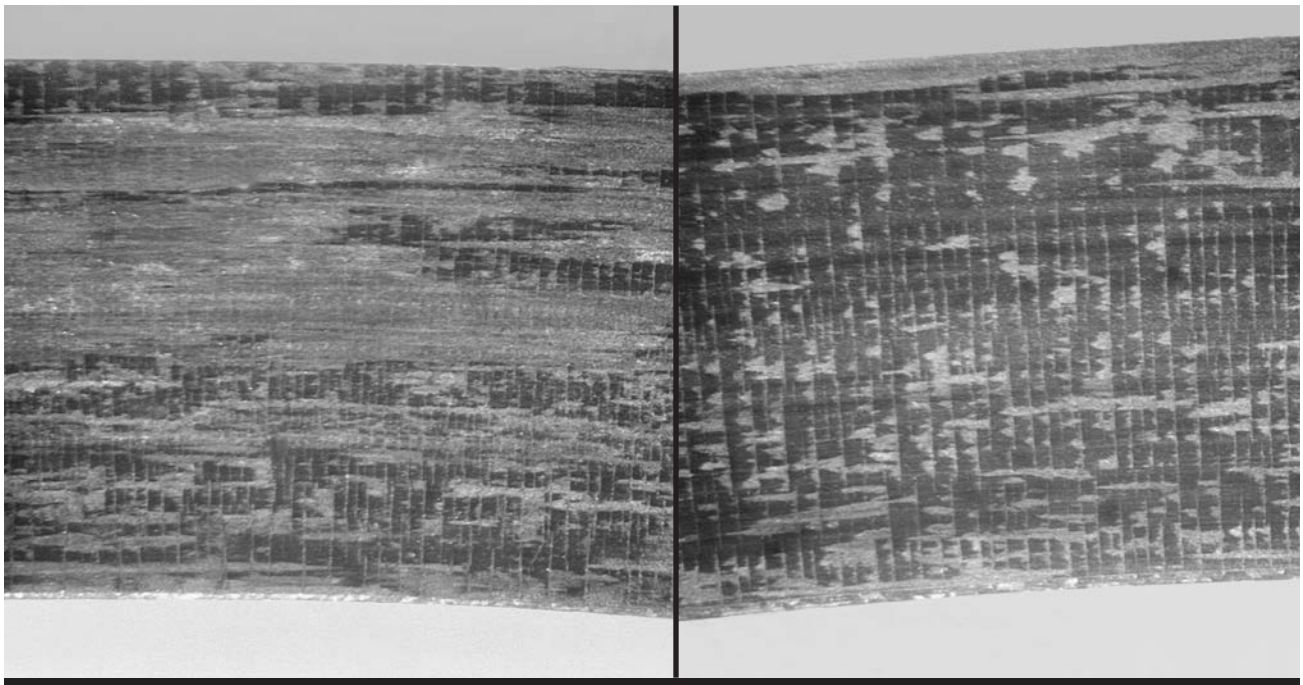
SOLUTIONS

- Proper use of environmental controls
- Operate within seal limits
- Understand the temperature envelope of the fluid being sealed

FAILURE MODES

- Inadequate environmental controls
- Product harden, set-up or coked
- Exceeded limits (speed, temperature, pressure)

Seal Face Symptoms Continued



SEAL FACE – HEAT CHECKING

SEAL FACE – HEAT CHECKING

SYMPTOMS

- Heat cracking or checking

CAUSES

- Exceeded PV limits of seal face materials
- Dry running
- Excessive heat from product

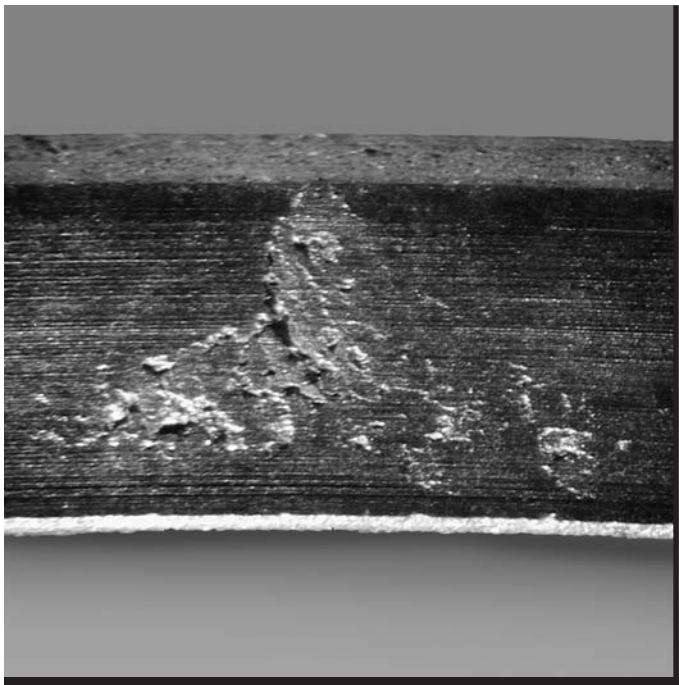
SOLUTIONS

- Operate within seal limits
- Eliminate dry running conditions
- Proper use of environmental controls

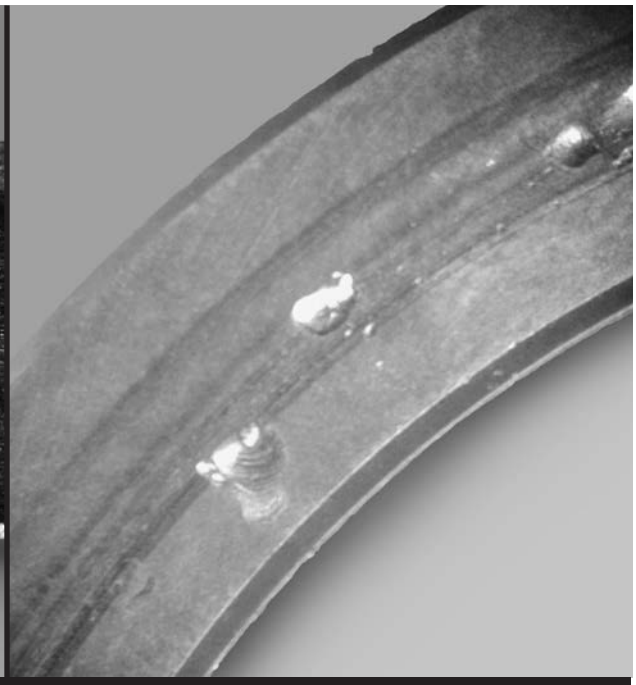
FAILURE MODES

- Lack of seal face lubrication
- Exceeded limits (speed, temperature, pressure)
- Inadequate environmental controls

Seal Face Symptoms Continued



SEAL FACE BLISTER – CARBON



SEAL FACE BLISTER – SILICON CARBIDE

SYMPTOMS

- Blistering of the seal face

CAUSES

- Using carbon seal faces in oil (all types)
- Exceeding the limits of the material
- Flashing

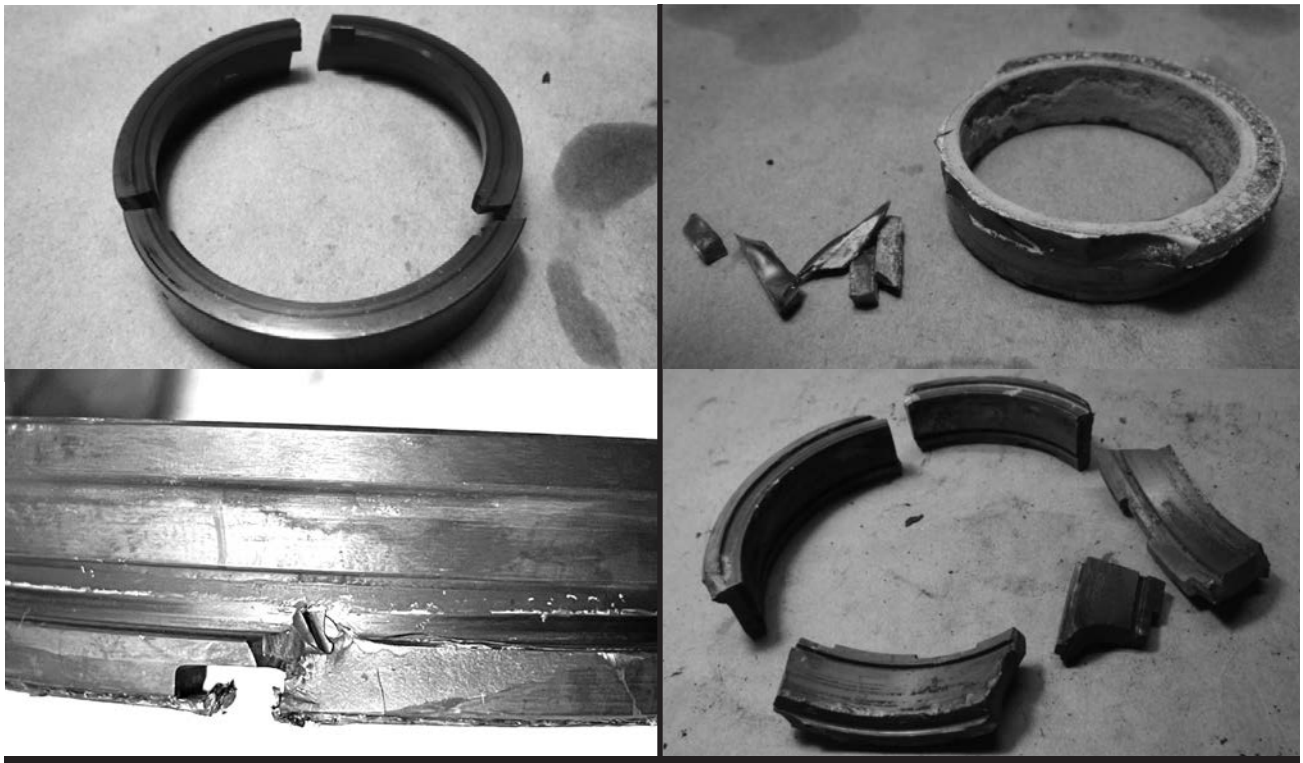
SOLUTIONS

- Use SC/TC face combination in oils
- Operate within seal limits
- Insure seal face lubrication

FAILURE MODES

- Seal face incompatibility
- Exceeded limits (speed, temperature, pressure)
- Misapplication

Seal Face Symptoms Continued



FRACTURE AT DRIVE(S) FRACTURE

SYMPTOMS

- Fractured

CAUSES

- High pressure
- High breakaway torque
- Radial force (swollen O-Ring, metal contact)

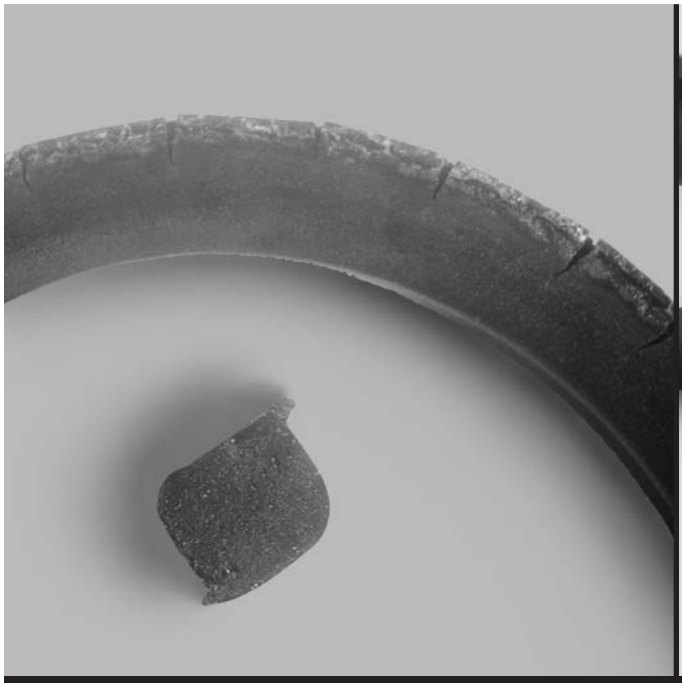
SOLUTIONS

- Operate within seal limits
- Proper use of environmental controls
- Proper O-ring selection for the application

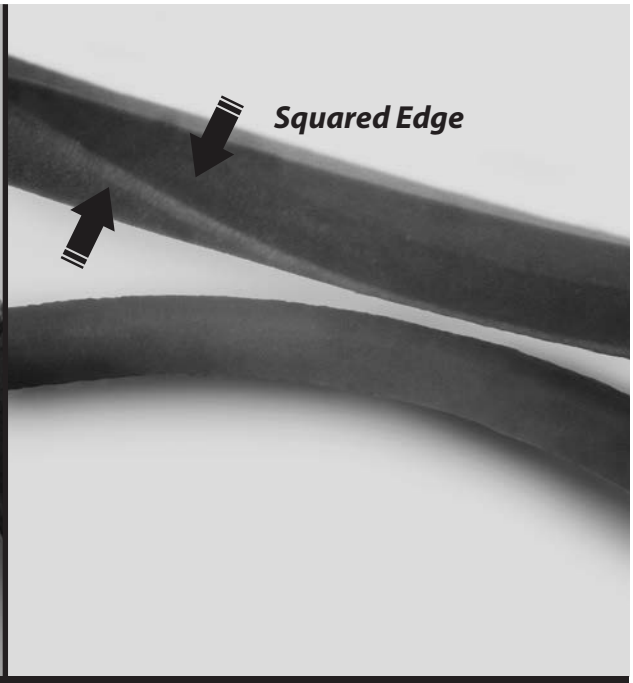
FAILURE MODES

- Exceeded limits (speed, temperature, pressure)
- Product hardened, set-up or coked
- Inadequate environmental controls

Elastomer Symptoms



COMPRESSION SET (SEVERE)



COMPRESSION SET (SLIGHT)

SYMPTOMS

- Hard/compression set (squared edge)

CAUSES

- Exceeding the temperature limit of the material
- Incompatible with the fluid – Chemical attack/ weakening of material

SOLUTIONS

- Use the proper O-Ring material for the fluid and temperature conditions
- Avoid dry running situations
- Proper use of environmental controls

FAILURE MODES

- Misapplication
- Exceeded temperature limit
- Excessive heat from dry running or loss of barrier fluid
- Inadequate environmental controls

Elastomer Symptoms Continued

EXTRUSION

NIBBLING

SYMPTOMS

- Extrusion or nibbling

CAUSES

- Excessive clearances
- Excessive pressure
- O-Ring material is not proper durometer (too soft)

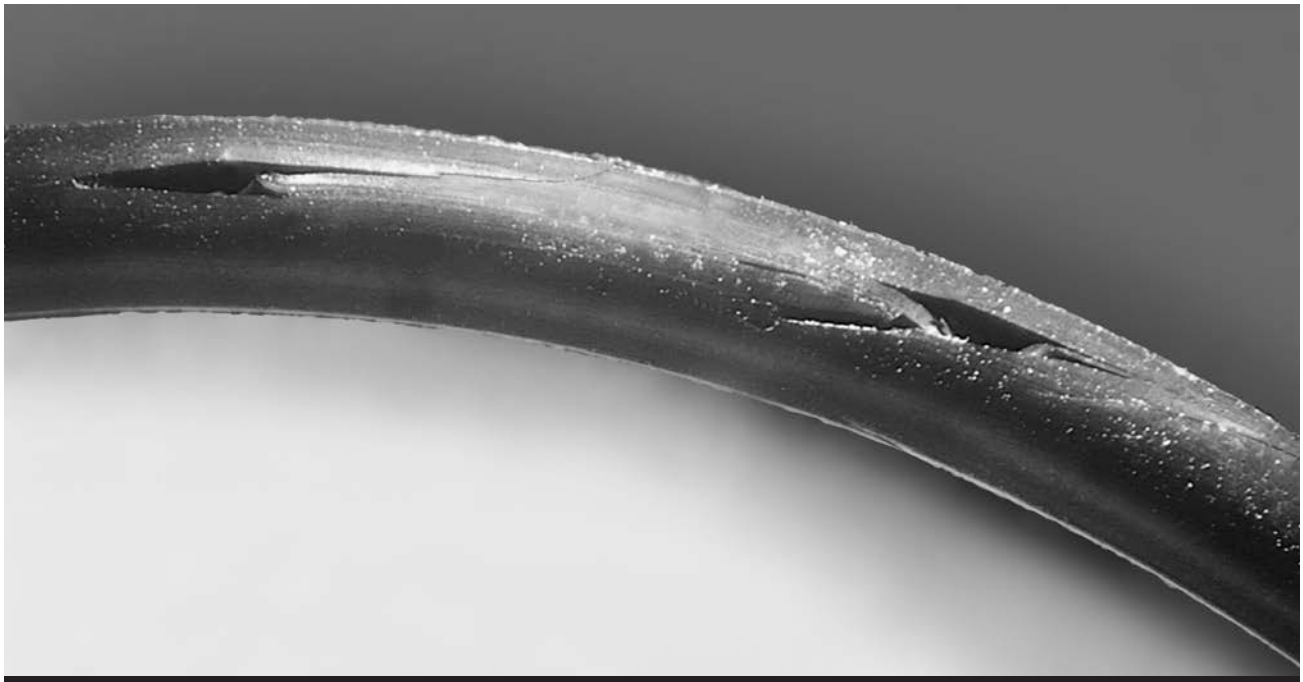
SOLUTIONS

- Proper O-Ring material selection for the application
- Improper seal design
- True knowledge of stuffing box pressure
- Adequate cooling for seal environment

FAILURE MODES

- Misapplication
- Excessive pressure
- Quality/design issue
- Excessive temperature for material

Elastomer Symptoms Continued



EXPLOSIVE DECOMPRESSION

SYMPTOMS

- Explosive decompression

CAUSES

- Trapped gas/vapor from the process fluid is forced into the O-Ring and with an instantaneous decrease of process pressure the trapped gases rapidly expand causing ruptures of the material.

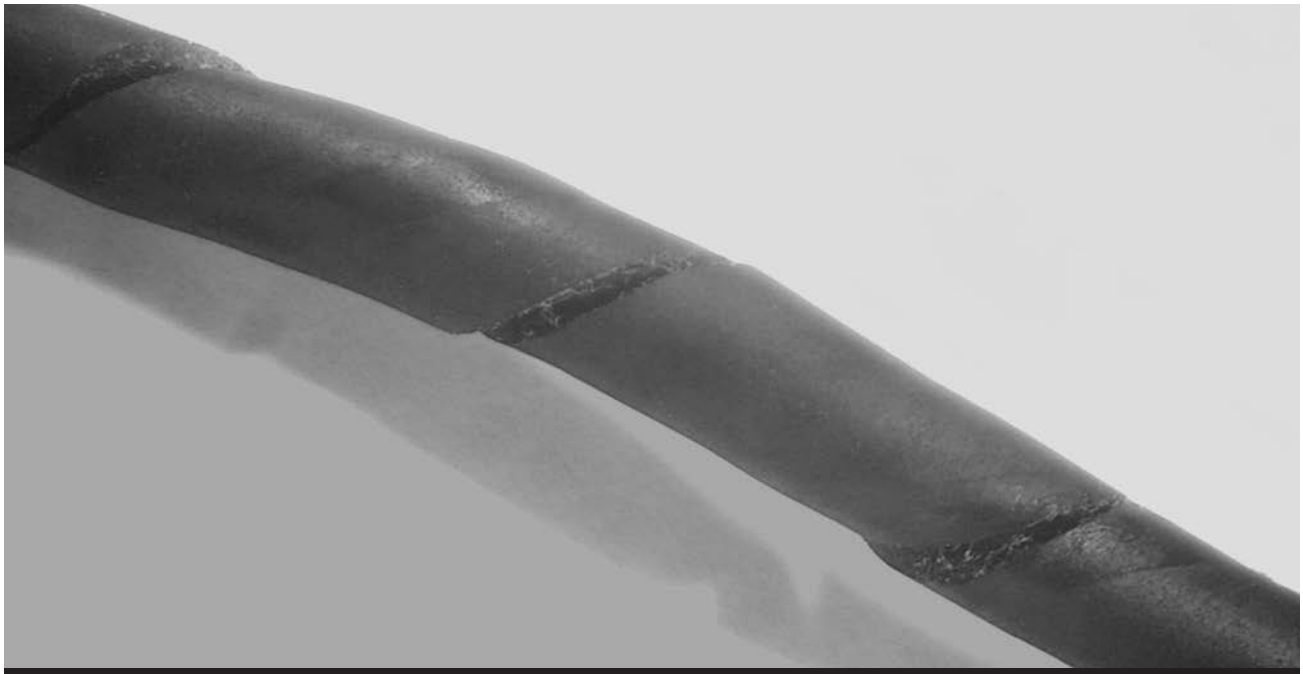
SOLUTIONS

- Use of proper O-Ring material (type and durometer)
- Knowledge of system operation (shutdowns)

FAILURE MODES

- Misapplication
- Equipment/system operation

Elastomer Symptoms Continued



TWISTED

SYMPTOMS

- Soft/mushy, or swollen, or twisted

CAUSES

- Chemical attack
- Exceeding material temperature limit

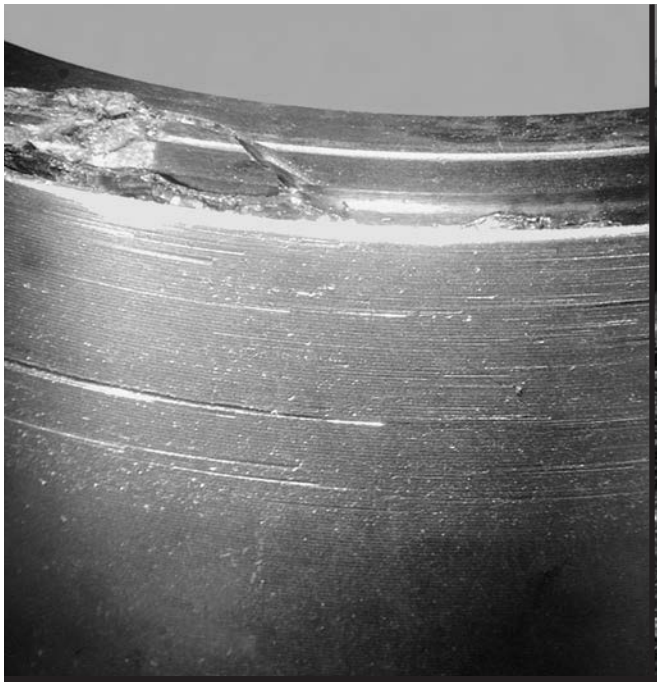
SOLUTIONS

- Use of proper O-Ring material selection for the fluid

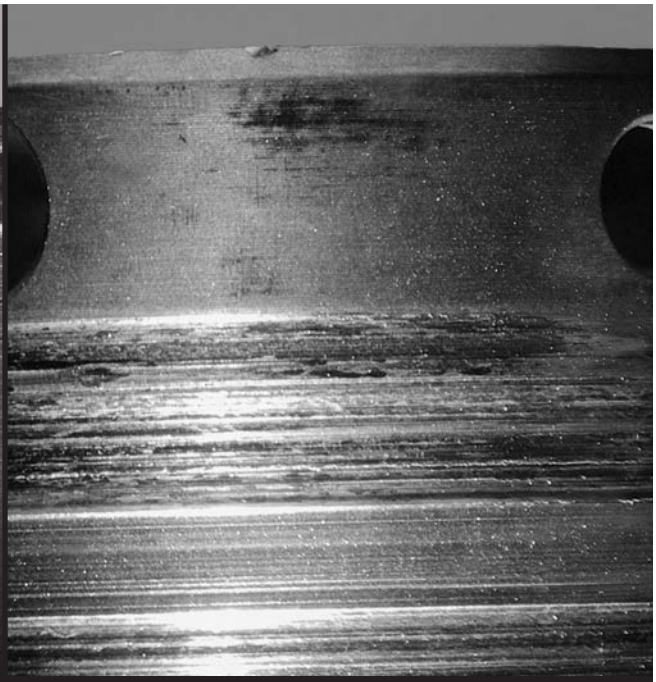
FAILURE MODES

- Misapplication
- Exceeded maximum temperature limit
- Chemical attack of the elastomers

Parts Inspection



SCORING O.D. (SEAL FACE)



SCORING O.D. (SEAL SLEEVE)

SYMPTOMS

- Scoring of inside/outside diameters of seal faces and metal parts

CAUSES

- Miscentering of seal
- Shaft runout or deflection
- Build-up of product in seal chamber
- Contact between seal components or between seal and pump
- Spinning on the shaft

SOLUTIONS

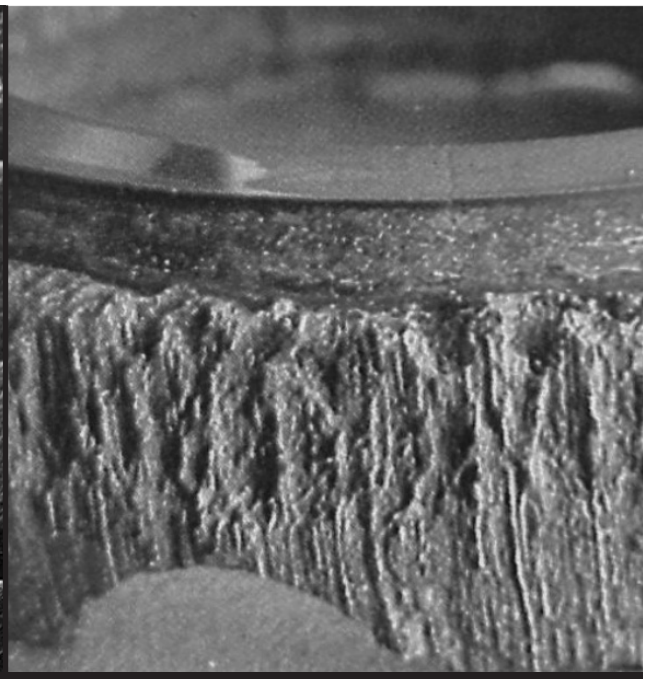
- Proper installation techniques
- Check equipment for radial runout and end play
- Use proper environmental controls
- Open up seal chamber to increase clearances

FAILURE MODES

- Misinstallation
- Equipment conditions
- Inadequate environmental controls

Parts Inspection Continued

CORROSION (METAL)



CORROSION (SEAL RING)

SYMPTOMS

- Corroded/pitted

CAUSES

- Chemical attack
- Excessive temperature (increases corrosiveness)
- Leaching of binder material

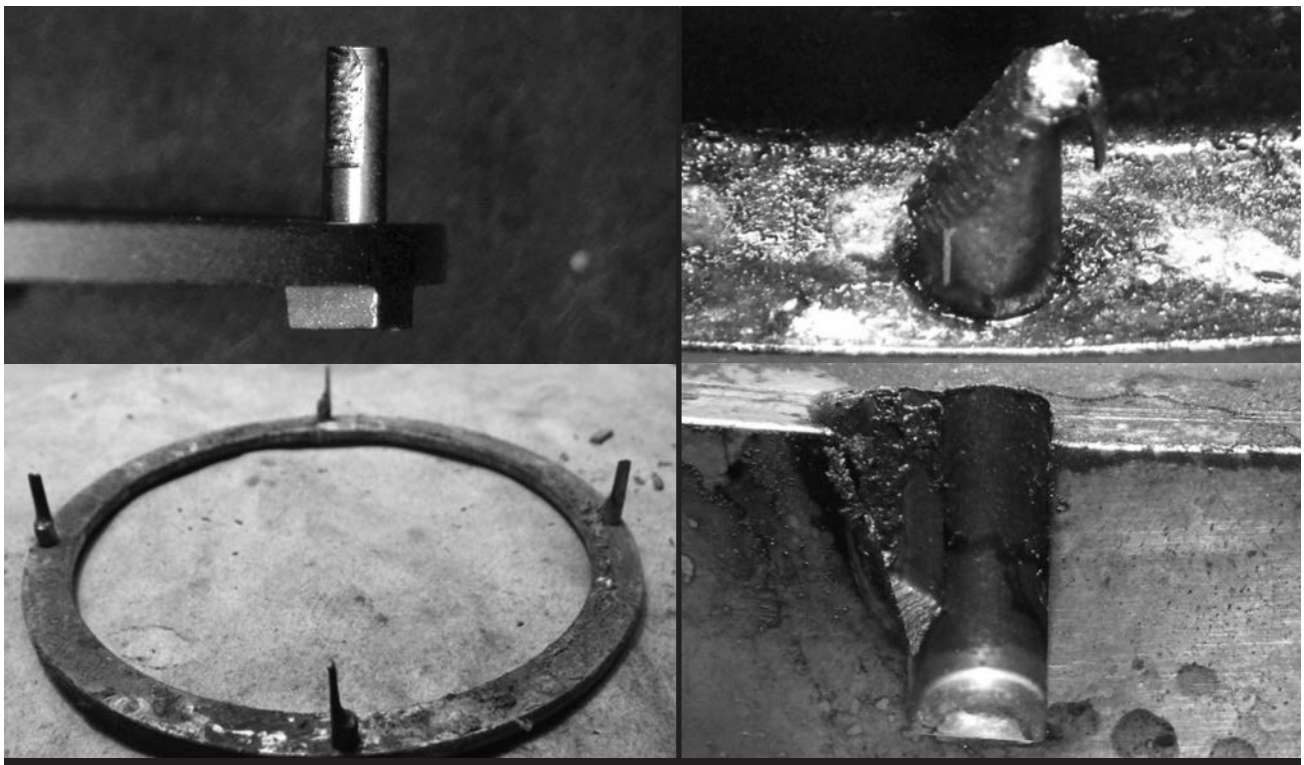
SOLUTIONS

- Use proper metal type for fluid being pumped
- Select proper seal face material
- Be aware of temperature influence on corrosive properties of the fluid being pumped

FAILURE MODES

- Misapplication
- Chemical attack of seal faces or metal parts

Parts Inspection Continued



DRIVE PIN WEAR (ABOVE, LIGHT; BELOW, EXTREME)

SHUTTLING (ABOVE, DRIVE PIN; BELOW, GLAND PIN SLOT)

SYMPTOMS

- Material removed from drive pin
- Shaving off drive pin (shuttling)

CAUSES

- Excessive torque
- Shaft deflection
- Dynamic runout

SOLUTIONS

- Operate within seal limits
- Check shaft for axial and radial runout
- Pump realignment

FAILURE MODES

- Exceeded limits (pressure)
- Failure to realign the seal after impeller adjustments
- Equipment conditions

Parts Inspection Continued

FLATTENED SET SCREWS

SYMPTOMS

- Flattened set screw cup points

CAUSES

- Rotary components sliding on shaft
- Excessive pressure (above holding power of screw)
- Use of stainless screws on hardened shaft
- Pressure spike or surge in system

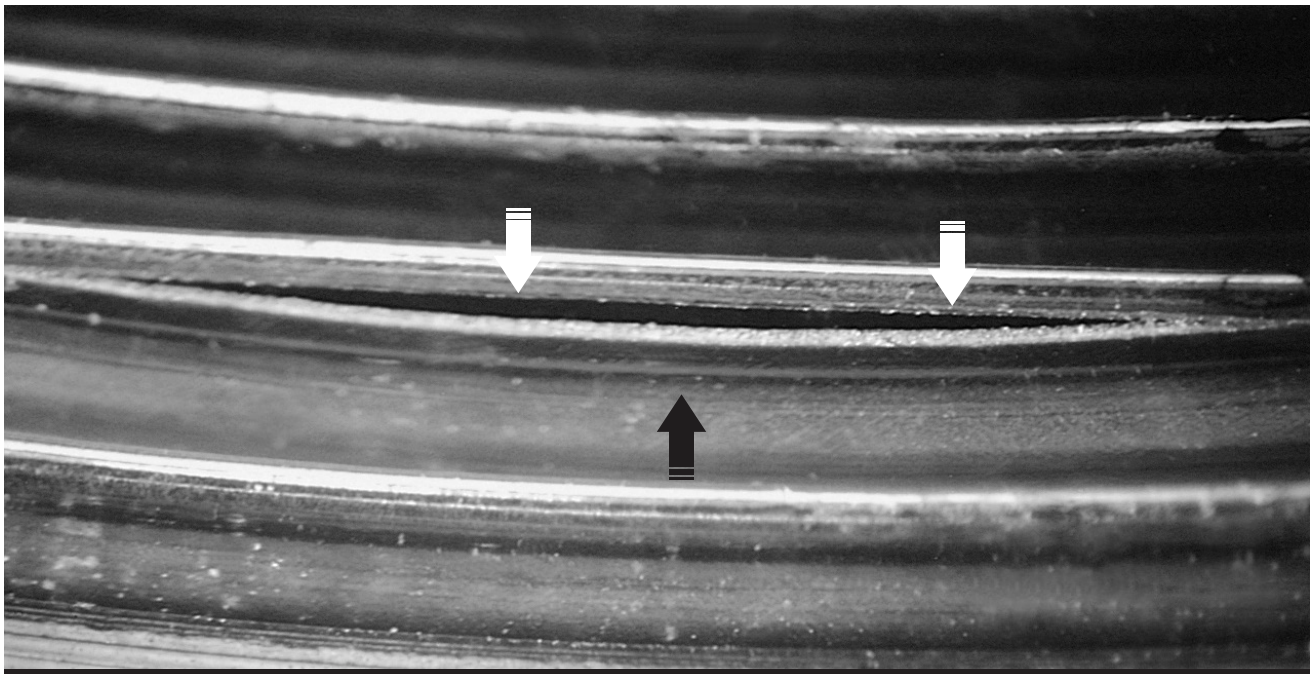
SOLUTIONS

- Use hardened set screws (as directed in installation instructions)
- Use indicating pressure gauge to determine the presence of pressure spikes or surges
- Check pump shaft material (hardness)

FAILURE MODES

- Exceeded maximum pressure limit of seal
- Misinstallation
- Improper set screw selection

Bellows Symptoms



BELLOWS CRACK (I.D. WELD)

SYMPTOMS

- Crack at or near weld

CAUSES

- Excessive pressure
- High torque from product setting up
- Dry running or non-lubricating volatile fluid
- Quality/design related issue
- Corrosion caused by incompatible fluid
- Excessive vibration/equipment movement

SOLUTIONS

- Proper application of bellows seals
- Proper use of quench/drain
- Insure lubricity of process fluid at the seal faces
- Avoid dry running bellows seals
- Use in clean, compatible fluids
- Minimize equipment vibration

FAILURE MODES

- Misapplication
- Inadequate environmental controls
- Product hardening, setting-up
- Exceeded maximum pressure limit of the seal
- Lack of seal face lubrication
- Chemical attack of the bellows unit
- Equipment condition

Bellows Symptoms Continued

BELLOWS CLOGGED WITH PRODUCT

SYMPTOMS

- Coated or clogged with product/coked product

CAUSES

- Product hardening due to heat
- Dirty or contaminated process fluid
- Insufficient clearances in the seal chamber

SOLUTIONS

- Increase clearances in seal chamber
- Proper use of steam (quench/drain)
- Use of clean compatible flush fluid
- Obtain knowledge of process fluid characteristics

FAILURE MODES

- Inadequate environmental controls (flush or quench)
- Product hardening or set-up

NOTES

NOTES

Global Solutions, Local Service

Since its founding in 1884, the A.W. Chesterton Company has successfully met the critical needs of its diverse customer base. Today, as always, customers count on Chesterton solutions to increase equipment reliability, optimize energy consumption, and provide local technical support and service wherever they are in the world.

Chesterton's global capabilities include:

- Servicing plants in over 113 countries
- Global manufacturing operations
- More than 500 Service Centers and Sales Offices worldwide
- Over 1200 trained local Service Specialists and Technicians

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