Gearbox Rebuild Program

Seal options for your gearbox rebuild program

The purpose of this paper is to explore the best style of bearing isolator (seal) to be used for gearbox repair programs. To achieve this, we need to compare the differences between pumps, electric motors and large gearboxes.

Many seal vendors tend to group gearboxes with pumps and electric motors but there are too many internal differences between these basic rotating machines for us to ignore. To try and cover everything using labyrinth or lip seal technology is not a great idea. If your gearbox repair program has not been updated in the past few years it will not have taken into account the recent evolution in seal technologies. In the past, end-users have experienced the benefits of upgrading from lip seals to labyrinth seals and more recently, to magnetic flat-face seals (good, better, best).

It is the opinion of the author, based on over 30 years of rotating equipment experience, that lip seals and labyrinth seals are not well suited for large gearbox repair programs. There are several reasons for this, but the main reason is that neither seal design works well in aggressive flooded oil when shafts are rotating. Most large gearboxes use Timken tapered roller bearings on all shafts while most pumps and electric motors use ball bearings. A tapered roller bearing is a great oil pump and when oil is introduced to the center from the top of the double tapered bearing assembly, the oil will flow down into the bearing set and exit out of both sides of the bearing. Half of the oil gets pumped back into the gearbox reservoir while the other half gets pumped aggressively toward the lip or labyrinth seal. Labyrinth seals do not work well in a flooded oil condition because they have a leak-path built into the design (see figure 3). Some labyrinth seal vendors claim that their internal O-ring design will move or adjust to block the leak path when the seal is not rotating. This O-ring concept has proven to be ineffective in the past [reference, “Pump Zone” by Heinz Bloch, Oct. 2001]. The author agrees that an inner O-ring does not work as designed. Even if the O-ring worked, a gearbox seal needs to hold oil in a dynamic flooded condition as well as a static condition.

FIG. 1 Typical Gearbox

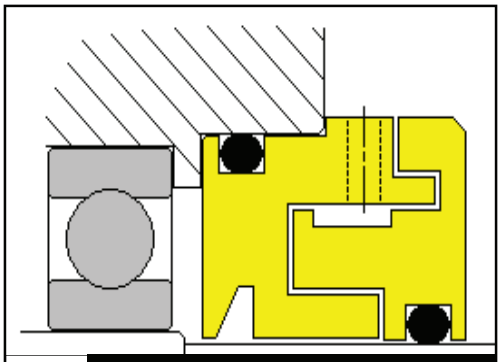


FIG. 2 Typical Labyrinth Seal Design

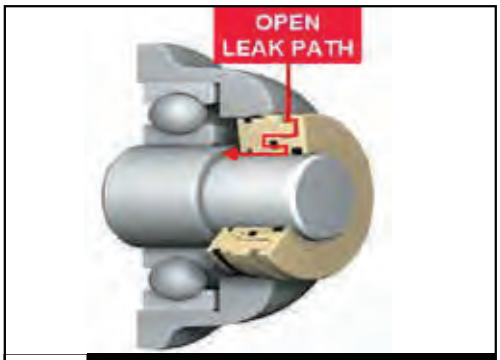


FIG. 3 Traditional Labyrinth w/Inner O-ring

Lip seals will hold a head of oil but they do not last as long as most gearbox OEMs assume [reference, "Are lip seals obsolete?" by David C Orlowski, Inpro seals Nov. 2006]. Most effective gearbox designs have a drain on the seal side of the tapered roller bearing which returns the excess oil back into the reservoir. If this drain is too small or becomes blocked, then a leaky seal is imminent. As part of your normal gearbox repair program you should inspect the oil-return drain hole and make sure it is clean, clear and large enough for the amount of oil being pumped to each bearing location. Another issue with a lip seal is that the lip cuts a groove into the shaft and causes expensive shaft damage (see figure 4). This fact alone illustrates a strong argument for not using lip seals for high speed (input) shafts on gearboxes.

FIG. 4 Typical Lip Seal Groove

Gearboxes use heavier oil than most pumps and electric motors, as well; all the shafts do not typically run as fast as pumps and electric motors. On a normal gear reducer you have one high speed shaft that can run as fast as any motor or pump but the low speed shaft rotates very slowly in comparison. Most gearbox OEMs have a satisfactory lip seal design that they will offer as an extra feature over their standard single lip seal offering. This special design utilizes two lip seals with a grease purge between the two lips to act as a barrier for contamination as well as lubricating the lip surface. Due to the slower speed of the low speed shaft this special lip seal design may last for many years without any issues. The author recommends that end-users review the style of (input and output) seals for each repair. Input seals run at a higher rotational speed so the risk of oil leaking or cutting a groove in the shaft is much greater than output seals. The size of the input seal is also smaller, which keeps the cost of an aftermarket seal option lower than if you need an aftermarket solution for the output shaft. The output seal options can be very large and expensive. If the output shaft seal has never leaked oil then it may not need to be upgraded past an OEM solution. If the output shaft seal permits oil to leak, or allows the ingress of contamination, then the more expensive aftermarket seal is definitely worth exploring. Lip seals are not a great barrier from outside contamination especially once the lip wears a groove on the shaft surface. The author is of the opinion that a better aftermarket seal is worth the extra cost for all input seals for every gearbox application.

"...a better aftermarket seal is worth the extra cost for all input seals for every gearbox application."

What is the best aftermarket seal style for your gearbox repair program?

The author has made reference to pumps and electric motors earlier in this paper. It is recognized that using labyrinth seals on pumps or electric motors has been the accepted tradition for many years for most end users. There are better, more modern seal options than the traditional labyrinth for pumps and electric motors but this paper is based on gearbox repairs only. The best style of seal known to the author that will work effectively on all large gearboxes is a magnetic flat face style seal, which can hold a head of oil up to 20 PSI (static and dynamic). There are several magnetic seals on the market today. The best magnetic seal has the least amount of seal faces which creates less drag, less wear and less heat and allows for slight misalignment of the shafts in all directions. The Isomag magnetic seal performs all these functions

"The best magnetic seal has the least amount of seal faces which creates less drag, less wear and less heat..."

with a single face seal and inner O-ring for misalignment. The Isomag inner O-ring is nothing like the inner O-ring design found in labyrinth seal designs. The Isomag inner O-ring allows for the seal cartridge to adjust, accommodating for shaft misalignment. This O-ring has nothing to do with holding the oil pressure, as the seal faces retain the oil. The Isomag seal has been carefully designed to accommodate for the heavier oil found in gearboxes. Recently, Isomag has developed a "MPG" seal designed especially for gearboxes which has a slightly higher face load than their new magnetic "MP" pump seal.The magnets are now outside, isolated from the lubricant and the sealing surface has been increased for longer MTBF.

Isomag V7 technology: The latest Isomag V7 technology has incorporated an internal static Labyrinth designed to steer excess oil away from the sealing faces. It eliminates any point of lubrication collection, and thus limits the possibility of leakage and/or lubrication breakdown. The internal labyrinth has circulation ports to drain oil back into the reservoir. The Isomag V-7 seal design is a major breakthrough for sealing all rotating equipment. This new design has reduced the running temperature on the faces by as much as 40% (see figure 5).

Isomag can also design the seal with a bolt-on flange to fit existing bolt patterns for any gearbox.

The author has no doubt that there are other magnetic and labyrinth seals that may work on some gearboxes, but the best field proven seal for all gearboxes is the Isomag magnetic MPG gearbox seal with V7 technology.

If you would like the author Nick Agius to email you the two papers referenced above, or any other information, please email him at nickagius2014@gmail.com.

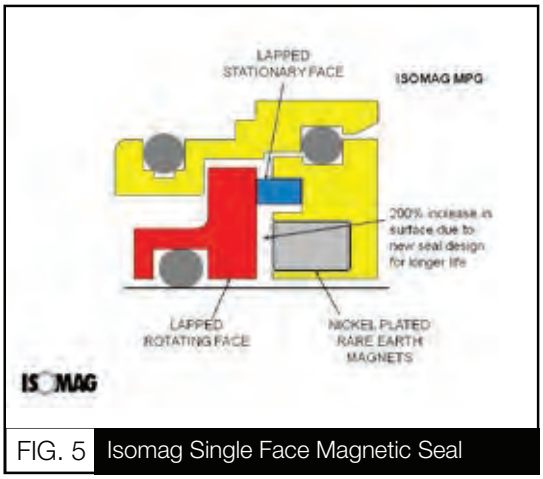
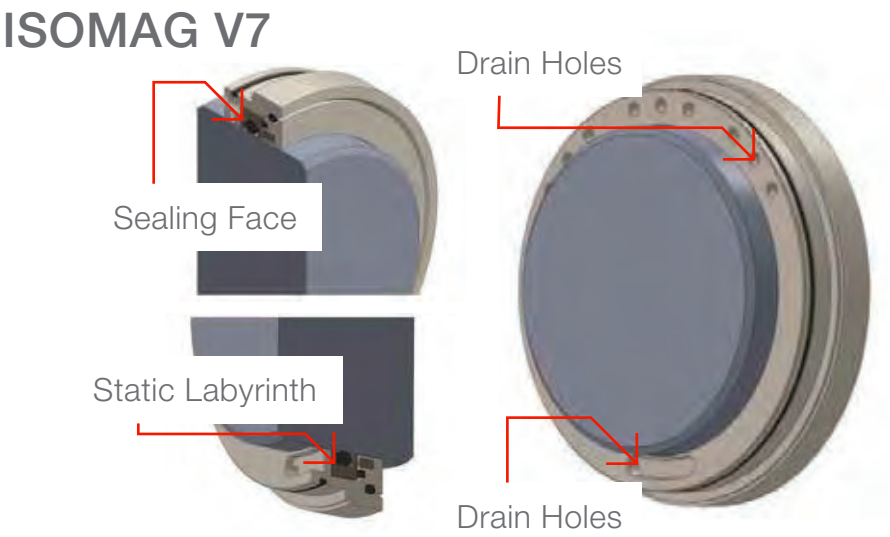


FIG. 5 Isomag Single Face Magnetic Seal



Nick Agius has over three decades of experience with bearings, seals, cooler fans, material handling and power transmission products and is well known within the petrochemical industry worldwide as a solution provider. He presently holds three patents for an anti-rotation device that he invented and developed to solve wind milling with fans on air-cooled heat exchangers. Mr. Agius has authored a technical paper on fans and blowers as well as a paper on air-cooled heat exchangers; both have been published by international magazines. He is also the only person to have developed a very unique and detailed cross-over catalog for angular contact ball bearings that has been utilized and appreciated by pump end users globally.

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