Causes and Corrective Procedures for Seal Leakage

john crane

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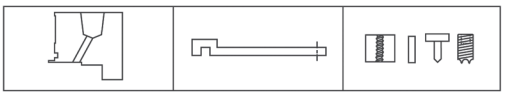
The purpose of this brochure is to provide educational information about seal leakage to those involved in the application and maintenance of mechanical seals. Identifying and correcting the cause of leakage will promote long, trouble-free operation. Observations made about the seal parts and installation are compared to symptoms, possible causes and corrective procedures. Pictures of common seal difficulties are given for easy identification. For purposes of illustration, these pictures, symptoms, causes and corrective procedures are based on the assumption that the primary ring is rotating.

CAUTION: Seal repairs should be undertaken only by qualified personnel.
If problems continue, contact your local John Crane sales representative immediately.

1ST SYMBOL	2ND SYMBOL	3RD SYMBOL	4TH SYMBOL	5TH SYMBOL	6TH SYMBOL	7TH SYMBOL
Secondary Seal for Primary Ring	**Primary Ring**	**Hardware: Retainer, Disc, Etc.**	**Secondary Seal for Mating Ring**	**Mating Ring**	**Loading Force**	**Metallurgy 3rd/6th**
Bellows Types 1 & 2	Types 1, 2,& 21	Types 1, 2, & 21	Gaskets, O-Rings, Cups	Pinned O-Ring	Multiple-Coil Spring	
O-Ring Types 8 & 48	Type 8	Types 8, 9, & 48		Rectangular O-Ring	Single-Coil Spring	
Wedge Type 9	Type 48	Metal Bellows		Floating L-Pinned	Single-Wave Spring	
Bellows Type 21	Type 9			Cup-Mounted	Multiple-Wave Spring	
Compression Ring Type 37	600 Series			Clamped-In	Metal Bellows	
PTFE Bellows Type 20				Modified Clamped-In		
Metal Bellows O-Ring Grafoil						

Note: Seal adaptive hardware including glands, sleeves, collars, pins, screws, etc. are not described by this code.



Checklist for Identifying Causes of Seal Leakage

SYMPTOMS	POSSIBLE CAUSES	CORRECTIVE PROCEDURES
Seal spits and sputters "face popping" in operation	1. Seal fluid vaporizing at seal interface	1. Increase cooling of seal faces 2. Check with seal manufacturer for proper seal balance ratio 3. Check design and operation of seal flush system 4. Increase flush flow rate 5. Check for seal interface cooling with seal manufacturer
Seal drips steadily	1. Faces not flat 2. Blistered carbon graphite seal face 3. Thermal distortion of seal faces	1. Check for incorrect installation dimensions 2. Check for improper materials or seals used for application 3. Check for gland plate distortion due to over-torquing of gland bolts 4. Check gland gasket for proper compression 5. Clean out foreign particles between seal faces Re-lap faces if necessary 6. Check for cracks and chips at seal faces during installation. Replace primary and mating rings. 7. Improve cooling flush lines
	1. Secondary seals nicked or scratched during installation 2. Over-aged o-rings 3. Compression set of secondary seals (hard and brittle) 4. Chemical attack (soft and sticky)	1. Replace secondary seals 2. Check with seal manufacturer for proper seals 3. Check for proper lead in chamfers, burrs, etc. 4. Check seal manufacturer for other material
	1. Spring failure 2. Erosion damage of hardware 3. Corrosion of drive	1. Replace parts 2. Check seal manufacturer for other material
Seal squeals during operation	1. Inadequate amount of liquid to lubricate seal faces	1. Check design and operation of seal flush system 2. Increase flush flow rate
Carbon dust accumulating on outside of gland plate.	1. Inadequate amount of liquid to lubricate seal faces 2. Liquid film evaporating between seal faces	1. Check design and operation of seal flush system 2. Increase flush flow rate 3. Check with seal manufacturer for proper seal design if pressure in seal chamber is excessively high
Seal leaks	1. Nothing appears to be wrong	1. Refer to list under "seal drips steadily" 2. Check for squareness of seal chamber to shaft 3. Align shaft, impeller, bearing, etc., to prevent shaft vibration and/or distortion of gland plate and/or mating ring
Short seal life	1. Abrasive fluid	1. Prevent abrasives from accumulating at seal faces 2. Check design and operation of seal flush system 3. Use abrasive separator or filter
	2. Seal running too hot	1. Increase cooling of seal faces 2. Increase flush flow rate 3. Check for obstructed flow in cooling lines
	3. Equipment mechanically out of alignment	1. Align this equipment 2. Check for rubbing of seal on shaft

1 Full Contact Pattern

OBSERVATION

Typical and desired contact pattern for a mechanical seal. Full contact on both mating ring and primary ring surface through 360°. Little or no measurable wear on either seal ring.

SYMPTOM

Seal drips steadily whether shaft is rotating or stationary. Fails allowable emission limits.

POSSIBLE CAUSES

1. Secondary seals nicked or scratched on installation.
2. Damaged or porous secondary seal surfaces.
3. Compression set of o-rings.
4. Chemical attack of secondary seals.
5. Not a low emission seal or arrangement.
6. Materials not conducive to low emissions.

CORRECTIVE PROCEDURES

1. Replace secondary seals.
2. Check secondary sealing surfaces.
3. Check with seal manufacturer for proper materials.
4. Check for proper lead in chamfers, burrs, etc.
5. Change seal to low emission design, materials or arrangement.

2 Coning (Negative Rotation)

OBSERVATION

Heavy contact on the mating ring pattern at the outside diameter of the seal. Fades away to no visible contact at the inside diameter of contact pattern. Possible edge chipping on the outside diameter of primary ring.

SYMPTOM

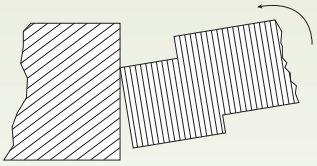
Little or no leakage at high pressure. Leaks steadily at low pressures.

POSSIBLE CAUSES

1. Faces not flat due to pressure.
2. Faces not flat.
   Incorrect lapping.

CORRECTIVE PROCEDURES

1. Check for over-pressurization of seal.
2. Check flatness of lapped parts.



Deflection of primary ring due to pressure

3 Thermal Distortion (Positive Rotation)

OBSERVATION

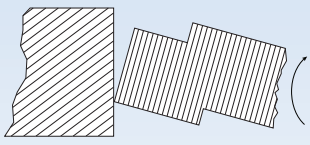
Heavy contact on the mating ring pattern at the inside diameter of the seal. Fades away to no visible contact at the outside diameter of contact pattern. Possible edge chipping on the inside diameter of the primary ring.

SYMPTOM

Seal leaks steadily when shaft is rotating. Usually no leakage when shaft is stationary.

POSSIBLE CAUSES

1. Thermal distortion of seal faces.
2. Faces not flat.
   Incorrect lapping.



Deflection of mating or primary ring due to temperature

CORRECTIVE PROCEDURES

1. Improve cooling to seal.
2. Consult seal manufacturer for proper materials.
3. Check flatness of lapped parts

4 Mechanical Distortion

OBSERVATION

Two large contact spots on mating ring pattern fades away between contact areas. 360° contact on primary ring.

SYMPTOM

Seal leaks steadily when shaft is rotating or stationary.

POSSIBLE CAUSES

1. Mechanical distortion.
2. Faces not flat.

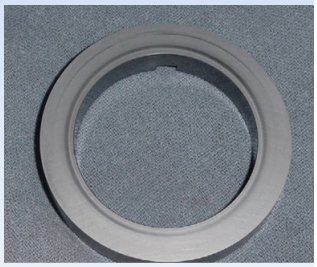
CORRECTIVE PROCEDURES

1. Check for gland plate distortion due to over-torquing of bolts.
2. Check squareness of parts used to hold mating ring in place.
3. Check seal chamber face flatness of split case pumps.
4. Check the gland plate surface in contact with the mating ring. Must be free of nicks and burrs. Surface must show full pattern when blued with mating ring.

5 Mechanical Distortion

OBSERVATION

Uneven circumferential contact spots on mating ring, pattern fades away between contact areas. 360° contact on primary ring.



SYMPTOM

Seal leaks steadily when shaft is rotating or stationary.

POSSIBLE CAUSES

1. Mechanical distortion.
2. Faces not flat.

CORRECTIVE PROCEDURES

1. Check for gland plate distortion due to over-torquing of bolts.
2. Check squareness of parts used to hold mating ring in place.
3. Check seal chamber face flatness of split case pumps.
4. Check the gland plate surface in contact with the mating ring. Must be free of nicks and burrs. Surface must show full pattern when blued with mating ring.

6 Mechanical Distortion

OBSERVATION

Mating ring shows intermittent contacting and non-contacting areas. High spots are at each bolt location. 360° contact on primary ring.

SYMPTOM

Seal leaks steadily when shaft is rotating or stationary.

POSSIBLE CAUSES

1. Mechanical distortion.
2. Faces not flat.

CORRECTIVE PROCEDURES

1. Check for gland distortion due to over-torquing of bolts.
2. Change to softer gasket materials between seal chamber and gland plate.
3. Provide full face gasket contact or contact above centerline of bolts to prevent bending of gland plate.

7 High Wear or Thermally Distressed Surface

OBSERVATION

High wear of mating ring or thermally distressed surface (heat checking) through 360°. High primary ring wear with carbon deposits on atmosphere side of seal. Possible edge chipping of primary ring.

SYMPTOM

Seal leaks steadily when shaft is rotating or stationary. Sound from flashing or face popping.

POSSIBLE CAUSES

1. Sealed liquid vaporizing at seal interface.
2. Overloaded seal faces.

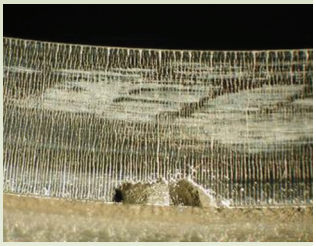
CORRECTIVE PROCEDURES

1. Check seal chamber pressure for adequate vapor pressure margin.
2. Check seal setting for proper working height.
3. Check for proper running clearances between shaft and primary ring at operating temperature.
4. Review flush system design; increase flush flow rate.
5. Review details of seal selection.

8 Section of Thermally Distressed Surface

OBSERVATION

Thermally distressed area approximately 1/3 of the contact pattern. Distressed area 180° from inlet of seal flush. High primary ring wear with possible carbon deposits on atmosphere side of seal



SYMPTOM

Seal drips steadily when shaft is rotating or stationary. Possible sound from flashing or face popping

POSSIBLE CAUSES

1. Sealed liquid vaporizing 180° from seal flush.
2. Overloaded seal faces.
3. Inadequate flush distributed around seal faces.

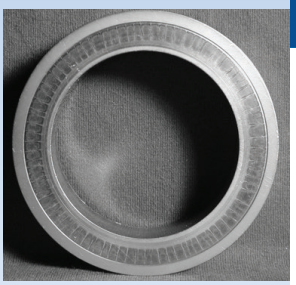
CORRECTIVE PROCEDURES

1. Check seal chamber pressure for adequate vapor pressure margin.
2. Check seal setting for proper working height.
3. Check for proper running clearances between shaft and primary ring at operating temperature.
4. Review flush system design; increase flush flow rate.
5. Review details of seal selection.
6. Use distributed flush design instead of single point flush.

9 Patches of Thermally Distressed Surface

OBSERVATION

One or more patches of thermally distressed surface (heat checking) on mating ring. High primary ring wear with possible carbon deposits on atmosphere side of seal. Most likely to occur on low specific gravity liquids at high speeds and pressures.



SYMPTOM

Seal drips steadily when shaft is rotating or stationary. Possible sound from flashing or face popping.

POSSIBLE CAUSES

1. Seal liquid vaporizing at seal interface.
2. Overloaded seal faces.
3. Inadequate flush distributed around seal faces.

CORRECTIVE PROCEDURES

1. Check seal chamber pressure for adequate vapor pressure margin.
2. Check seal setting for proper working height.
3. Check for proper running clearances between shaft and primary ring at operating temperature.
4. Review flush system design; increase flush flow rate.
5. Review details of seal selection.
6. Use distributed flush design instead of single point flush.
7. Check for mating ring distortion.

10 High Wear and Grooving

OBSERVATION

High wear of the mating ring. Primary ring has grooved the mating ring evenly through 360°.

SYMPTOM

Seal drips steadily when shaft is rotating or stationary.

POSSIBLE CAUSES

1. Poor lubrication from liquid being sealed. Common when both seal faces are made of hard materials.
2. Abrasives are embedded in softer primary ring material.

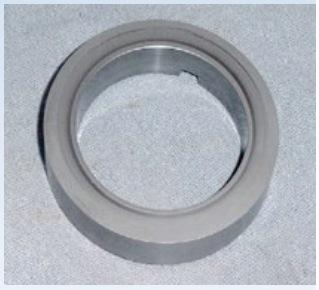
CORRECTIVE PROCEDURES

1. Increase cooling of seal faces.
2. Check procedures for lapping carbon primary ring. Do not use abrasives for lapping hard mating ring.
3. Check for abrasive particles in the pumpage.
4. Check for dead-ended seal chamber.

11 Out-of-Square Mating Ring

OBSERVATION

Contact pattern through 360° slightly larger than primary ring face width. High spot may be present on the mating ring opposite a drive pin hole. Mating ring without static seals will rock or move in gland plate.



SYMPTOM

Seal does not leak when shaft is stationary. Leaks steadily when rotating.

POSSIBLE CAUSES

Mating surface is not square to shaft.

CORRECTIVE PROCEDURES

1. Check the gland plate surface in contact with the mating ring. Must be free of nicks and burrs. Surface must show full pattern when blued with mating ring.
2. Check for proper drive pin extension from gland plate.
3. Check shaft for proper alignment to be sure that it is not passing through stuffing box at an angle.
4. Check for piping strain on pump casing.

12 Wide Contact Pattern

OBSERVATION

Contact pattern considerably wider on the mating ring than the face width of the primary ring.

SYMPTOM

Seal does not leak when shaft is stationary. Leaks steadily when rotating.

POSSIBLE CAUSES

1. Equipment bearing failure.
2. High shaft deflection whirl.

CORRECTIVE PROCEDURES

1. Check and/or replace bearing.
2. Check and determine if equipment is being operated within specifications.
3. Check and determine if shaft is bent.
4. Check and determine if coupling has been properly aligned.
5. Check for piping strain on pump casing.

13 Eccentric Contact Pattern

OBSERVATION

Eccentric contact pattern on mating ring. Width of contact equal to primary ring through 360°. No leakage if shaft has not contacted inside diameter of mating ring.

SYMPTOM

Seal does not leak when shaft is stationary. Leaks steadily when rotating.

POSSIBLE CAUSES

1. Misalignment of mating ring.

CORRECTIVE PROCEDURES

1. Check for proper clearances between gland plate and seal chamber.
2. Check for proper mating ring design and clearances.
3. Check for proper concentricity between outside diameter of shaft and inside diameter of seal chamber.

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