FOOD & BEVERAGE

ENGINEERING & MAINTENANCE

Supplement of

MACHINERY AND EQUIPMENT MRO

November 2019

In Co-operation with

EXCELLENCE IN MANUFACTURING CONSORTIUM

Inside:

CHOOSING THE BEST SEAL FOR YOUR GEARBOX REBUILD PROGRAM

NICK AGIUS

In the strive for operation efficiency, it is well worth the effort 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 in with pumps and electric motors but there are many internal differences between these basic rotating machines.

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 considered 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.

Based on over 40 years of rotating equipment experience, lip seals and labyrinth seals are not well-suited for large gearbox repair programs. For several reasons, including, neither seal design works well in aggressive flooded oil when shafts are rotating. Most large gearboxes use tapered roller bearings on all shafts and most pumps and electric motors use ball bearings. A tapered roller bearing is a great oil pump and when oil is introduced to the centre 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.

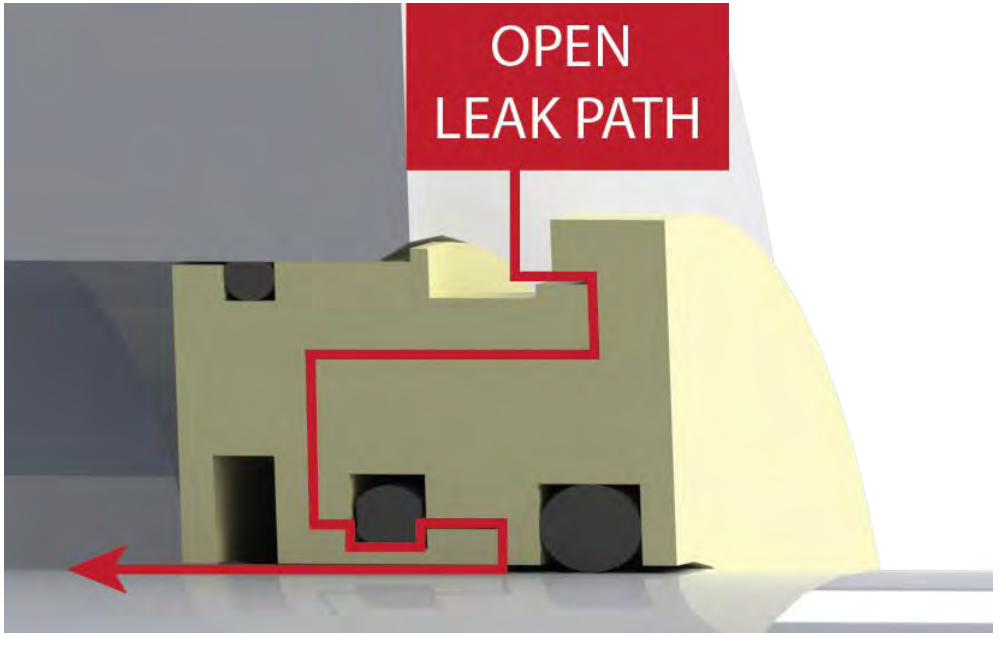
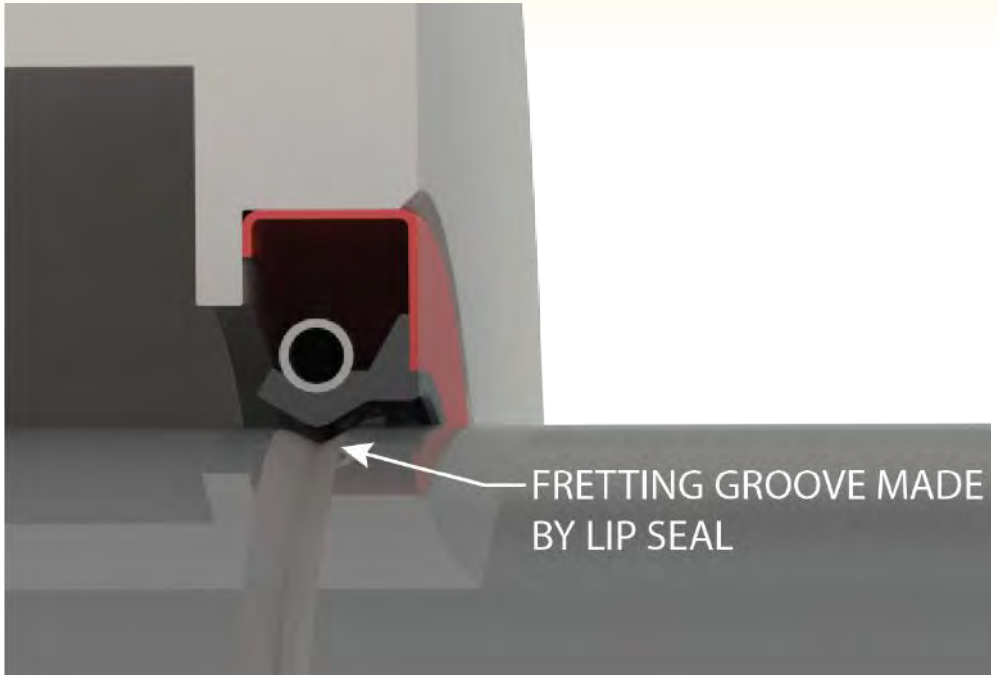
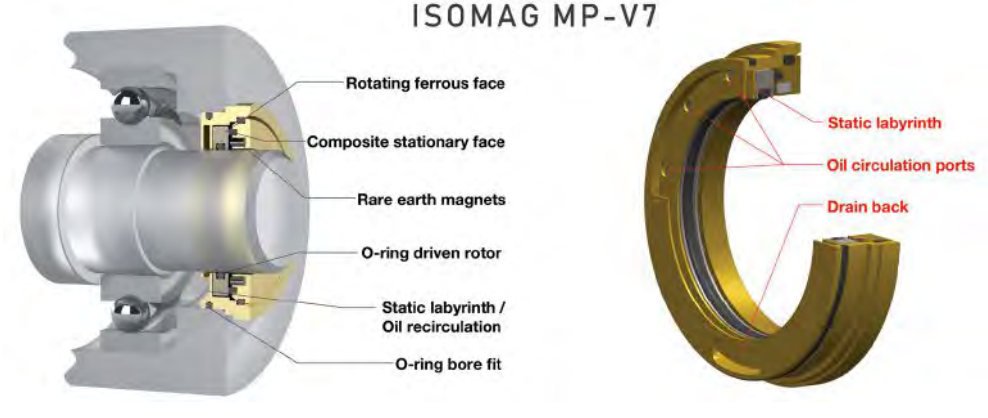


PHOTO: ISOMAG

Labyrinth seals do not work well in a flooded oil condition because they have a leak path built into the design (figure 1). 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 ("Pump Zone" by Heinz Bloch). I've consulted with Bloch for years and agree that the inner O-ring does not work as designed. Even if the O-ring worked, a gearbox seal needs to retain oil in a dynamic flooded condition as well as static.

Lip seals will hold a head of oil but they do not last as long as most gearbox OEMs assume. 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, 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 in the shaft and causes expensive shaft damage (figure 2). This fact alone illustrates a strong argument for not using lip seals for high speed (input) shafts on gearboxes.

Gearboxes use heavier oil than most pumps and electric motors. Also, the shafts do not typically run as fast as these higher speed machines. On a normal parallel shaft gear reducer, you have one high-speed shaft that can run as fast as any motor or pump, but the low-speed shaft rotates much slower in comparison. Most gearbox OEMs have a good lip seal design that utilizes two lip seals with a grease purge between the two lips to act as a barrier for contamination, and 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. 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

PHOTO: ISOMAG

seal is also smaller, which keeps the cost of the aftermarket seal option lower than the larger output seal.

This is not always the case for the output seal as they can be very large and expensive. If the output shaft seal has never leaked oil than it may not need to be upgraded. If the output shaft seal permits oil to leak or allows the ingress of contamination, than 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. A better aftermarket seal is worth the extra cost for all input seals for every gearbox application.

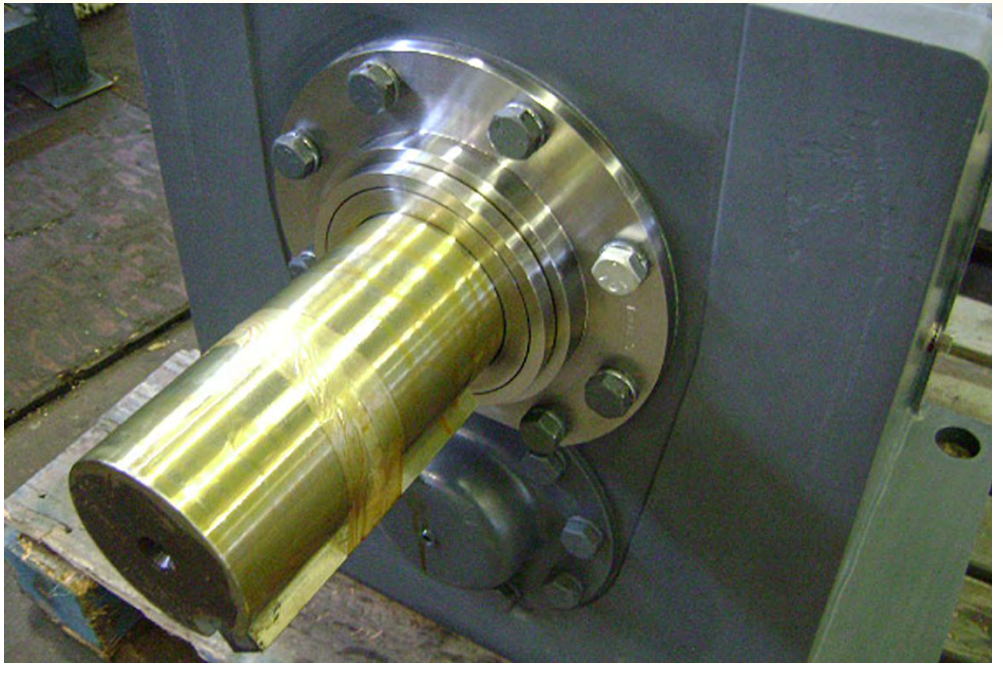


PHOTO: MOTION CANADA

WHAT IS THE BEST AFTERMARKET SEAL FOR YOUR GEARBOX REPAIR PROGRAM?

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 options than the traditional labyrinth for pumps and electric motors, but this discussion is based on gearbox repairs only.

The best style of seal that will work effectively on all large gearboxes is a magnetic flat face style seal, which can hold a head of oil (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.

One such magnetic seal does all these things with a single face seal and inner O-ring for misalignment. The inner O-ring is nothing like the inner O-ring design found in labyrinth seal designs. The 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.

One magnetic seal has been carefully designed to accommodate for the heavier oil found in gearboxes. Figure 3 shows a magnetic seal design with the rotor (and rotor O-ring) on the outside. If the lip seal wore a groove in the shaft then this style of seal would avoid having the rotor O-ring sitting on the worn area of the shaft so the damaged area would not need to be replaced or repaired. Avoiding these extra repair costs would offset the extra cost for this innovative seal solution. This is a major cost saving for any end-user.

You can also request the seal with a bolt-on flange to fit existing bolt patterns of your gearbox. See figure 4 for this option for your gearbox repair program.

Nick Agius is a Rotating Equipment Specialist for Motion Industries (Canada). His Anti-Rotation Device (ARD) solution for Canada and the U.S. was first patented in 1996, followed by two other patents.