Considerations in the selection of dual pressurized seal piping plans - Part 2

Dual mechanical seals are commonly used to provide enhanced equipment reliability for centrifugal pumps and other rotating equipment. The presence of a pressurized barrier fluid between the two seals makes the seal less dependent on the pump process fluid. In addition, dual seals minimize or prevent process leakage to the atmosphere. These benefits require that the user select an appropriate piping plan to provide the pressurization, monitoring, and conditioning of the barrier fluid. Fortunately, there are several options which have a large successful installed base and are defined as industry standards. The user, however, must compare the benefits of each of these options against their own unique application requirements in order to select the most appropriate piping plan.

Michael Huebner, Principal Engineer, Flowserve Corporation

Pressurized seal support systems
The most commonly used mechanical seal piping plans have been standardized in API 682. Dual pressurized seals will utilize either a Plan 53A, Plan 53B, Plan 53C, or Plan 54. The Plan 53 series involves defined piping systems complete with definitions for piping, reservoirs, seal coolers, and instrumentation. The Plan 54, however, is more of a functional definition with no specifics related to the system design. API 682 defines a Plan 54 as "a pressurized external barrier fluid system supplying clean fluid to the seal chamber." A Plan 54 system will provide both the pressurization and circulation of the barrier fluid in the seal system.

With only this general description as a guide, it is no surprise that literally hundreds of different variations of Plan 54’s exist in the field. These can be divided into several categories which allows for easier comparison of the relative strengths and weaknesses of the available options.

Plan 54 – Process fluid systems
In some locations, end users will provide a Plan 54 from existing process fluid streams in their plant. The barrier fluid itself will be a process stream which has adequate properties to properly support the mechanical seal operation. The barrier fluid will come off of a high pressure line, go through the mechanical seal, and then return to a lower pressure line in the plant.

Figure 1: API 682 Plan 54.
This option is not commonly considered due to the unique combination of factors which must be present. The plant must have the barrier fluid supply available at all times including during commissioning, start-up, operation, upset, and shutdowns. The barrier fluid supply must be at a pressure greater than the seal chamber pressure of the pump. The plant must also have a low pressure return line which captures the barrier fluid for re-introduction into their processes. The barrier fluid supply and return lines, as well as the mechanical seal, must be in the same general area in the plant to allow for easier piping and monitoring. Even with these challenges, this option is used in applications ranging from high temperature hydrocarbon processing down to low-duty corn processing pumps.

Advantages:
- Simple system
- Uses available process fluid as barrier fluid
- No routine maintenance

Disadvantages:
- Affected by reliability of barrier pressure supply
- Potential to contaminate low pressure return line with process
- Barrier fluid selection limited to available process fluids

**Plan 54 – One seal support system**

It is far more common for an end user to utilize a dedicated barrier fluid system to support the mechanical seal. These systems are specifically designed to provide reliable pressurization and circulation of the barrier fluid for one dual mechanical seal. The Plan 54 will commonly provide fluid conditioning (filtration) and cooling (water or air cooling) as well as monitoring and alarming of the seal system. This option can be designed as an autonomous system and is suitable for remote locations.
Since one Plan 54 system is used for one seal, it is easy to monitor the seal performance through the level in the supply tank. It is also easy to ensure that the Plan 54 is operational prior to starting the pump through start-up procedures or interlocks. As a standalone system, this option offers the flexibility of providing a specific barrier fluid for one specific pump. This may be required for fluid compatibility or unique operating conditions. The use of a Plan 54 system on only one seal also minimizes the impact of the barrier fluid becoming contaminated in the case of a seal or system failure. These systems will require operator maintenance both for monitoring barrier fluid levels and adding additional barrier fluid as required. These systems have proven to be very reliable and are the most commonly used Plan 54 option used in industries.

Advantages:
- Pre-engineered systems
- Easy-to-monitor seal performance
- Flexibility in barrier fluid selection
- Suitable for remote locations

Disadvantages:
- Large number of systems may be required
- Operator maintenance at each Plan 54 location

Plan 54 - Multiple seal support systems
In a plant with a large population of dual pressurized mechanical seals, it may be advantageous to provide one large Plan 54 system to support multiple seals. In a small case, it may provide support for both seals on a between bearings pump. In a larger case, it may be a system to provide support for dozens of pumps or an entire operating unit in the plant. Since the scope of the system and services it provides are so varied, these systems are engineered for each specific application. Since they serve such a critical function in the plant, they are often designed with multiple redundancies to ensure uninterrupted operation.

Plan 54 systems, which support multiple pumps, are commonly designed with a large supply header and return line which runs through a unit. Barrier fluid lines come off of the header, go through the mechanical seal, and flow back to the return line. Each line can have instrumentation and controls to provide the specific conditions required for each seal. It is relatively easy to monitor the barrier fluid pressure and flow rate to each seal.

Having one central location for the Plan 54 system can make maintenance and monitoring of the system much easier. All major system components are located on one skid. The barrier fluid for all of the supported seals is provided from one supply tank. This makes barrier fluid maintenance easier, but requires that all seals operate on the same fluid. Large systems are designed with redundant components (barrier fluid pump & motors, heat exchangers, filters) to allow for maintenance and repair without affecting the system availability. This option provides the most consolidated, easy-to-maintain system for supporting a large number of pumps.
TECHNICAL ARTICLE: DUAL PRESSURIZED SEAL PIPING PLANS

Advantages:
- Engineered for the specific plant requirements
- One point for maintenance
- Multiple redundancies provide high reliability
- Higher initial cost
- Challenges with monitoring leakage from one specific seal
- One barrier fluid for the entire system

Disadvantages:
- Lower initial cost
- Challenges with monitoring leakage from one specific seal
- One barrier fluid for the entire system

Conclusions
Piping Plan 54 is a functional definition to provide pressurization and circulation for a barrier fluid. This provides a wide range of options to engineer a system that is unique for the requirements of the application and end user. Successful systems in the field range from small stand-alone systems to large systems supporting dozens of pumps. The end user and seal OEM should consider all of the options for Plan 53s and Plan 54s to determine the best fit for the specific application.

ABOUT THE AUTHOR: Michael Huebner
Michael Huebner is a Principal Engineer at Flowserve Corporation in Pasadena, Texas. He has over 30 years of experience in the design, testing, and application of mechanical seals both in the USA and Europe. He has authored numerous articles and lectured extensively around the world. He has a BS in Engineering Technology from Texas A&M. Mr. Huebner is a member of the API 682 Task Force on Mechanical Seals, the ASME B73 Committee on centrifugal pumps, the Advisory Committee for the Texas A&M Pump Symposium, and the ASME. He is also on the Steering Committee for a brand new pump event coming to Houston in 2016 called Pump Summit Americas.

Table 1: Comparison of Plan 54 Systems.

<table>
<thead>
<tr>
<th></th>
<th>Plan 54 - Process Fluid Systems</th>
<th>Plan 54 - One Seal Support Systems</th>
<th>Plan 54 - Multiple Seal Support Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barrier pressure</td>
<td>Constant</td>
<td>Constant</td>
<td>Constant</td>
</tr>
<tr>
<td>Pressurization source</td>
<td>From barrier fluid source</td>
<td>From Plan 54</td>
<td>From Plan 54</td>
</tr>
<tr>
<td>Monitoring seal leakage</td>
<td>Instrumentation and procedures</td>
<td>Level in supply tank</td>
<td>Level in supply tank, instrumentation, and procedures</td>
</tr>
<tr>
<td>Maximum barrier fluid pressure</td>
<td>Limited by pressure in barrier fluid supply</td>
<td>Limited only by system components</td>
<td>Limited only by system components</td>
</tr>
<tr>
<td>Suitable for remote location</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Barrier fluid selection</td>
<td>Limited by available process fluids</td>
<td>Can be unique for each seal</td>
<td>Common for all seals supported by system</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Minimal maintenance</td>
<td>At each location</td>
<td>At central location</td>
</tr>
</tbody>
</table>

SCP – Sustainable, Energy Efficient Solutions for Chemical Industry
Standart Pompa has been offering sustainable and innovative solutions in the market for years. SCP type pumps represent reliability and efficient pumping solution to hardest process requirements with ”Customer-oriented Approach”. SCP pumps, being ISO 2858 complaint, are specially designed for heavy duty conditions up to 175°C in chemical and petrochemical industry. SCP type pumps minimize maintenance costs and maximize operating life establishing “set and forget methodology.”

Standart Pompa
Organize Sanayii Bölgesi 2, Cad. No: 9 Omerbay / Istanbul / Turkey
www.standartpompa.com / info@standartpompa.com T: +90 216 466 69 89
https://twitter.com/standartpompa  facebook.com/standartpompa