

Expanded Use Of Split Seal Technology For Large Pumps And Agitators

Split-sealing systems that combine high-performance split seals with an advanced split centrifugal force device can provide more reliable and cost-effective service than packing and solid seals.

BY SCOTT BOYSON

New advances in split mechanical seals have expanded its application for use in both water and wastewater systems. These systems move vast amounts of fluid through pipes and tanks. Water-based fluid systems comprise the largest fluid transport systems in the world with wastewater streams being the largest. While the systems' designs can vary by region, most use centrifugal pumps to move fluid. Many of the centrifugal pumps are very large and difficult to assemble, so they have not typically been sealed by mechanical seals which require total equipment disassembly. However, split mechanical seals have advanced so that these pumps can now be sealed without equipment disassembly.

Compression Packing

Compression packing is commonly used to seal the shaft of large equipment. Tightening the packing gland compresses the packing axially and the packing expands radially. A static seal is created between the stuffing box wall and packing. A dynamic seal is created between the rotating shaft and the packing inside diameter. The dynamic interface between the packing and shaft generates frictional heat and wear. Packing requires the pumped fluid to leak to minimize the impact of the frictional heat. This leakage provides the necessary long-term lubrication to the packing set and will carry heat away to minimize heat buildup.

Each packing ring should be cut to fit the equipment and seated correctly. A gland load is then applied to the packing to contain it within the stuffing box. Too much gland load will cause the packing to exert excessive pressure against the shaft, which creates high-frictional heat. This heat can cause the packing to fail quickly or to even seize the shaft. Too little gland load may cause the packing to

unseat or have solids wedge into the packing set, resulting in decreased life and excessive leakage. The packing needs to break in through controlled packing gland adjustments. During the break-in process, the mechanic needs to periodically tighten the packing to minimize leakage to an acceptable rate based on the application conditions.

A sacrificial shaft sleeve is used to prevent wear directly on large rotating shafts and needs to be replaced periodically as it wears. Often, packing sets are equipped with lantern rings that enable an external clean-fluid flush to be supplied to minimize the negative impact of process particulates. Over time, as the packing is adjusted, the lantern ring is moved forward and may be positioned such that the flush is no longer effective as the packing is now positioned under the lantern ring inlet in the stuffing box.

Packing is still the most popular sealing option on large pumps as these are difficult to disassemble. Significant advances have been made in packing materials and their construction. High-temperature, thermoset fibers have proven to be superior when compared with PTFE-based packing in wastewater streams. Graphite packings that have been reinforced with carbon in both the corners and internal braid have improved performance.

Unfortunately, all packing eventually wears the equipment, eventually requiring complete equipment disassembly.

Packing leakage typically runs along the shaft toward the bearings. The leakage often migrates across the bearing seal and enters the bearing housing. The oil or grease becomes contaminated, drastically reducing bearing life. Water contamination of bearing lubrication systems has a large negative impact on bearing fatigue life and is one of the major



Figure 1: Split seals are being used in wastewater systems ranging from raw water intake, remote lift stations, and many other applications.

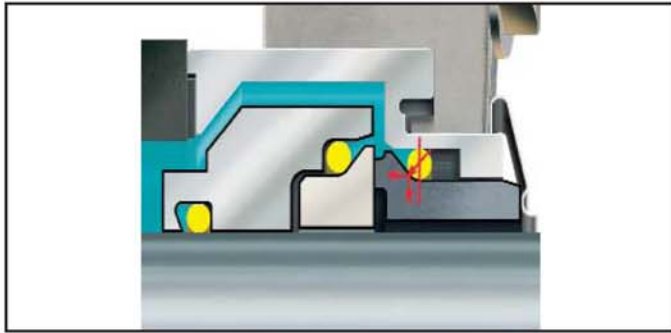


Figure 2: Newer split seal designs will seal both vacuum and positive pressure which alleviates the concerns with pressure variations during pump start-up and shutdown.

factors for premature bearing failure.

Mechanical Seals

Mechanical seals operate by having two flat surfaces in contact with each other. The surfaces are kept in contact by spring and hydraulic fluid pressure. Typically, the seal parts are solid and require the equipment to be dismantled. When the seal wears out, the equipment needs to be taken apart again to replace the seal.

On large equipment, this is often an area of concern as dismantling large equipment can require rigging and overhead cranes set in place. This large equipment often is critical and has a large impact on the plant as thousands of gallons per minute of fluid can flow through these pumps, and when taken offline, they can have a noticeable impact on plant performance. In some cases, emergency backup systems need to be used to operate the plant at lower capacity until the main system can be brought back online.

Split Mechanical Seals

Split seals are now available and no longer require equipment to be disassembled. Reliability and ease of installation have been the focus of improvements during the past few years. Advanced split seal technology provides many years of reliable sealing on a wide range of water and wastewater processes.

A split seal eliminates the need for dismantling the equipment required for solid seal replacement or packing-shaft sleeve replacement. Downtime reduces, and man-power requirements are much lower. Removing, replacing, and aligning large motors is no longer required with split seals.

Split seals can also eliminate packing leakage which eliminates the need for sump pump operation. Bearings and lubrication systems operate free of water spray from packing leakage and operate much more reliably.

Advanced split seal designs are easily replaced at the pump and do not require full backup. Component parts are easily replaced at the site. Advanced split seal designs have also eliminated glued components. Older designs required removal of glued split seal component parts at the pump and

reapplication of glue, which contributed to repair complexity.

Installation Made Easy

Split seals typically mount to the shaft using two stationary halves that clamp onto the shaft.

The rotary seal faces and o-rings are split. Gluing of o-rings is avoided with ball-and-socket designs. Once the rotary component is installed, the stationary seal components can then be installed.

The stationary seal ring is completely split and easily mounts onto the shaft. A ball-and-socket o-ring holds it in place. The split stationary gland halves slide over the stationary seal ring and clamp together.

Some split seals contact and seal the pumped fluid on the inside diameter of their seal rings. These designs would be problematic in waste streams with particulate as the particulate is centrifuged toward the seal rings causing abrasion, hang-up, and premature seal failure. In addition, the pump pressure working against the inside diameter of the seal rings will exert a force to split the seal rings apart which will result in leakage. These seals are more sensitive to pressure fluctuations. Newer designs have pressure applied at the outside diameter of the seal rings, minimizing the impact of particulate and eliminating pressure, which forces the seal rings apart. The pressure on the outside diameter actually forces the split parts together, creating a more reliable seal.

Pressure and speed limits have increased with advanced split seal technology. Seal faces generate frictional heat as the seal faces are pressed together by spring load and hydraulic force. The frictional heat developed is a function of both closing force on the faces and circumferential speed. Hydraulically balanced seals minimize the hydraulic force exerted axially on the seal rings, and the seals run cool. Large-diameter seals can operate at high shafts. In fact, split seals are being used in high-pressure and high-speed applications such as boiler feed pumps and large-diameter turbines. Newer split seal designs will seal both vacuum and positive pressure which alleviates the concerns with pressure variations during pump start-up and shutdown (figure 2). Transient vacuum pressure operation is typically problematic in older split seal designs as the pressure is reversed, resulting in higher atmospheric pressure than vacuum pressure, which forces the seal rings apart.

Seal engineers have focused their efforts on sealing performance at the split surfaces. Over the years, many design iterations have improved sealing performance to the point where leak-free operation can be expected. Large-diameter seals have a number of forces acting on them, ranging from hydraulic pressure to bolt loading. Split designs need greater consideration as the movement occurs between splits. Newer designs have had their elastic loading analyzed using finite element analysis to minimize seal face flexure



Figure 3: When combined with a split centrifugal force device and used as a sealing system, split seal reliability offers the most cost-effective sealing system for large pumps.

during loading. As a result, users are now obtaining repeatable and reliable performance in thousands of installations. Older designs could easily flex and distort causing less reliable operation at start-up and during pressure variations.

Conclusion

Even though tens of thousands of pumps are using split seals in wastewater treatment worldwide, many users are often surprised when they hear about the extent of the applicability of split seals in water and wastewater streams

(figure 1). Split seals are being used in wastewater systems ranging from raw water intake, remote lift stations, and many other applications.

Large pump manufacturers are commonly supplying split seal technology. Some have even standardized on split seals with split centrifugal devices due to the inherent end-user advantages associated with split sealing. High-performance split seals offer plants a cost-effective solution for sealing large equipment. When combined with a split centrifugal force device and used as a sealing system (figure 3), split seal reliability offers the most cost-effective sealing system for large pumps.

A complete list of applications for split seal applicability in typical wastewater flow streams can be found at www.chesterton.com/wastewater.



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