MAKING THE MOST OF MECHANICAL SEALS

by **Ross Mackay**

Any practical discussion of mechanical seal operation starts with the acceptance that it takes more than just a good seal to secure the leakage in a centrifugal pump. The seal must be properly installed and protected in a strong pump that is properly designed to accommodate a mechanical seal.

In the interest of space availability for this article, we will not be going into a lot of detail on the actual installation of the seal. However, one important point must be noted when following the seal manufacturer's installation instructions for a component seal. The seal setting dimension that is measured from the face of the stuffing box to a point on the shaft determines the correct setting of the rotating portion of the seal on the shaft. It must be remembered that the dimension shown on the seal manufacturer's drawing assumes that the position of the shaft in relationship to the stuffing box face has been finalized. This means that the impeller clearances have been set and that all new gaskets on the stuffing box/back cover have been installed.

We will also assume that the bearing housing has been properly repaired and that all shaft tolerances and runouts are within the appropriate limits.

It is also necessary that the seal be mounted on a strong, rigid shaft that is capable of minimizing the detrimental effects of shaft deflection and vibration. This is particularly important on an end suction pump where the shaft is cantilevered from the bearing arrangement and has no support at the impeller.

The Seal Chamber

The introduction of the larger bore seal chamber has provided three major benefits to mechanical seal operation, all of which contribute to increased reliability.

1. The increased volume of pumpage in the chamber permits the liquid to dissipate the heat generated by the seal faces much more readily than the lesser volume in a stuffing box. Consequently the mechanical seal will run cooler.

2. As the outer wall of the chamber is moved to a greater distance from the seal, seal rub has been eliminated. (Seal rub is a condition where excessive radial shaft movement brings the seal into contact with the bore of the stuffing box, causing premature failure.)

3. As the seal itself acts as a centrifuge in the chamber, any solid particles in the chamber will be thrown further away from the seal faces, therefore the seal will run in a cleaner environment.

A number of different seal chamber designs are currently in use. The large cylindrical bore chamber shown in Figure 1, is the same design as the stuffing box, except that the bore diameter is larger, but only in the area occupied by the seal. As the traditional close clearance is maintained at the bottom of the chamber, this perpetuates the capability to control the temperature and pressure of the pumpage inside the seal chamber.

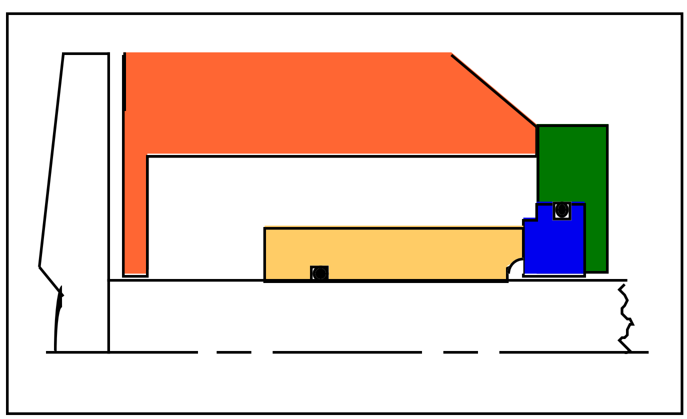

Figure 1

The through bore design shown in Figure 2, is also very popular and, while it permits self draining and self venting of the seal chamber, it severely limits the amount of control that can be exerted on the pumpage in that area.

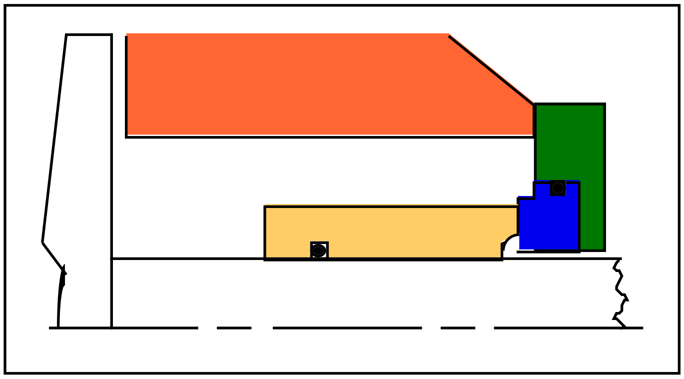

Figure 2

Other designs include a taper bore that was designed to encourage the flow of particles back towards the impeller and away from the seal faces.

Various devices and baffle type modifications have been added to change the flow pattern in the seal chamber. They encourage active circulation of the liquid to eliminate abrasive particles from the seal chambers, thus providing an even cleaner environment for the seal faces.

Environmental Controls

One very important condition necessary for reliable seal operation is the control of the environment in which the seal is located. Even with a strong shaft and a large bore seal chamber, the liquid being pumped may prove difficult to seal without some degree of modification.

Many pumps are equipped with a stuffing box cooling jacket that can be used to cool a high temperature liquid or raise the temperature of an excessively cold product.

Seal Flush

Even with a cooling jacket (or when one is not available) an excessively hot liquid may cook the elastomers and distort other parts of the seal, causing premature failure. Similarly, any abrasives in the pumpage can cause rapid wear of the seal faces and also result in premature failure.

In these, and other difficult applications, the product may have to be either diluted or replaced in the stuffing box by an appropriate seal flush, and this can be achieved in a number of ways.

In one method, the flush is brought from a very reliable, external source at a pressure higher than that in the stuffing box. This is frequently used when pumping a dirty product and, in such cases, the flush becomes the main source of lubricant for the seal faces. It can also dilute the pumpage and carry any abrasive particles from the seal faces into the pump casing behind the impeller. In some services the flush would be considered to have contaminated the main process and render this an inappropriate and unacceptable solution.

Other systems use the high pressure process fluid at the discharge nozzle of the pump and recirculate it into the stuffing box as shown in Figure 3. In such systems, the recirculation pressure and flow rate must be carefully controlled to ensure that it does not create harmful velocities around and onto the seal.

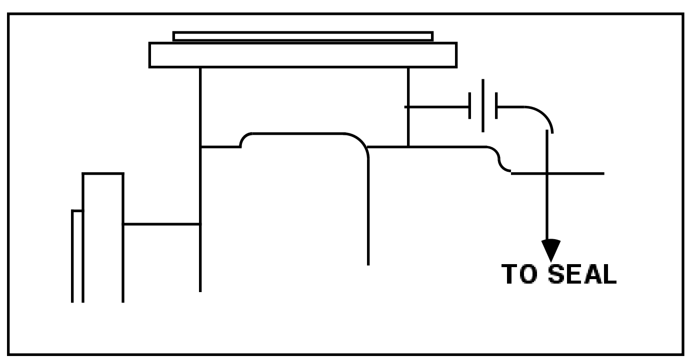

Figure 3

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Depending on the condition and nature of the product, it will often be necessary to make certain modifications to the recirculation line, to suit the conditions in the stuffing box. This may involve adding various items such as; an orifice, a heat exchanger, a strainer, or a cyclone separator. These will ensure that the liquid is delivered to the seal in such a manner as to improve the lubrication, pressure or temperature conditions at the seal faces.

The reverse flush arrangement shown in Figure 4, moves the liquid in the stuffing box to the pump suction. This can be very effective in purging gases from the stuffing box and removing the heat generated by the faces, from the seal area. In intermittent slurry applications, where the recirculation line is taken from the lowest side of the stuffing box, it is also considered very effective in removing abrasive particles from the seal area during startup.

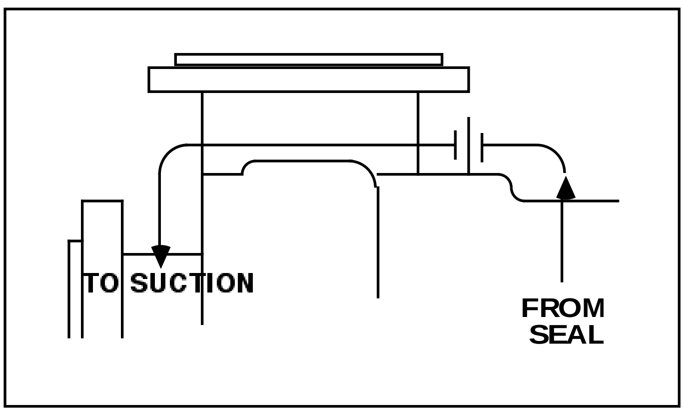

Figure 4

Seal Quench

Unlike the Flush, the Seal Quench never enters the process line. It is designed to remove any leakage from the outside of the seal faces that would tend to solidify and cause hang-up of the seal faces. It usually incorporates a disaster bushing to keep the quench in the seal area.

Barrier Fluid Systems

Barrier fluid systems are required with all types of double seals. They are usually external closed loop systems containing a fluid that is normally different, but compatible, with the process liquid. The system will contain a reservoir which should be as close as possible to the seal. An audible alarm may be designed into the system to alert Operations of any changed condition.

Consequently, to make the most of a mechanical seal, it takes much more than a well selected seal.

This article is an excerpt from the book, "12 Steps to Mechanical Seal Reliability in Centrifugal Pumps" by Ross Mackay

Ross Mackay specializes in helping companies reduce pump operating and maintenance costs through consulting and training programs which are presented personally and through a self-directed video program.

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