FLUID SEALING ASSOCIATION FSA

From the voice of the fluid sealing industry

SEALING SENSE

Which piping plan should I choose: API 53A, 53B or 53C?

This month's *Sealing Sense* was prepared by FSA Member Eric Vanhie

This article is related to an earlier *Sealing Sense* that answered the question "When and how do I use API Flush Plan 53?" (June 2005). Now we will focus on the three variances of Plan 53 (see Figure 1).

Operational Features

Plan 53 is the most commonly used auxiliary system for the operation of dual pressurized mechanical seals. It provides a clean external barrier fluid at a constant or variable pressure greater than that of the product pressure on the inner seal to ensure virtually zero emissions to the atmosphere. The mechanical seal will usually contain an internal pumping ring or screw that circulates the barrier fluid through some type of cooling device, which is installed in close proximity to the pump.

From an operational point of view, the system must maintain pressure above product pressure at all times.

It must also maintain the barrier fluid within a specific temperature range such that the seal faces operate under favorable lubricating conditions, typically below 150 deg F for most barrier fluids. The saying "a cool seal is a happy seal" is true in most applications and should be considered during the selection and sizing process of a dual mechanical seal support system.

Maintenance Considerations

From a maintenance point of view, the system must allow for replenishment of fresh barrier fluid without interruption of the operational requirements. The amount of clean, fresh barrier fluid makeup depends on the leak rate of the seal faces. The refill frequency can be estimated or predicted by comparing the available volume of the reservoir with the anticipated leakage of the seal over time. Contact a seal OEM for estimated leak rates since they allow the use of barrier fluid consumption as a benchmark for the performance of the seal and predict the need for maintenance.

All three plans require some type of makeup system for barrier fluid lost through natural leakage of the mechanical seal. The makeup system can be a simple hand pump (see Figure 2) or a more elaborate system that automatically feeds multiple seals.

Barrier Fluid

The choice of the barrier fluid is the most important consideration for determining the best system. Water-based fluids will dissipate heat twice as effectively as petroleum-based fluids and leak rates may be much different for the same operating conditions. The important point is that a water-based fluid, i.e. 100 percent water or glycol/water mixtures, may be used in a smaller system as compared to oil-based fluids, all other operating conditions being equal.

Basis for Selection

Plan 53A is the simplest plan of the three; it has no moving parts and is easy to operate. A gas, usually nitrogen, is used to maintain constant pressure on the barrier fluid in a stainless steel reservoir. The gas is typically sourced from a plant system. API 682 specifies these systems should not be used

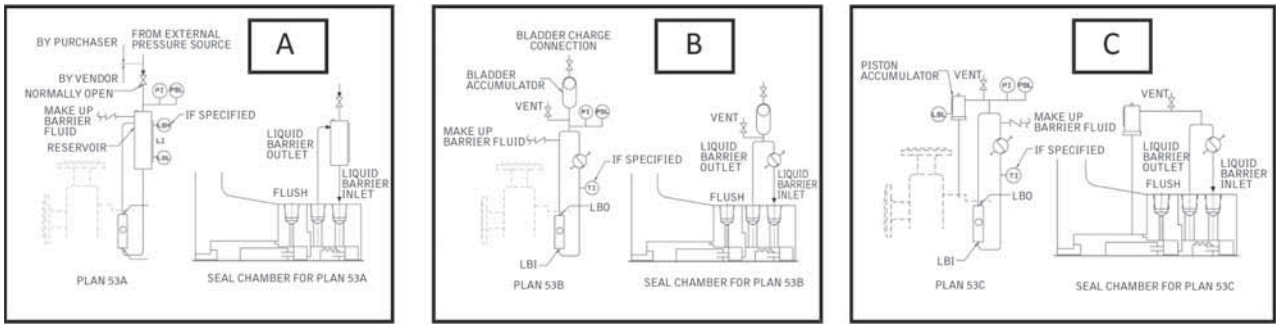

Figure 1. Overview of API Plan 53A, 53B and 53C

Figure 2. Plan 53A hand pump for barrier fluid

above 150 psig because of the danger that gas absorption in the barrier fluid may affect the lubricating state or regime of the sealing faces.

The reservoir has typical fluid storing capacities between 1 and 5 gallons. Cooling is obtained by circulating the barrier fluid over a cooling coil in the reservoir. Cooling water flow rates through the coil will vary between 1 and 3 gpm for the majority of applications. Cooling capacity is typically limited to approximately 6 kW for the larger reservoir sizes. The signal for barrier fluid refilling is normally delivered by a level switch in the reservoir or by visual monitoring of a level gauge.

This system is commonly used on single overhung pumps and only one dual seal can be operated with each system. A variety of highly standardized products is readily available for ANSI and API applications from most seal OEMs.

In **Plan 53B**, the pressurizing gas does not come into direct contact with the barrier fluid. Instead of the storage and cooling reservoir in Plan 53A, a heat exchanger (air or water-cooled) maintains suitable temperatures for the barrier fluid. A pre-charged bladder-type accumulator maintains reasonably constant barrier pressure. A bottle of nitrogen is used to pre-charge the accumulator and a hand pump brings the loop to the desired barrier pressure.

Since a plant nitrogen system is not required, this plan is suitable for remote installations where no or limited utilities are available. From a pressure range standpoint, Plan 53B is typically used for pressures between 150 and 750 psig. The size of the accumulator is critical since sufficient volume compensation must be available to compensate for the barrier fluid lost from normal leakage of the mechanical seal. Volume expansion of the barrier fluid must be included in the selection and sizing process. The refill signal is created by a pressure switch that senses barrier pressure decay and notifies the need for refill well before the product pressure is reached. Periodic checking of the accumulator pre-charge is necessary and manual refilling can be used if the anticipated leak rates are reasonable.

The heat exchanger allows for larger heat load dissipation as compared to the coil in Plan 53A, so this plan can be used for more severe operating conditions, i.e., API 610 overhung and between bearing pump applications. Air fin coolers can be used if cooling water is not available or of poor quality. Plan 53B also offers the advantage that process leakage is fully contained within the system in case of a seal failure, whereas provisions are necessary to isolate the nitrogen system from contamination in Plan 53A. Plan 53B systems are not as standardized as Plan 53A systems.

Plan 53C is the most complex, and least standardized of the three. It is sometimes called a pressure boosting or pressure intensifying system. It contains moving parts that regulate the barrier pressure as a function of the pump's product pressure. The moving part is a sealed piston pressurized with the pumped medium. On the other side of the piston, the barrier fluid is

pressurized in a hydraulic cylinder to a pressure that is higher than the reference or pump pressure. The difference is driven by the piston ratio in the cylinder. The typical input/output pressure ratio is 1:1.1 or about a 10 percent increase or boost.

These systems can have an internal cooling coil or an external cooler in the loop as in Plan 53B. With an internal coil, their cooling capacity is typically limited to 4 kW. The makeup volume is typically limited to approximately 1 gallon with a maximum operating pressure of roughly 1,000 psig. Plan 53C is typically used in applications where the pressure differential across the inner seal must be maintained within a narrow range. Use is limited to clean pumping fluids since fine abrasives may cause the piston seal to malfunction and the system to fail due to lost pressure differential. Any leakage of pumped fluid is contained within the system.

The greatest benefit of this system is that no external energy is required to pressurize the barrier fluid. Plan 53C systems require periodic maintenance and, in general, are not as reliable as Plans 53A or B.

Specialized Applications

Engineered seal applications, not within the scope of API 682, may require automatic refill and pressurization systems. In some cases flush systems contain an external pump mounted on a relatively large reservoir with instrumentation system and control equipment like API **Plan 54**. In multiple pump installations, it may be more economical to select one large common system for many seals rather than the one system per seal of **Plan 53**.

Conclusion

All three API **Plan 53** versions are intended to isolate the pumped product from the atmosphere and create a favorable artificial environment for the mechanical seal. Which of the three is optimal will depend on the specifics of the application. The choices of barrier fluid and maintenance capabilities are fundamentally important design considerations. Differences in the three include cooling and pressure capability as well as fluid cleanliness and energy requirements. Mechanical Seal manufacturers are best equipped to provide the guidance for selection and installation of the appropriate **Plan 53** for an application's requirements.

Next Month: *What gasket properties are most important and how do I use them?*

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

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