

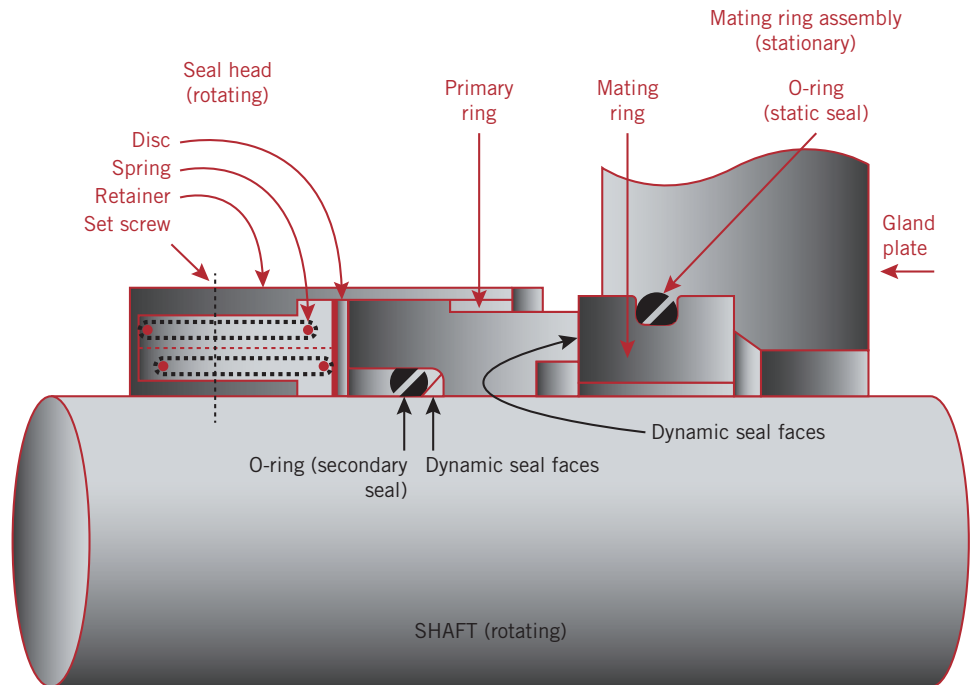
# THE ABC'S OF MECHANICAL SEAL LEAKS AND IMPACT ON THERMAL FLUID OPERATIONS

Common questions among industrial plant professionals are: “Under what conditions will a mechanical seal leak?” and “What is a normal degree of leakage when the equipment is operating?” This article will provide insights into this sometimes-confusing area of plant maintenance and operation with additional focus on applications involving high-temperature heat transfer fluids.

## WHAT IS A MECHANICAL SEAL?

A mechanical seal consists of two members: a stationary seat and a rotating head. The head is statically sealed to and rotates with a pump shaft. The seat is statically sealed to a non-moving cover. The head has a spring-loaded, highly polished, very flat face that is also frequently pressure-loaded against that same seat face. Primary sealing takes place where the rotating and stationary faces are in near contact.

The most common mechanical seal face material combination is carbon against a nickel-iron alloy (Ni-Resist). Very hard face materials such as tungsten carbide and silicon carbide are also available to better resist abrasive wear albeit at higher initial cost. Hard-on-hard face combinations, such as silicon carbide on tungsten carbide, are very susceptible to formation of surface cracks (heat checking) if allowed to run dry for even a few seconds. They should not be applied where the liquid side of the seal is exposed to lower pressure than its atmospheric side, usually less than 1 atmosphere (14.7 PSIA)



Typical single shaft seal

## THE NEED TO LEAK

### MECHANICAL SEALS MUST LEAK TO OPERATE PROPERLY; THEY ARE CONTROLLED LEAKAGE DEVICES, NOT ZERO LEAKAGE DEVICES.

A leakage rate of 10 drops per hour or less per seal is considered an acceptable leak rate for mechanical seal pumps manufactured in most facilities.<sup>1</sup>

However, many pumps operate well below these limits.

Seal faces cannot be permitted to run dry, as the frictional heat buildup of hard contact will very quickly cause them severe damage and lead to extensive leakage. Thus, seal faces are designed to allow a very thin film of liquid to exist between and migrate across them.

In a properly operating mechanical seal, this thin liquid film, out of necessity, leaks to the low-pressure side of the seal, usually outside the pump. In a single type mechanical seal pump, the liquid is normally the fluid already being handled by the pump.

1. [Manual No. SRM00046](#). General Installation, Operation, Maintenance and Troubleshooting Manual for Three Screw and Cig Series Pumps, CIRCOR, 2015

In more complex designs (double, tandem or other configurations), a barrier fluid is placed between seals, such that one of the seals is exposed only to the barrier fluid, while the inner seals are exposed to the liquid being pumped. There are also seal arrangements that use pressurized gas at the seal faces to prevent liquid leaking out and also to prevent seal face contact.

Many pumped liquids are sufficiently volatile that the fluid frictional heat gain from traversing the seal face causes the leakage to vaporize. In this situation, no leakage may be visible to the eye, but it is still occurring. Liquids not prone to vaporizing readily may show an accumulation of leaked liquid outside the pump.

## VARIANTS IN DESIGN OPTIONS

Some manufacturers design seals for high-face loads that minimize leakage but also shorten the seal life. Others use lightly loaded faces for long life but these seals are more prone to greater leakage. The chance of shaft misalignment being one of the main reasons for excessive seal leakage can be effectively reduced, however, by using a flange-mounted pump over a foot-mounted version, as long as the C-face bracket used between the pump and motor is accurately manufactured.

Seal systems with liquid or gas barriers can minimize detectable leakage, but at significant increase in expense. Beyond that solution, there are seal-less pumps such as canned or magnetically driven designs that can also be costly but completely leak free.

If the leakage is not an immediate health hazard, some systems, including lubricating oil packages, can use vertically mounted pumps located inside the oil reservoir. Properly designed, these pump arrangements need not have shaft seals; flow that would normally cool and lubricate the seal is simply allowed to exit the pump and run directly back to the reservoir.

## NEW EQUIPMENT OPERATIONS

Startups can be particularly hard on mechanical seals, which is why it is critical to ensure that the pump seal chamber is filled with appropriate liquid before starting. Otherwise, initial dry start damage will progress to a severe leak. Dirt and other small particles can degrade the surface finish of a mechanical seal face, leading to deterioration and premature leakage. Such undesirable conditions result in increased friction, which may be detected early in the form of a temperature increase of the fluid or components adjacent to the seal.

Note that seals will sometimes “run in” and leakage will gradually diminish over several hours of operation with new seals. Disturbing (separating) seal faces may cause them to leak slightly more than before being disturbed, since the faces will not be tracking in exactly the same manner. These, too, may wear back in and cease or nearly cease apparent leakage.

## THE ROLE OF CONDITION MONITORING

Understanding the above, it's easy to see that a mechanical seal acts as a predictor of pump health, helping maintenance and operations professionals gauge the fitness of the pump on which the seal has been installed. This can be especially important in the case of high-temperature thermal fluid applications using pumps with single mechanical seals, where the hazard of fire must be avoided at all costs to prevent loss of life and property.

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## THE MECHANICAL SEAL IS THE ONLY ROTATING COMPONENT OF A PUMP SYSTEM THAT STANDS BETWEEN HOT, POTENTIALLY COMBUSTIBLE FLUID AND THE AIR.

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Collecting seal leakage in a closed container keeps fluid from spilling into the workspace, reducing fire risk while also capturing a contaminant that can foul the work area. When the container is half filled, a signal from the condition monitoring master control unit alerts an operator that the container should be drained and notes the collection time, typically measured in a span of months.

In comparing times to collect this known volume of fluid, operators can determine if the seal leak rate is stable. A reduced interval between tank drainings would result from increased seal leakage. Should that occur and liquid rapidly fills the container, a high-level signal would alert the operators the situation needs urgent attention to determine the best course of action.

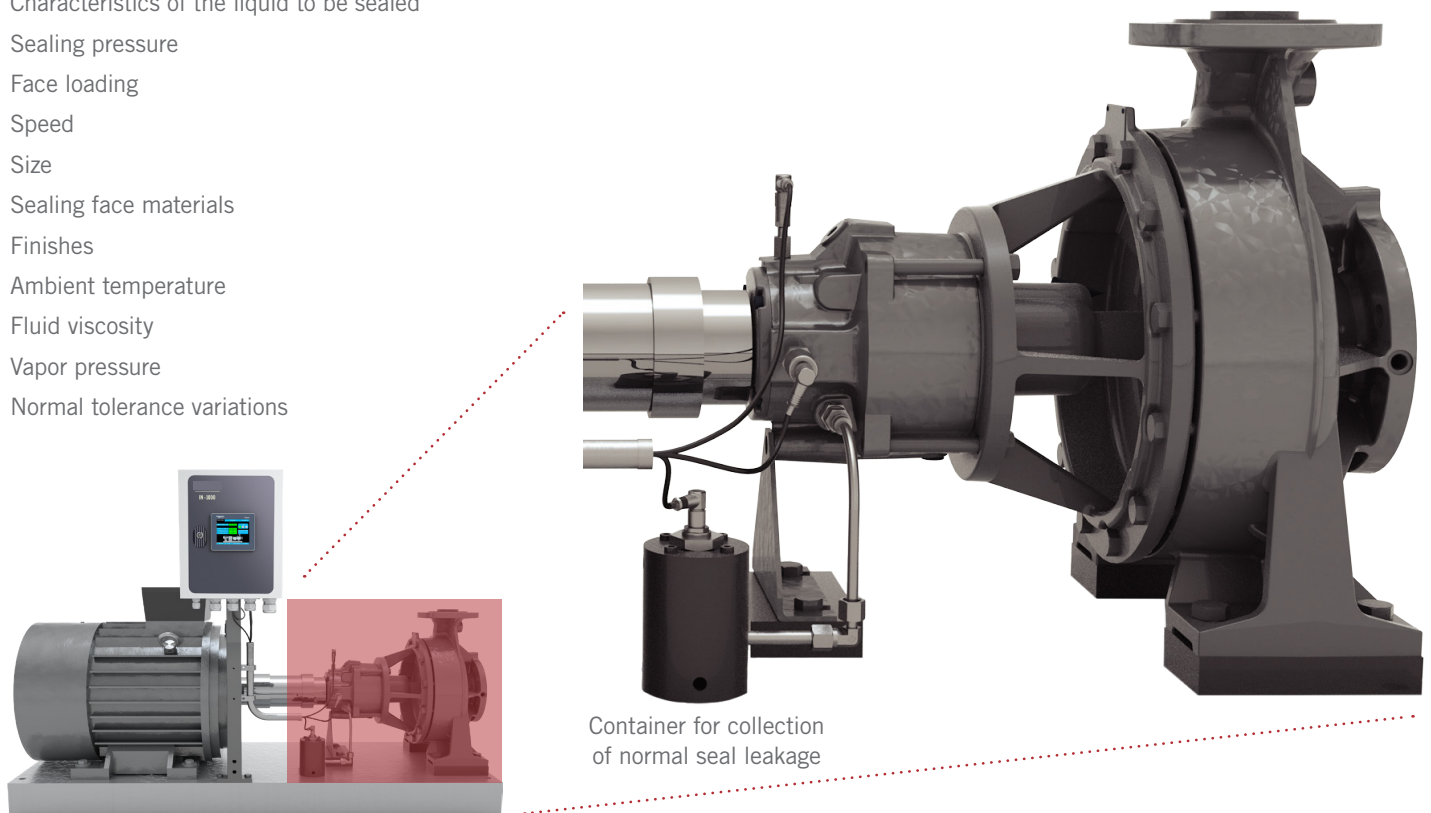
With condition monitoring, sensors can also detect small fixable problems so that they don't get worse. In addition to providing visibility into the state of industry key performance indicators against threshold values for vibration and bearing temperature, this equipment will alert plant professionals to anomalies with mechanical seal leak rates. This information enables the operations team to schedule small-scale repairs at a convenient time.

## CONCLUSION

Mechanical seals are designed to produce an acceptably low level of leakage to function effectively. Many individual internal and external factors, as well as interactions between them, will affect the rate of seal leakage. Pump and system parameters having an impact on how much mechanical seal leakage will be incurred could include:

- › Characteristics of the liquid to be sealed
- › Sealing pressure
- › Face loading
- › Speed
- › Size
- › Sealing face materials
- › Finishes
- › Ambient temperature
- › Fluid viscosity
- › Vapor pressure
- › Normal tolerance variations

Having visibility into a seal's regular (and irregular) leakage history is now possible. As plant management grows more complex, a decision to integrate automated central condition monitoring into thermal fluid operations especially can make it possible to strike dangerous seal leaks from the list of operating headaches and preventable problems.



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