FLUID SEALING ASSOCIATION FSA

From the voice of the fluid sealing industry

SEALING SENSE

What are the considerations in applying mechanical seals to abrasive slurry applications?

Many process industries are confronted with pumping abrasive slurries of various types. This article will focus on one that deals with some of the most aggressive, high solids content slurries. Continuing growth in worldwide demand for industrial metals has increased the value of nickel, aluminum (bauxite), copper, and other key ores. As a result, the mineral and ore processing industry (M&OP) is investing in more efficient processes for extracting and processing these ores to maximize the output of their operations.

Because many of the operations associated with the M&OP industry are located in remote regions of the world where the ore deposits exist, issues like power consumption and flush water consumption are significant considerations in selecting the equipment used in these processes.

Pumps are a key component in M&OP processes, serving to move slurries which contain ore particles throughout the process. In order to reduce their power and flush water requirements, many mineral and ore processing operations are considering shifting from packing, their traditional sealing method, to the application of mechanical seals for their process pumps. Total life cycle cost calculators have received increasing acceptance in the M&OP market as tools to quantify the full economic benefit of this shift to mechanical seals.

In remote locations where water is scarce, flush water can cost as much as $0.016 (U.S.) per gallon. Because packing relies heavily on substantial flush rates to maintain adequate cooling, lubrication, and sealing performance, annual flush water costs for a single packed pump can be in the range of $50,000 (U.S.).

Additional costs are incurred to remove the effluent water from the slurry through evaporation and other processes. Many mechanical seals that are designed for slurry applications require no seal flush water, resulting in flush water savings of the total flush water and water removal costs. In addition to these cost savings, environmental issues, including water conservation, are growing in prominence and also becoming key drivers in the use of *flushless* mechanical seals.

However, the abrasive slurries that are handled by many M&OP operation pumps require special mechanical seal designs to ensure reliable performance in these harsh environments. Key design considerations include:

- Face materials
- Adaptive hardware metallurgy
- Seal geometry
- Dynamic O-ring and spring designs
- Drive collar design capable of working with hardened pump shafts

Face Materials

Most abrasive slurry applications require hard versus hard face material combinations to avoid premature wearing of the seal faces. The most common face material in these applications is direct sintered silicon carbide, because this material offers abrasion resistance and broad chemical resistance. Tungsten carbide is also applied in some mining applications, but care must be taken to ensure that the binder material (typically nickel or cobalt) will not be leached out of the seal rings by chemicals used in the processing of the ore.

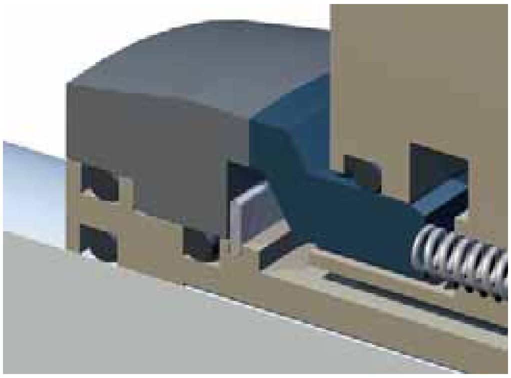

Figure 1. Line-on-line face geometry.

Adaptive Hardware Metallurgy

The wetted components of most slurry pumps are either manufactured from special steel or iron alloys with very high hardness or are lined with elastomers to protect them against abrasion from the slurry particles. The seal adaptive hardware must also be made from abrasion resistant metallurgy with high toughness values coupled with good corrosion resistance.

Specialty metals, such as duplex stainless steel and high chrome iron, are common materials for slurry seals. Lining of wetted surfaces with elastomer coatings may be an alternative to these special metallurgies.

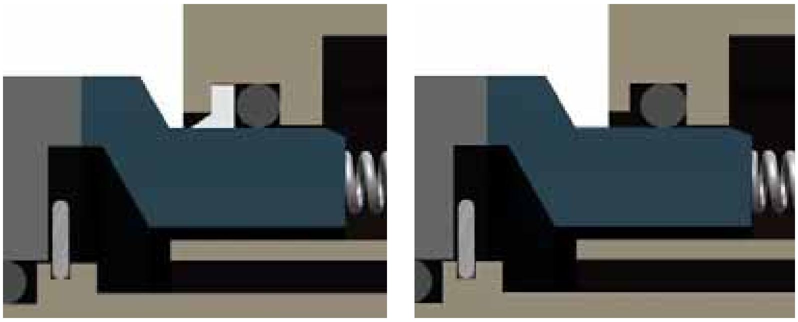

Figure 2. O-ring groove designs (right); wiper ring design (left).

Seal Geometry

The design of seals intended for abrasive slurry applications must include a profile that will create desirable flow patterns in the seal chamber, especially in the area of the seal faces. These profiles will avoid the creation of recirculation vortices that trap and circulate particles across critical surfaces of the seal components. A typical slurry seal profile will include line-in-line seal faces in which both the rotating and stationary seal faces share the same inner and outer seal face diameters.

Dynamic O-ring and Spring Design

If slurry particles are allowed to collect around the dynamic O-ring, the axial movement of the flexibly mounted seal face can be constrained, resulting in seal hang-up and possible failure. Slurry seal designs may include an "open" O-ring groove on the process fluid side to avoid creating cavities or crevices where particles can collect. Alternative designs may include wiper rings to isolate the O-ring groove from the process fluid.

Slurry particles can also collect around the springs, clogging the springs and adversely impacting their function. One option is to locate the springs outside of the process fluid to isolate them from the particles. Another design option is to orient the design so that the springs act on the rotating face and

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. *This month's Sealing Sense was prepared by FSA Member Rob Phillips.* 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 technology issues on rational Total Life Cycle Cost (LCC) 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. 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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rely on the centrifugal forces to direct the heavier particles radially outward, away from the springs.

Still another design option is to use a cone spring design that is not susceptible to clogging. In some designs, an elastomer coated cone spring can also eliminate the need for a dynamic O-ring.

Drive Collar Design

To avoid abrasive wear on the pump shaft, this component is often manufactured from very hard steel. As a result, typical seal drive collar designs that use set screws to "bite" into the shaft are not capable of providing adequate drive and alternative collar designs that rely on wedges to create high clamping forces against the shaft are required.

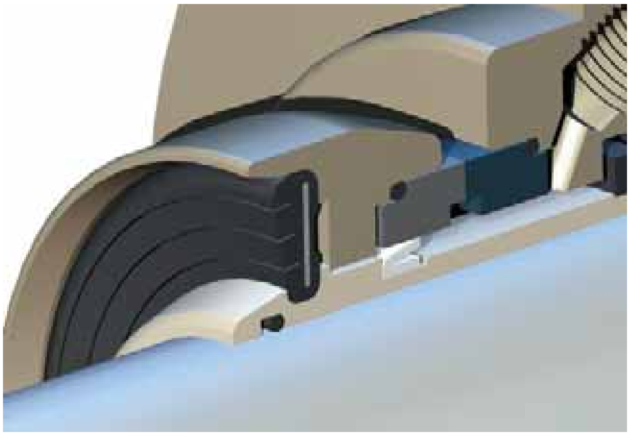

Figure 3. Mechanical seal design using a cone spring.

Summary

When seal designs are applied to abrasive slurry applications that properly address the five design considerations noted above, mechanical seals can provide very reliable sealing performance. Even in the harsh environments of many abrasive slurry mining applications, seal MTBF will typically exceed 40 months with proper seal design and application. Reliable sealing performance, coupled with reduced operating costs over packing, are a driving force in application of mechanical seals in many M&OP slurry pumps.

Next Month: *How can I reduce consumption of seal flush water going to my packing and mechanical seals?*

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.

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