FLUID SEALING ASSOCIATION FSA

From the voice of the fluid sealing industry

SEALING SENSE

Where mechanical seals meet pumps: What is the next generation?

Almost all centrifugal and rotary pumps require a sealing system to provide sealing integrity of the drive shafts carrying the impellers and protect against pumped fluid leakage and the environment outside of the wetted areas. These sealing systems range from traditional braided materials packed around the shaft to complex mechanical seal systems used in many modern pumps.

Throat Bushings

Pump Standard API-610 requires that the pump casing contain a seal chamber in which mechanical seals compliant with API-682 can be mounted. A common component in both of these specifications is the so-called *throat bushing*, which is defined as: "A device that forms a restrictively close clearance around the sleeve (or shaft) between the (inner) seal and the impeller."

The throat bushing can form a primary interface between the pump and the mechanical seal. According to the arrangement of the mechanical seal and the type of flush plan applied, such bushings are not always required. When they are used, the details of their design and use can be lost in the API-610 and API-682 standards. Here is a look at throat bushings in more detail.

Function

As its definition implies, the primary role of a throat bushing is to provide a restriction between the fluid being pumped by the impeller and the mechanical seal area, so that flow is reduced or controlled. Such a flow restriction can be required in either direction; for instance, the restriction would stop the flow into the seal chamber to avoid particulate contamination of the chamber. When the mechanical seal flush plan uses "processed fluid"—either cooled, filtered or physically different from the pumped media—the flow from the seal chamber into the pump may need to be controlled. Throat bushings must be designed to provide the optimum environment for both the mechanical seal and pump since the fluid flow amount through a concentric annular restriction is proportional to the cube of the clearance and their axial length.

Clearances Critical

For pumps working at high pressures, fluid pressure control in the seal chamber, which provides loads on the mechanical seal faces, is important and often requires a very small throat bushing clearance. It is often debated how small the clearance should be. All parties agree that controlling the clearance between the shaft and throat bushing leads to increases in efficiency and performance of both the pump and mechanical seal since the isolation provided can allow optimum operation of both systems.

Reducing the clearances between the throat bushing and the rotating element can often lead to an increased risk of contact between the two components, especially during times of start-up and any upset situations within the pump or mechanical seal. The interface materials should be able to tolerate such contact without problems, including:

- Galling or seizing of the two components, which can occur between metallic materials
- Particulate generation, which could possibly upset the micron level gaps found in the mechanical seal interfaces
- Heat generation, which can increase the temperature of the seal chamber

In essence, the throat bushing must behave as a wear part, so its material selection must be considered in the same way as it's considered for a wear component within the pump. In addition to the bearing requirement for a throat bushing, effects like fluid erosion and thermal expansion differences between the pump, shaft and throttle bushing must also be considered.

Nonmetallic Composites

With micron levels of clearance between mechanical seal faces, high levels of vibration in the pump system can often be problematic. The use of composite wear rings to reduce these vibrations and assist with "Lomakin Effect" support of the rotating components has proven an asset to mechanical seals when used with composite wear ring equipped pumps. Extending the use of composites into the mechanical seal area can also provide similar benefits to those found in pumps. In

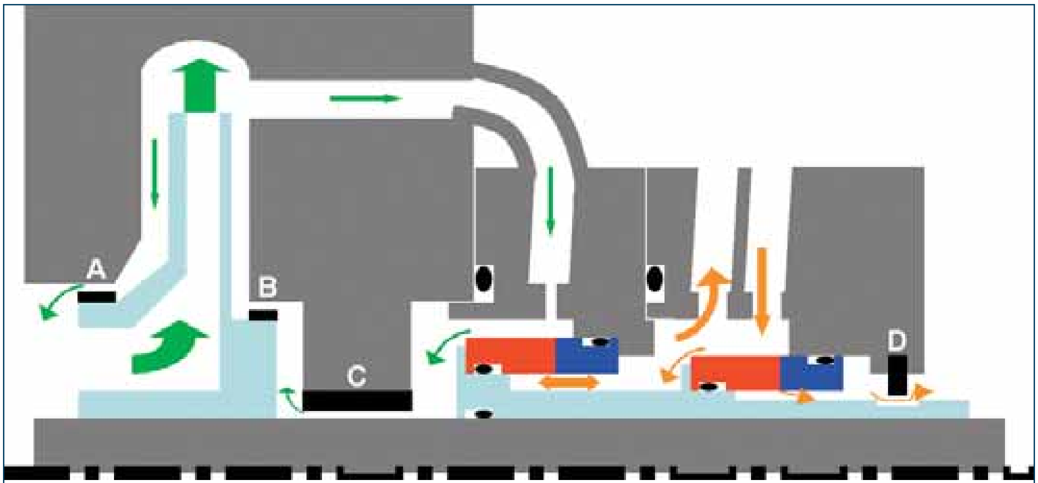

Figure 1. Typical pump and mechanical seal arrangement

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 Craig Watkinson.* 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. This handbook served as the basis for joint development of the more comprehensive **Hydraulic Institute** publication: *Mechanical Seals for Pumps: Application Guidelines*. 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. The *Sealing Systems Matter* initiative also was launched to support the case for choosing mechanical seals that optimize life cycle cost, safety and environmental compliance.

The following members of the **Mechanical Seal Division** sponsor this *Sealing Sense* series:

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the wetted area of the pumps, losses across the impeller eye can be reduced by closing the clearances between the wear gaps of the casing and impeller. The ninth edition of API-610 first recognized the use of nonmetallic wear rings, particularly carbon fiber reinforced Polyetheretherketone (PEEK) composites.

Such materials have reduced the wear ring gaps below those possible with more traditional metallic systems and have done so without compromising the risks of contact-induced problems.

The typical single stage pump and mechanical seal arrangement in Figure 1 shows the pump wear parts, impeller (A) and hub (B). The flow arrows indicate the direction of the media flow with pumped and flush (green) and barrier (orange) fluids in the system. The "joint" in the system is the throttle bushing (C) between the impeller and the mechanical seal chamber.

As maintenance, reliability and efficiency become ever more critical and the costs of pumps and mechanical seals continue to increase, materials such as polymer composites can significantly improve system design.

Other areas where such light weight, wear-resistant materials can provide tangible benefits within mechanical seals are:

- Internal circulating devices such as those required in Plan 23 flush plans, where inertial effects and closer clearances may provide benefits
- Mechanical seal sleeves where thermal and centrifugal expansion of the supporting component must be matched with ceramic faces such as Silicon Carbide
- Throttle bushings located on the outboard of the mechanical seal to reduce the low leakages from the mechanical seal even further (see D in Figure 1)
- Labyrinth flow restrictors within the mechanical seal controlling and directing flow within the seal itself

Conclusion

The next generation of materials where pumps meet mechanical seals may already be here in polymeric composites. The pump and mechanical seal industries just need to recognize, define and standardize these materials to realize their benefits.

Next Month: *What are bolt torque considerations for valve packing that ensure reliable performance?*

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

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