FLUID SEALING ASSOCIATION FSA

From the voice of the fluid sealing industry

SEALING SENSE

How long will a mechanical seal last? The conclusion of a two-part series on five factors that must be considered.

Five performance factors affect the life of a mechanical seal and guide the determination of an optimum replacement cycle for that seal. They also lead to improved seal life and mean time between repair (MTBR), thereby reducing the Life Cycle Cost (LCC) of the pump population.

Last month we reviewed the first two of these factors. Here are the other three.

Seal Application Limits

The third factor is *published mechanical seal application limits, typically defined by pressure, speed and temperature, are prone to misinterpretation*.

Most seal manufacturers say that operation of the seal at one of these limits will result in a minimum life span of two years; three years with some seal types such as those specified in Standard API 682. The published limits, while reliable for steady state operation, may be overstated or unreliable for cyclic operation. An exception may be API 682 seals, which specifically address that shortcoming by including a series of cyclic tests to qualify a specific seal type for a range of services.

Generally, no fixed rules exist on how much particular transient-pressure, speed, temperature, gas or solid entrapment, or vibration a seal can tolerate. Expert advice is needed in this area.

Seal Face Deflection

The amount a seal face deflects during a transient depends on several factors, including the magnitude and rate of the transient, and the robustness or strength of the seal face. The bottom line is that seal face deflections occur as operating conditions change and may either improve or starve lubrication of the seal faces. A reliable seal is one having a low degree of sensitivity to the expected or unexpected transients. The sensitivity of a seal can be defined by its ability to maintain more or less parallel seal faces during all possible transients.

Sensitivity can also be controlled by properly selecting the materials and the environmental control system. For example, seals with hard/hard face combinations, such as tungsten carbide (WC) and silicon carbide (SiC), which are preferred for dirty fluids or in some cases for high pressures, are very vulnerable to complete or partial loss of the fluid film. Any type of damage to these materials, when run against each other, is typically unrecoverable and only gets worse as time progresses.

New face materials and treatment technologies, such as diamond coatings, promise significant improvement in this area. On the other hand, hard/soft combinations with carbon-graphite as the wearing material offer the distinctive advantage that they can carry much higher loads, sustain longer periods of inadequate lubrication and, most importantly, more readily recover after damage to the carbon-graphite face.

Silicon carbide against a hard carbon-graphite is generally accepted to have one of the highest load capability limits of the readily available materials, best tolerates dry running and, therefore, should be the preferred material combination for many applications.

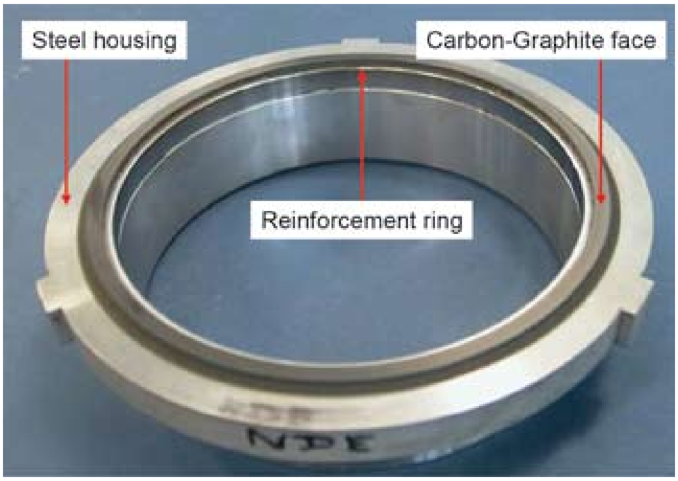

Figure 1. Robust seal face for demanding applications.

Limiting Application Parameters

Without question, an application becomes more difficult and risky when using a larger shaft diameter, faster speed, and higher temperature, pressure and solids content. It is imperative that the robustness of the faces and their ability to dissipate heat efficiently are optimized accordingly.

In many tough applications, it may be wise to consider custom engineered mechanical seals that are designed specifically to deal with unusual events or predefined operating modes of the equipment. Different face designs and lubrication technologies can be selected to increase the life of the faces.

Seal life well in excess of three years is possible for the large majority of applications. The seal face shown in Figure 1 is an example of a robust design that is used in high pressure or speed applications with the ability to handle severe transients and periods of inadequate lubrication. The carbon-graphite face is shrunk-fit into a metal housing and reinforced at the inside diameter with a hardened steel ring. The API 682 and Hydraulic Institute publication *Mechanical Seals for Pumps: Application Guidelines* offers good rules for specifying an engineered seal.

Leakage requirements

The fourth factor is *all face seals must leak a minute amount to sustain an adequate lubricating film during all operating modes*.

Because seals operate in these favorable lubrication regimes, energy consumption is minimized, which makes seal operation more economical. The amount of leakage is typically a few milliliters per day or less and not visible. This may be significantly higher for special applications involving high pressures, speeds or large shaft diameters. Consult your seal vendor for the calculation of expected leak rates.

Mechanical seals meet today's emission limitations in the vast majority of applications. Predicting the leakage and friction behavior for any given application is possible with a good degree of accuracy, which helps set operator guidelines for normal, questionable, and failure behaviors of the seal.

The leak rate increases or decreases when conditions such as pressure, temperature, or speed are changed. This means the leak rate varies depending on how the pump is operated and how responsive the seal faces are to any transient operating conditions. The key to a low and consistent leakage pattern is to maintain face flatness. The Key Performance Indicators (KPIs) of the seal may differ depending on the face technology and materials used.

Any given application usually has several solutions that vary widely in cost and benefits. Seal vendors often promote unique features to enhance or optimize the lubrication of the faces. Some OEMs promote hard/hard combinations for high pressure applications, whereas others uphold the hard/soft approach. Each differs in their ability to cope with unusual events, and the best choice is not always evident.

Seal Environment

Finally, *the seal is only as reliable as the environment in which it operates.*

The operating environment can be manipulated or controlled by selecting and applying a suitable system from a wide choice of methods – and that is almost as important as the seal itself. Most seals need a flushing system to evacuate the heat developed by the seal. If this system malfunctions it may cause problems. "A cool seal is a happy seal" remains true for the majority of applications.

Some fluids may change state as pressure or temperature changes. In the seal chamber the faces are exposed to the suction or discharge conditions of the pump, while at the seal face gap the fluid pressure reduces and its temperature increases. At the exit of the seal faces, the pressure and temperature are close to ambient. The point here is that as pressure and temperature change, the fluid properties may be significantly altered and possibly cause trouble for the seal if not addressed when selecting the seal and control system.

Environmental control systems can be applied to prevent or minimize the negative affect of certain transients, remove the frictional heat of the faces, reduce the presence of solids in the flush flow, improve conditions to prevent vaporization or freezing of the fluid. Most importantly, they minimize the consequences of a failure to the surrounding environment.

A wide choice of flush plans is included in ANSI, API and ISO standards. The variety of seal types and materials, combined with a wide array of flush plans, can make seal selection quite challenging. Helpful hints and tools, such as the FSA Seal Life Cycle Cost Estimator, can be found on www.fluidsealing.com. This tool can compare a wide variety of seal types and systems to aid with effective seal system selection.

Selecting the "Most Effective Sealing Technology" requires a sound understanding of what drives seal performance behavior . . . not only under normal operating conditions, but more importantly, under abnormal conditions.

Next Month: *When should I use braided PTFE packing and in what form?*

We invite your questions on sealing issues and will provide best efforts answers based on FSA publications. Please direct your questions to: sealingquestions@fluidsealing.com.

P&S


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A revolutionary sealless gear pump.
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But Also For benign applications that cause 'housekeeping' headaches.
No Cantilever
Not Just Designed with proven gear pump technology...
But Also For breakthroughs in reliability.
Not Just A revolutionary sealless gear pump...
But Also Interchangeable with mechanically sealed and packed gear pumps.
Not Just A high performance magnetically coupled pump...
But Also Affordable.
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