

CENTRIFUGAL PUMP BEARINGS

by **Ross Mackay**

As one of the parts that is manufactured to the most exacting of tolerances, the ball bearing does not deserve its reputation in the process pump market as being one of the two parts of a pump that is constantly failing. Yet that is the reality. To alleviate this situation, we need some understanding of what bearings do and what we need to do in order to let that happen.

The bearings in every process pump accomplish three important functions;

1. They locate the rotating element in its correct position relative to the stationary parts of the pump.
2. They allow the shaft to rotate with the least amount of friction to maximize the pump operating efficiency.
3. They absorb all the radial and axial loads which are transmitted through the shaft during the different operating modes.

The most commonly used bearing in the pump market is the single row, deep groove ball bearing. In addition to its ability to handle radial loads, it is also capable of handling an axial thrust load in either direction. Consequently, this bearing is also used as the thrust bearing on certain lighter duty pumps where the axial thrust load is relatively low.

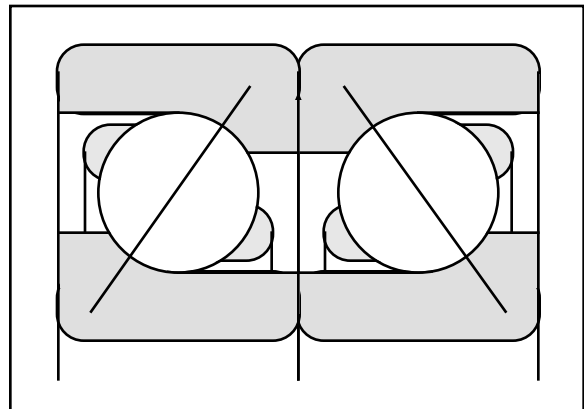
The double row, deep groove ball bearing is a thrust bearing that has substantial thrust capacity in both directions. It can also handle very high radial loads. This bearing is being gradually replaced in heavy duty process pumps by the double row angular contact bearing.

The single angular contact bearing is designed to support a heavy thrust load in one direction only. It can also handle a moderate radial load. The contact angle is achieved by a high shoulder on the inner race, and another shoulder that is diametrically opposite on the outer race.

The double row angular contact bearing can be configured in three different ways to accommodate the expected thrust loads. The Tandem arrangement can accommodate axial loads in one direction only, but evenly divided between the two bearings.

The Face to Face arrangement and the Back to Back arrangement can both accommodate axial loads in either direction, but only by one bearing at a time. In view of this similarity, it is frequently assumed that these arrangements are interchangeable. Not in end suction process pumps!

The Back to Back arrangement is the only one that can accommodate a tilting moment. Consequently this one must be used when the thrust bearing is located close to the source of a tilting moment. As that can occur as a result of shaft misalignment, the Back to Back arrangement must always be used in an end suction pump where it is close to the shaft coupling.



The thrust bearing in a “double-ender” type of pump is located at the opposite end of the shaft from the coupling. But if we continue to use the Back to Back arrangement in this pump style, it will ensure that the maintenance team don’t have to remember which bearing style goes in which pump. Therefore, every time a double angular contact bearing is used, it should be mounted in the Back to Back arrangement.

Total Bearing Arrangement

To ensure that these bearings provide long-lasting, trouble-free service, it must be recognized that they are only a part of the total bearing arrangement. Other important aspects include the support and the protection of these bearings. Such support includes a strong shaft and housing to minimize the effect of any externally induced stresses or vibration.

A strong shaft that will minimize the effect of vibration is essential to the support of the pump bearings. Therefore the slenderness ratio of the shaft must be kept at as low a level as is possible.

In view of the tendency of some companies to make their own spare shafts, it must be noted that the machining profile and accuracy of the bearing fits is essential for reliable operation.

Bearing Lubrication

The lubricant separates the rolling elements and raceway contact surfaces, and minimizes the effect of friction. The selection of the lubricant is a consideration of its viscosity, and depends on the operating temperature, the bearing size and its rotational speed. While the bearing manufacturer can identify the minimum viscosity required for these conditions, the selected lubricant should provide a higher viscosity than the minimum identified.

Grease Lubrication

Lubricating grease is essentially a soap thickening agent in a mineral or synthetic oil. When selecting the right grease, the base oil should be able to satisfy the bearing's lubrication requirements. When using grease, two rules must be followed;

1. Do not apply too much grease to a bearing as it will

cause the grease to overheat and reduce the lubricating effectiveness.

2. Do not mix different types of grease as many of their contents and preservatives are incompatible.

Oil Lubrication

Mineral oils are still the most common lubricating oil in general service pumps, while synthetic oils tend to be more resistant to higher temperatures and seem to require less frequent change in these applications.

The oil level in the bearing housing should be maintained at the centerline of the lowest ball in the race, and the oil must be able to enter the bearing from both sides.

An increasingly popular method of pump bearing lubrication is the Oil Mist system where the mist is a collection of atomized oil droplets that are sprayed in the bearings by compressed air.

The Purge Oil Mist system incorporates a static oil bath for the bearings, while the Pure Oil Mist system comprises the only form of lubrication used. The latter is gradually taking over almost exclusively as it has been found that the Purge System is less effective. The Pure Oil Mist System is used to fill the bearing housing as much as possible with oil in order to minimize the entry of contaminants.

Lubrication Protection

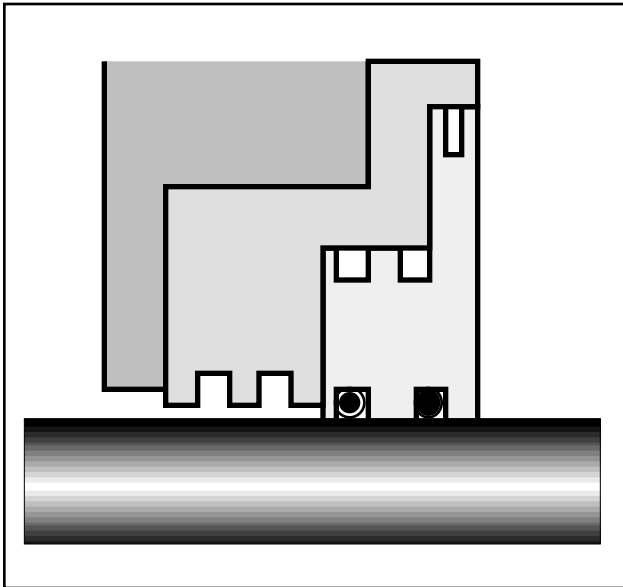
Other methods of protecting the lubricant from external contaminants involve sealing the bearings themselves, or the bearing housing.

Sealed bearings are fitted with seals on each side of the bearing and are considered sealed for the life of the bearing.

In these bearings, the bearing cavity is filled to approximately 25 – 35 percent with grease.

The most common method of sealing the housing is with the lip seal, in spite of the fact that it is misapplied when installed in most process pumps. Lip seals are designed to operate in a well lubricated environment where they can achieve an effective life of approximately 1,000 operating hours.

However, most process pumps have little or no lubricant in the immediate area of the lip seals. But even if we did get the full 1,000 hours, it is still totally inadequate in an application where we should be able to expect 25,000 hours from the bearings.



A less damaging option is a non-contacting labyrinth seal or bearing isolator. These seals are not new. The concept has been around for well over 25 years and they have proved to be infinitely more effective in protecting the bearing lubricant and extending the life of the bearings.

In conclusion....

- Install the right bearing in the right place.
- Mount it correctly in a strong housing and on a strong shaft.
- Use an appropriate lubricant.
- Protect that lubricant continuously against contamination.

That way, we can eliminate the unjustified reputation of the ball bearings in your pumps, and increase the pump reliability.

*Ross Mackay is an international authority
in pump reliability and the author of...*

***“The Practical Pumping Handbook”
“12 Steps to Mechanical Seal Reliability”
“A Practical Approach to Pumping” Video
“The Pumpline” Enewsletter”***

*He specializes in helping companies
stop repetitive pump failure and
slash pump operating and maintenance costs.*

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