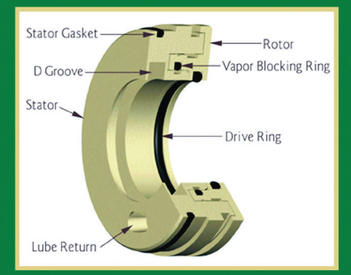
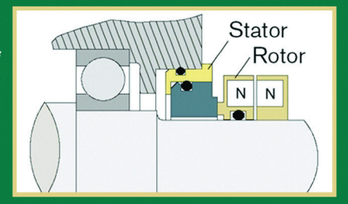
What's Protecting Your Pump Bearings?

By Kevin Delaney, Contributing Editor

With production costs on the rise, it's more important than ever to know what bearing protection is utilized in your plant's pump population, as well as the impact it can have on premature equipment failure.



A labyrinth seal with a vapor-blocking O-ring *(courtesy of Inpro/Seal)*



A flat-faced bearing seal. *(courtesy of Inpro/Seal)*

Have you ever inspected a bearing that came out of a failed pump—before the bearing was cleaned in a degreasing sink? In most cases, these bearing will be coated with a black slime that looks quite different from the grease comes out of a grease gun. And it is quite different. That slime is an emulsification of grease, water, dirt and whatever other contaminants in the atmosphere found its way into the pump bearing.

How those contaminants got into the bearings in the first place is another good question, with a rather surprising answer.

Old Technologies Linger On

Despite technical advances, a high percentage of pump bearings still depend on spring-loaded lip seals to keep water and dirt out of the bearing lubricant. Spring-loaded elastomeric lip seals were designed over a half century ago as grease retainers to keep grease in aircraft landing wheels. This is clearly an intermittent duty if there ever was one. Long operating life was not a primary design consideration, and even today, manufacturers of spring-loaded lip seals indicate an expected life in the range of 2,000 hours. For a pump in continuous operation, 2,000 hours actually amounts to less than three months.

No one really notices when a lip seal stops sealing. The pump keeps working, and the duration of service depends on the atmosphere. Pumps that see wash-downs, or those that operate in very dirty environments are going to see sudden bearing failures due to lubrication contamination. Pumps operating in clean-room environments with an every-other-month regreasing may last for an extended period of time.

This article was first published in Pumps & Systems Magazine, December 2004

When a spring-loaded lip seal stops sealing, a wash-down will rinse the grease right out of the bearing, leading to a fairly quick bearing failure. A typical process pump is going to see temperature fluctuations, which will result in moisture condensation. This condensed moisture will mix with the grease to form an emulsion—*and it doesn't take much to cause problems*. As little as 200 ppm concentration of water in the grease will decrease bearing life by half or more. Similarly, a small amount of particulate or dirt contamination will result in a dramatic reduction of bearing life.

According to the Electrical Apparatus Service Association (EASA), some 51% of motor failures are due to bearing failures. Conversely, lubrication failure is a primary cause of bearing failure, and lubrication contamination is the primary reason for lubrication failure.

Anyone responsible for operating or maintaining pumps needs to know what's protecting the lubricant in their pump bearings. What's keeping the lubricant in the bearings, and what's keeping contaminants out? If the answer is spring-loaded lip seals, the pump repair records should be examined carefully for clues that bearing lubrication is the root cause of equipment failure.

Primary Alternatives

Luckily, technology has advanced to the point that there are three viable alternatives to spring-loaded lip seals. These are: 1) magnetic seals; 2) dry-running mechanical seals; and 3) labyrinth seals with vapor-blocking dynamic O-rings.

- Magnetic seals are dry-running flat-faced seals that are held together by magnetic force.
- Dry-running mechanical seals are flat-faced seals that are held together by spring tension.
- Labyrinth seals with vapor-blocking O-rings operate by providing a tortuous path for liquid or particulate contaminates. Any liquids and contaminants entering while the unit is operating are essentially coalesced by centrifugal force and drained from the labyrinth seal. While the equipment is running, the elevated bearing area temperature is sufficient to keep any moisture from condensing. The intent of the dynamic O-ring is to engage and prevent liquid or contaminants from entering the labyrinth seal when the equipment is shut down.

As all of these technologies offer dramatic improvements over spring-loaded lip seals, which is appropriate for a given application? There are four factors for comparing bearing sealing options. These are relative cost, life expectancy, sealing capability and energy consumption.

Relative Cost

Looking at Figure 1, spring-loaded lip seals appear to be by far the least costly bearing seals. Progressively more expensive are labyrinth seals, mechanical seals and magnetic seals. Prices are estimated from the findings of an informal survey based on a group 2 ANSI pump with a 1.75" shaft on the stuffing box side, and a 1.125" shaft on the coupling side. These prices are what end users would typically be charged for a field retrofit situation.

Life Expectancy

As shown in Figure 2, spring-loaded lip seals appear to have the lowest expected service life, which is in the range of 2,000 operating hours. Labyrinth seals are rated for over 100,000 hours. Mechanical and magnetic seals are rated in the range of 17,000 to 25,000 operating hours. These are general numbers, and there are variations among manufacturers. Specific manufacturer's data should be consulted for comparisons relevant to a given application.

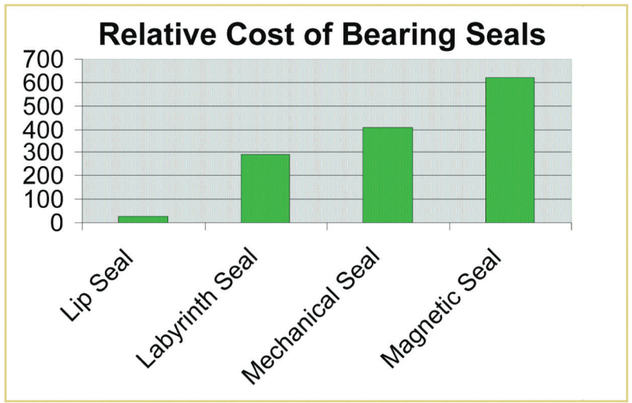


Figure 1.

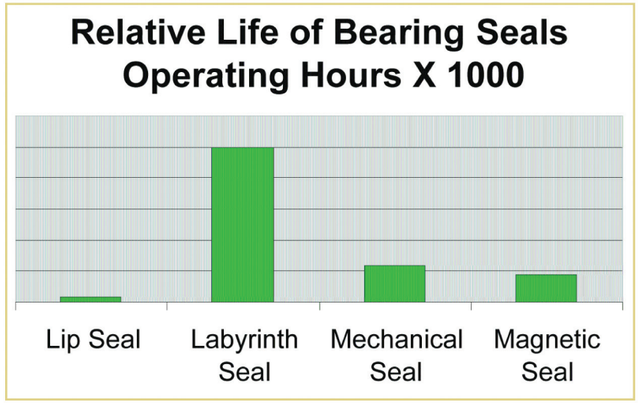


Figure 2. ***(Note: Scale is 20,000 hours per horizontal line shown)***

Sealing Capability

On a comparison of sealing capability, spring-loaded lip seals are excellent—*until they wear out.* But, since their effective life is so short, their sealing capability would be rated as poor. Manufacturers of magnetic seals and mechanical seals make the case that their particular technologies offer a closed environment akin to a "hermetic" seal. For those users that are most concerned with sealing bearings, double flat-face seals are supplied by some manufacturers.

The manufacturers of labyrinth-type seals make the case that labyrinth seals are a vast improvement over spring-loaded lip seals, and that they provide a very adequate barrier to moisture and contaminant intrusion for most pump applications. Furthermore, the dynamic O-ring vapor barrier they incorporate, a more recent innovation, is intended to address the issue of providing an effective contamination barrier when the equipment is not running. Users with very demanding environments may want to closely examine, and perhaps even field-test the sealing efficacy of the available designs to meet the unique challenges of a specific plant environment.

Energy Savings

The prospect for energy savings also may be a factor for consideration. While functioning, each lip seal consumes about .15 KW of power. With two operating lip seals for 2,000 hours at $.05/KW-HR, it costs $30 to operate a spring-loaded lip seal while it is functioning. This may not be a substantial factor for one pump, but for a plant that's operating hundreds of pumps, it clearly can add up.

The manufacturers of flat-faced magnetic seal and mechanical seal offerings indicate that the energy consumption of their designs is relatively insignificant. The labyrinth seal manufacturers maintain that their designs have zero energy cost.

Conclusions

The major consideration here is that bearing lubrication contamination may be a serious limiting factor in a plant's efforts to improve pump mean time between failures. Remember that the spring-loaded lip seal grease retainer is a decades-old technology that was intended for intermittent equipment operation. In the absence of a user specification, the default pump bearing protection may be some type of spring-loaded lip seal.

Users who are interested in reliability improvement would benefit by becoming aware of the bearing protection utilized in their plant's pump population, and the potential impact these components have on premature bearing and equipment failure. Newer technologies and approaches to bearing protection should evaluated, and, where appropriate, incorporated into pump procurement and pump rebuild specifications. **P&S**

Kevin Delaney is a consultant specializing in the development of new products for some of the world's leading pump manufacturers. His career in the pump industry spans more than 25 years, during which time he worked in the areas of sales, applications engineering, field service, warranty administration and repair services. This month marks his second year as a Contributing Editor with Pumps & Systems Magazine. For more information, e-mail: kdelaney@kevindelaney-ms.com