FLUID SEALING ASSOCIATION FSA

From the voice of the fluid sealing industry

SEALING SENSE

Q. *What are the principal symptoms, causes and corrective actions for failure of mechanical seals induced by mechanical breakdown?*

A. *Fretting* is one of the most common types of mechanical attack. Induced mechanically, it ultimately leads to corrosion. Fretting causes leakage past secondary seals and leaves the shaft or sleeve beneath the secondary seal corroded and damaged. This area will appear pitted or bright and shiny compared with the overall finish of the shaft or sleeve.

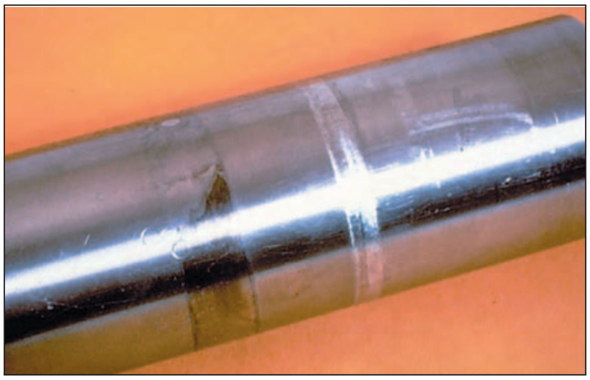

Figure 1. Results of fretting that led to a corroded and damaged shaft beneath secondary seal

Fretting results from reciprocating movement of secondary seals over a shaft sleeve, with consequent removal of the passive coatings intended to protect the sleeve from corrosion. Constant vibration of the shaft packing over this surface also removes the passive coating and allows further corrosion to occur.

Corrective actions include: (1) ensuring that shaft run-out, deflection and axial end-play are held to maximum of 0.003" (0.076 mm) total indicated run-out; (2) using hard-facing alloys, chrome oxide or aluminum oxide protective coatings under the area where secondary seals slide; (3) upgrading shaft or sleeve base material to one that doesn't depend on passive coatings for corrosion resistance (example: titanium); (4) changing PTFE V-rings, wedge rings and taper rings to elastomer O-ring secondary seals; (5) switching to non-pusher seals, such as rubber-PTFE or metal-bellows seals with truly static secondary seals.

Symptoms of *face distortion* include excessive leakage at the seal. Visual examination of the seal faces shows a nonuniform wear pattern, which is sometimes difficult to detect. By lightly polishing the seal faces on a lapping plate, high spots will appear at two or more points. This indicates uneven wear. Several things lead to seal face distortion:

1. Improper assembly of seal parts, causing nonuniform loads at two or more points around the seal face—this often occurs with rigidly mounted or clamp-style seal faces, when uneven torquing of gland nuts transmits uneven deflections directly to the seal faces.
2. Improper cooling, inducing thermal stresses and distortions at seal faces.
3. Improper processing of seal parts, producing a saddle surface or high spots at several points around the seal faces.
4. Improper gland supports, from debris or deposits left in the gland, and/or physical damage, upsetting metal in the gland and transmitting an uneven load to the stationary seal face.
5. Poor surface finish at the face of the stuffing box, due to corrosion or mechanical damage.

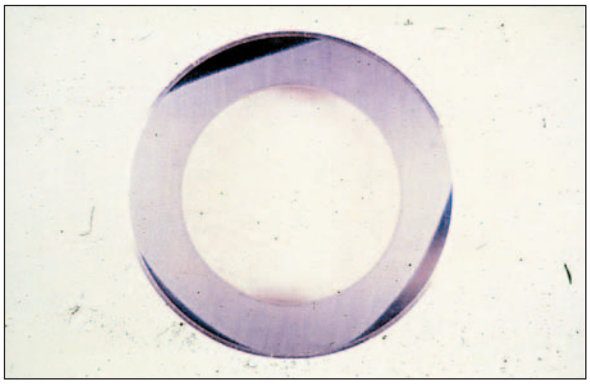

Figure 2. Evidence of uneven wear on mechanical seal due to face distortion

Corrective actions include: (1) relapping seal faces to remove cause of distortion; (2) using flexibly mounted stationary-seal faces to compensate for gland distortion; (3) readjusting glands by positioning gland nuts finger-tight, then torquing them evenly to the specified value.

Seal face deflection is typified by uneven wear at the seal face. The concave or convex wear pattern is continuous for 360° around the seal faces. A concaved seal face may result in excessive seal-face torque and heat, while one that is convexed results in abnormally high leak rates. Seals with either condition generally will not be stable under cyclic pressure conditions.

Seal face deflection may arise from improper stationary-seal-face support swelling of secondary seals, excessive deflection when seals operate above their pressure limits or inadequate balancing of hydraulic and mechanical loads on primary seal faces.

Corrective actions include: (1) maintaining operating limits for the seal design; (2) flexibly mounting the stationary seal; (3) replacing carbon seal face materials with those of higher modulus of elasticity such as bronze, silicon carbide or tungsten carbide.

Extruded O-rings or other secondary seals show deformation when squeezed past the close clearances around the primary seal faces. They often will appear cut or, in some cases, peeled. Excessive pressures or excessive stresses on the O-ring for the clearance can cause it to soften and then extrude. Excessive temperatures or chemical attack also can contribute.

Corrective actions include: (1) maintaining proper O-ring clearances for the application; (2) adhering to the secondary seals' chemical compatibility and temperature limits; (3) installing anti-extrusion rings if necessary.

Erosion typically washes out a seal face in one localized area, sometimes to the point that excessive distortion or breakage occurs. It most often occurs with carbon graphite, but also can occur in other materials under more severe conditions.

Excessive flush rates, or normal seal-flush rates with a flush fluid contaminated with abrasive particles can cause erosion. Both conditions result in a sandblast effect.

Corrective actions include: (1) reducing the seal-flush rate; (2) eliminating presence of abrasives in the seal-flush liquid with filters or cyclone separators; (3) switching to more erosion-resistant materials, such as bronze, tungsten carbide or silicon carbide, in place of carbon; (3) relocating the seal flush, or shroud, to protect the seal face from the direct flow of the flush.

Next Month: *A discussion of the symptoms, examination of the causes, and review of the corrective actions for failures of mechanical seals by thermal action.*

Sealing Sense is produced by the *Fluid Sealing Association (FSA)* as part of our commitment to industry-consensus technical education for pump users, contractors, distributors and manufacturers. As a source of technical information on sealing systems and devices, and in cooperation with the *European Sealing Association (ESA)*, the *FSA* also supports development of harmonized standards in all areas of fluid sealing technology. The education is provided in the public interest to enable a balanced assessment of the most effective solutions to pump technology issues on rational Total Life Cycle Cost principles.

The *Mechanical Seal Division* of the *FSA* is one of six with a specific product technology focus. As part of their mission, they develop fundamental technology publications such as the *Mechanical Seal Handbook*, a primer intended to complement the more detailed manufacturer's documents produced by the member companies. Joint FSA/ESA publications include the *Seal Forum*, a series of case studies in pump performance, are another example.

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