SEALING SENSE

Q. ***What are the symptoms, causes and corrective actions for failure of mechanical seals by chemical attack?***

A. Seal failure from chemical attack is typified by dull, honeycombed, flaky, crumbly or broken parts (see Figure 1). The weight and hardness measurements of the damaged parts will be substantially reduced as compared with the original values. Such failures result from using the wrong materials of construction for the chemical environment. If double seals have been used, it's a signal to check the reliability of the pressurizing system or the purity of the buffer fluid.

Figure 1. Signs of chemical attack on mechanical seal

Corrective Actions include: (1) a complete chemical analysis of the product being sealed, and upgrading the seal's materials of construction for the environment; (2) use of double seals to neutralize the corrosive environment or, when a single seal with a bushing or a lip seal is used in the bottom of the seal cavity, flushing the seal with a clean, compatible fluid.

Chemical attack can be suspected if the O-rings are swollen or have taken a permanent set that prevents axial movement of the sliding seal face. Chemical attack can leave O-rings hardened, bubbled, blistered on the surface, or with an eroded or broken appearance (see Figure 2). Typical causes include incorrect material selection or loss or contamination of the seal buffer fluid.

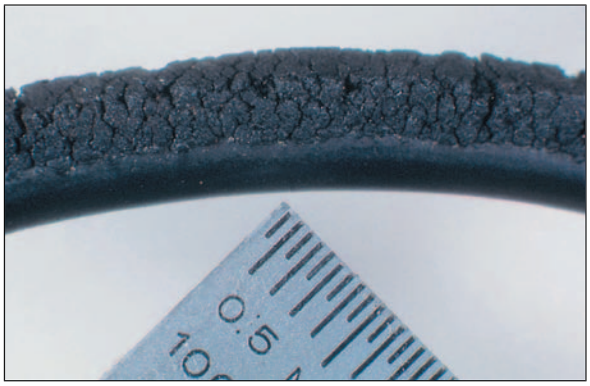

Figure 2. O-rings exhibiting symptoms of chemical attack *(courtesy of DuPont Dow Elastomers)*

A complete chemical analysis of the liquid being sealed and reevaluation of O-ring selection should be the first steps in investigating this type of failure. Frequently, the presence of trace compounds or elements, originally overlooked when specifying the seals, will be at fault. If a suitable material can't be found, an artificial environment must be created by flushing the seal from an external source.

Figure 3. Binder leaching in tungsten carbide insert.

Leaching normally causes a minor increase in seal leakage and a sharp increase in wear of the carbon faces. Ceramic and tungsten carbide faces that have been leached will appear dull and matted—even though no coating is present on them. Hardness readings on these seal faces will show a decrease of 5 points or more, on the Rockwell A scale.

Leaching results from chemical attack on the binder in powdered-metal and ceramic materials. This can occur from a few ten-thousandths to several thousandths of an inch deep, and leave the seal parts beyond repair. For example, caustic solutions such as those found in water treatment processes, as well as hydrofluoric acid solutions, will leach 5% or more of the free-silicon binders in ceramic seal rings (see Figure 3). This will cause excessive wear on the carbon-graphite seal face and further abrasive damage between the seal faces, resulting in very short seal life. Two methods protect against leaching:

1. Upgrading the seal face material to a higher-purity aluminum oxide, e.g., 99.5%, for applications in caustic or hydrofluoric acid solutions. For cobalt-bound tungsten carbide materials that leach in the presence of water and other mild chemicals, change the binder from cobalt to nickel.
2. Using a seal arrangement that provides buffer fluid at the seal faces, e.g., a single seal with a flush stream from an external source, or a double seal with suitable buffer-fluid system.

Coking leaves a varnish, lacquer or abrasive sludge on the atmospheric side of the seal. This can cause rapid wear of the seal faces and/or hang-up of both pusher and non-pusher seals.

Coking is caused by the oxidation or chemical decomposition of hydrocarbons and resultant formation of heavy residues. These corrective actions can prevent recurrence:

1. Applying a steam purge to the atmospheric side of pusher and non-pusher mechanical seals to carry away sludge or abrasive debris.
2. Flushing the seal from a clean, cool external source to eliminate coking in the seal cavity.
3. Cooling the seal cavity by using a stuffing-box water jacket, or a water-cooled or air-cooled heat exchanger.
4. Switching from carbon-graphite to ceramic, hard seal face materials that withstand the abrasive action of particles formed by oxidation and purge the seal on the atmospheric side with steam to remove sludge and debris.

In general, hydrocarbons should be cooled to below 250° F (121° C) in the seal cavity to prevent oxidation and coking. This temperature limit depends greatly on the fluid being handled. For example, oxidation limits for heat-transfer fluids are above 350° F (177° C).

Next Month: *Symptoms, examination of causes and review of corrective actions for failures of mechanical seals by mechanical action will be featured.*

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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