

Dust and water in bearings lead to early-life destruction. Therefore, protection methods against ingress are needed. This article introduces several protection methods and reviews shaft seal designs suited to contaminated conditions.

Machine Environment

Dusty surroundings are one of the most difficult environments for bearings. In equipment handling powders or in processes generating dust, the protection of bearings against contamination by fine particles requires special consideration.

Wet environments are even more difficult for bearings. Moisture in a bearing, whether it is water or a chemical, sits at the bottom of the race and emulsifies (mixes) with the oil. The roller runs through and displaces the mixture, creating conditions for rolling element to race contact and their destruction. Instead of hydrodynamic gliding through the loading cycle, the element rubs or scrapes against the surface. Eventually the surface interaction leads to failure of the race or roller.

Bearing Housings

Bearings are contained within a housing from which a shaft extends. The shaft entry into the housing offers opportunity for dust and moisture to enter the bearing. The shaft seal acts to close the gap between the housing and shaft. Choosing the appropriate shaft seal and seal configuration to protect against dust and moisture ingress is critical to bearing life.

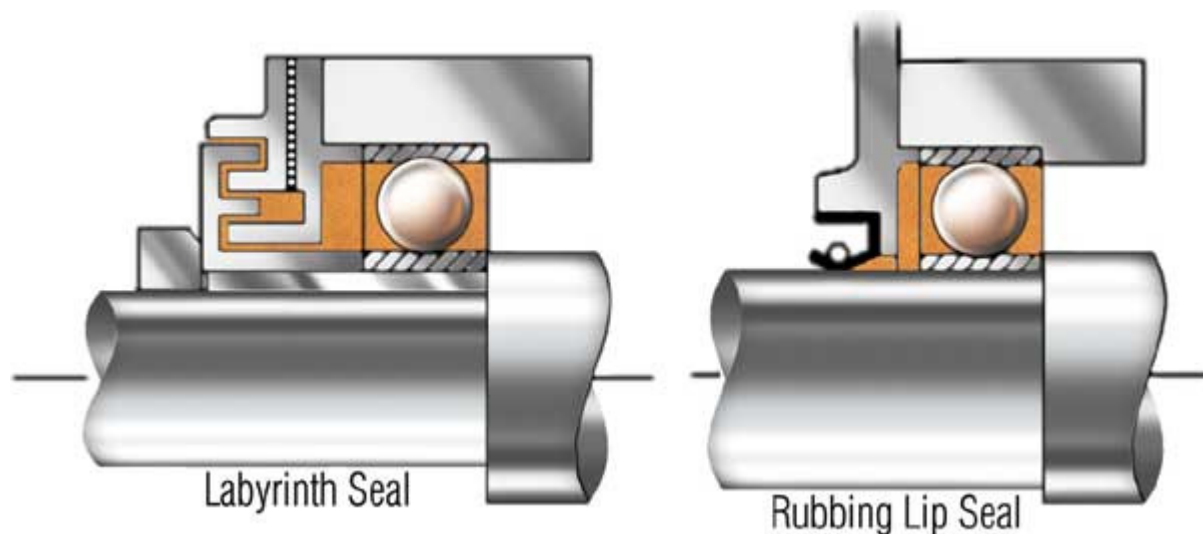


Figure 1. Shaft Bearing Housing Seals

Bearing housing seals for dusty environments are traditionally labyrinth or contact type (Figure 1). The labyrinth-type requires a straight shaft running true. Rubbing seals are the more common and allow for some flexing of the shaft. To prevent dust ingress when setting a lip seal into place, ensure the sealing lip faces outward.

Lip and Labyrinth Seals

The lip seal, while selected mainly for sealing the shaft to housing gap, is typically an unsatisfactory sealing device. Over time, the rubber used to make the lip is attacked by various oxidation catalysts, including oxygen, heat, wear metals and chemicals. It then degrades, cracks, hardens or deforms, and the lip causes fretting corrosion of the shaft

(the gouge seen under the lip when it slides off the shaft). Moisture on the shaft capillaries is drawn past the lip, and water sprayed directly at the lip seal blows past the seal and into the bearing. Lip seals are rarely replaced in installed equipment although, as the seal is a perishable component, it should be routinely replaced.

If you have equipment with lip seals, and you want reliable long-life operation, you must replace the lip seal before it fails. To decide the replacement frequency, estimate the mean time (the middle time of the range of times for seal lives) between the seal failures on each particular type of equipment in the operation and schedule a replacement preventive maintenance work order to replace them at 70 to 80 percent of those mean time spans.

The labyrinth seal has a better reputation for shaft sealing than the lip seal if used with grease flush. The gaps between the two parts of the labyrinth must be sealed to keep out dust and water.

To improve bearing life for both labyrinth and lip shaft seals, use an automatic lubricator. Only a small quantity is necessary when slowly flushed into the bearing cavity to force dust and moisture away from the elements.

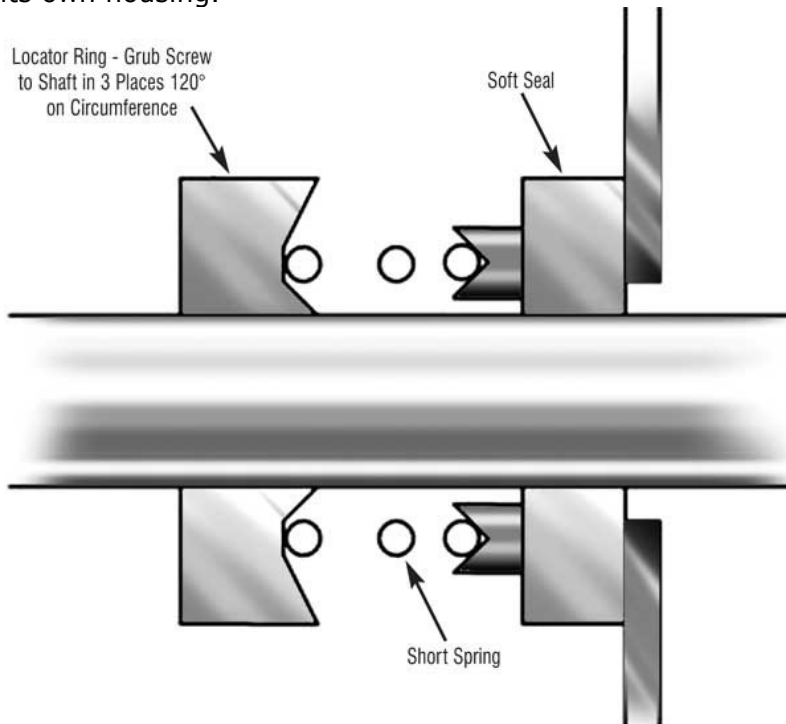
Grease flushing is not practical for oil-filled equipment. A better option is to replace shaft seals at a predetermined frequency just prior to failure.

Because of the inconvenience and high cost involved in caring for conventional shaft seals, there has been much development work to extend seal lifecycles. New designs and configurations are continually being developed and improved.

In situations of high dust contamination there may be a need to redesign the shaft seal arrangement for better dust protection than what is provided in standard housings. Some ideas which can reduce dust ingress into bearing housings include the following:

1. Parallel seal configuration. Bearing housings can usually be purchased with combination seals as standard equipment.
2. Design spring-loaded shaft-wiping devices to prevent dust ingress. The spring pushes the soft seal against both the shaft and the equipment wall to create a barrier. Figure 2 shows a conceptual design sketch. The assembly is installed in

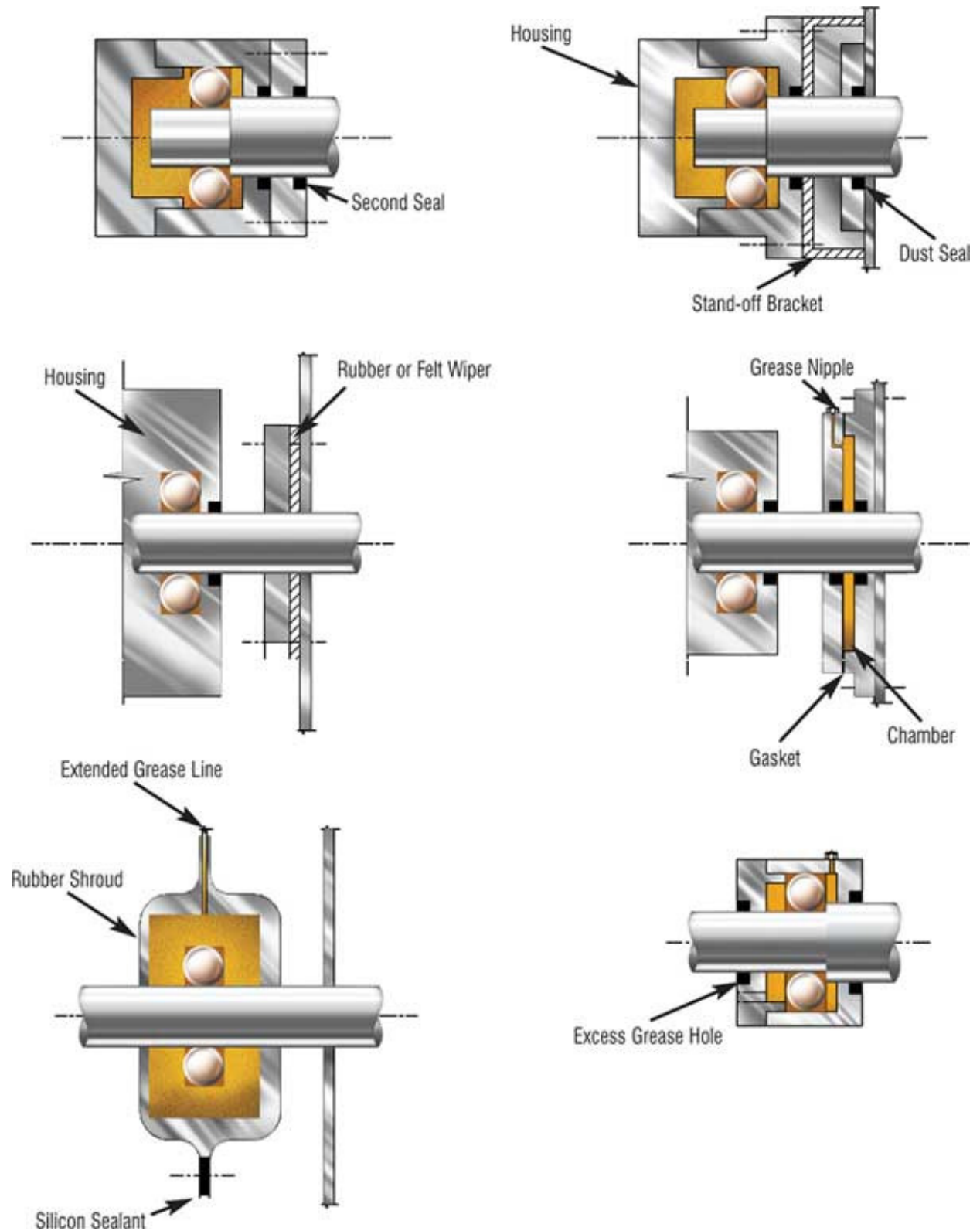
its own housing.



3. Stand the bearing off the equipment to create a gap between the end of the equipment and the bearing housing, and install a stuffing box and packing at the housing interface. This approach usually leads to scoring on the shaft in materials-handling equipment; therefore, it is best to install a surface-hardened, replaceable sleeve for the packing to run against.
4. Put in a felt seal wipe between the housing and the wall of the equipment to rub the shaft clean. This can be changed to a stuffing box and a packed gland if desired. It is best to install a hardened, removable sleeve on the shaft because the packing will eventually score the shaft.
5. Install a grease barrier chamber between two seals. This barrier is separate from the bearing housing and acts as the primary seal for the bearing. Grease pumped into the chamber will flush out past the seals. Provide an auto-lube set with slow discharge for continuous purging.
6. Replace the grease barrier chamber with an air purge (pressurized chamber).
7. Install a shaft-wiping rubber shroud covering the bearing or the dust-emitting opening. The potential for overheating the bearing in a fully enclosed shroud limits its use to slowmoving bearings only.
8. Purge grease through shaft seals or through a 15 mm hole (relief port) drilled in the housing. The hole must be on the side of the bearing opposite from the grease nipple, at the bottom of the bearing housing when in service and between the bearing and seal.
9. Mechanical seals can be fitted to the shaft with the stationary seal sitting against the machine and the rotating seal mounted back along the shaft. Combinations of other seals and wipers can also be used in conjunction with the mechanical seal. Mount the auxiliary seals so that they encounter the dust/water first, and keep the mechanical seal as the last line of protection.
10. In high-dust environments use a mechanical seal that has hard seal faces because the dust will score and scratch a soft seal face. An example is silicon carbide against silicon carbide.
11. Spray-on flexible and elastic plastic coatings such as soft polyurethanes and ethylcellulose to cover the housing and a short length of the protruding shaft. The length of coating over the shaft acts like a long wiping shaft seal. Because of its

length and continuous unbroken surface, it takes dust and moisture a long time to work their way up the shaft and into the housing.

The housing plastic coating does not prevent heat transfer because the coating is at the same temperature as the housing and still radiates and convects heat away. Some conceptual examples of alternate shaft seal designs for dusty situations are shown in Figure 3.



Assembly

Bearing assembly must be spotlessly clean. If contamination occurs when the housing and element are joined, no amount of external protection will stop the bearing from premature failure. When assembling bearings into housings, take the following steps to ensure cleanliness:

1. Wash your hands.
2. Ensure there is no dust or powder in the air.
3. Clear the work bench and wipe it clean.
4. To prevent creating dust, ensure that there is no grinding or sweeping nearby during assembly.
5. Use only fresh, clean grease (to the extent that you can control) to pack the housing.
6. Clean components and remove all old grease, grime and solid buildup.

Breathers

A breather releases hot air out of a confined space and allows the air to return when the space cools. Enclosed bearings get hot during operation and cool to ambient temperature when not in use. The air drawn back into the space should be clean of dust and moisture. A poorly screened and filtered breather on a bearing housing or bearing housing enclosure allows ingress of moisture and dust into the bearings, causing premature life failure.

An inadequate breather should be replaced with a low-micron air filter that removes dust particles that are two micron and larger. Protect the breather or filter from water spray and damp conditions (for example, ban "hosing down" if possible) with a shroud or by using an extension tube going into a clean, safe environment. Make sure the breather extension tube cannot be crushed closed.

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