SEALING SENSE

How long will a mechanical seal last? Part one of this two-part series analyzes the first two performance factors that must be considered.

"How long will I be able to run my equipment before it has to be taken down for servicing?" is a question often asked when a buyer or user decides to purchase a new pump, agitator, or other type of rotating equipment. In some cases, a user may consider upgrading his existing pump to improve its reliability, capacity, efficiency or to bring it into compliance with federal or local emission regulations. The question will usually be the same.

In many industrial pump applications, the seal is targeted as the most critical component. The seal usually will force removal of the pump from service because of an unacceptable leak rate or, in some cases, a level or pressure alarm. Although the seal is often blamed for the equipment failure, the real reasons are typically found in the operation and mechanical condition of the pump or the seals' environmental control system.

Companies that have successfully implemented programs to improve Mean Time Between Repair (MTBR) are achieving three years or more average seal life, and consequently, have reduced the Life Cycle Cost (LCC) of their pump population. LCC projections for pump applications may vary widely based on the seal MTBR. In cases where the risk of failure is high, it is prudent to look for expert advice since errors in life estimates may have costly consequences.

The key to any seal MTBR projection is to understand the factors that are most likely to drive the performance of the seal. Key Performance Indicators of a mechanical seal are normally the leak rate and power consumption.

Looking Into the Crystal Ball?

Predicting the service life of a mechanical seal is not an easy task, since the performance of the seal on the macro level is affected by many phenomena on the micro level.

The reliability of a seal depends to a very large extent on its ability to maintain a thin fluid film in the gap between the mating faces while simultaneously minimizing the duration and extent of mechanical contact between asperities on the rubbing areas of these faces. Too much contact may overheat the materials; not enough contact may cause high leakage rates.

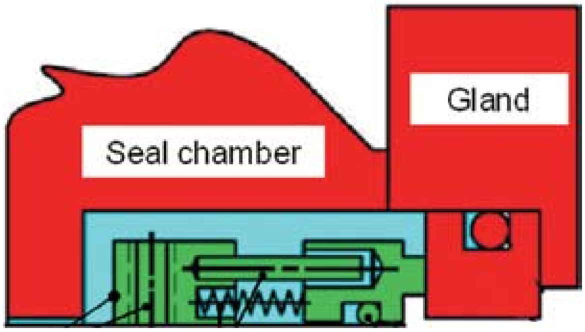

Figure 1. Cross-section of a typical mechanical seal assembly.

Key Components

Mechanical seal faces work much like bearings. The main difference is that the lubricant is usually the pumped fluid itself and may be dirty, volatile, viscous, toxic, or explosive while under pressure and sometimes at elevated temperatures.

It is evident that the seal faces are the most vulnerable parts of any mechanical seal, but other parts such as the secondary sealing elements (O-rings, bellows, polymer wedges) or metal parts such as springs, drive pins, or set screws also may affect the life of the seal when subjected to excessive movements or high temperatures and pressures. This article focuses on the factors that will affect the life of the seal faces.

In order to make a reasonable assessment of the expected life of a face seal, one needs to be aware of some basics about how a mechanical seal functions. Remembering five key performance factors can serve to guide determination of an optimum replacement cycle for a mechanical seal. This month we will focus on the first two of these considerations.

Seal Face Wear

First, it is imperative to know that seals seldom leak excessively because the faces have completely worn. Should this occur, the narrower of the two faces will have worn to the extent that contact would have been lost and a leak path created for the fluid to escape to the atmosphere. In fact, normal wear rates of seal faces are extremely low and thus *not* a typical reason for excessive leakage.

Seals that do wear out may be found in high pressure applications and fluids that cause abrasive wear of the face materials. In the majority of cases where seal removal is required, seal faces do show signs of distress. In these circumstances, the wear nose of the narrow face still has sufficient material, but the rubbing area of the faces is damaged to the extent that it caused an unacceptable leak rate. These distress symptoms can vary widely, from barely visible to the naked eye to severe damage such as the fracturing of a seal face.

Common distress symptoms are pitting, blistering, chipping, grooving, heat and thermal shock cracks. Wear-out seal removals are the exception, since in such cases the equipment will most likely have been taken out of service for some other reason not related to the seal or simply for preventative maintenance reasons. Excessive mechanical seal leakage is often the symptom, i.e. visible evidence of a deeper problem in the equipment, process or control system.

Types of Seal Failure

Seal failures may be categorized on the basis of MTBR as either infant, wear-out or random type. Statistically, *random failures* (also called chance or mid-life failures) are the predominate type. *Infant failures* are most often caused by incorrect seal selection, installation or startup and have been practically eliminated with the introduction of cartridge design mechanical seals.

Random failures tend to occur rather unexpectedly after a considerable run period and are typically characterized by a rapid change of the seal's leakage behavior from normal to excessive. Under operating conditions, this may manifest itself as a change from a non-visible leak rate to a drip or from a steady drip to a small stream of leakage in high pressure or speed applications.

Random failures are quite difficult to predict because they usually are the consequence of a process operation or equipment-induced transient, which could not be tolerated by the face materials. Transient operating conditions may be induced deliberately or be the result of a malfunction of a component in the pump or an unintended process deviation. Verification whether the seal can handle expected transients is a crucial step in the service life assessment because it is most likely the transient condition that may have a destructive effect on the seal faces.

Applications that are continuous, steady state in nature are relatively easy as compared with cyclic applications. In fact, it is safe to assume that if the lubrication film at the seal faces is stable at all times, the seal faces will last virtually forever, and thus the seal will not be the driver of the equipment's service life.

Application limits, minimum leakage requirements, and the seal environment also must be considered when estimating the life of a mechanical seal. Next month we will address these other three key factors that affect seal life and consequent need for replacement.

Next Month: *How long will my mechanical seal last? – Part Two*

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

Fluid Sealing Association

Sealing Sense is produced by the **Fluid Sealing Association** as part of our commitment to industry consensus technical education for pump users, contractors, distributors, OEMs, and reps. As a source of technical information on sealing systems and devices, and in cooperation with the **European Sealing Association**, 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 systems technology issues on rational Total Life Cycle Cost principles.

The **Mechanical Seal Division** of the FSA is one of five with a specific product technology focus. As part of their educational mission, they develop 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 such as the *Seal Forum*, a series of case studies in pump performance, are another example as is the *Life Cycle Cost Estimator*, a web-based software tool for determination of pump seal total Life Cycle Costs (LCC). More recently, the *Sealing Systems Matter* initiative has been launched. It is directed to support of the case for choosing mechanical seals that optimize life cycle cost, safety, and environmental compliance.

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