MORCOR Limited

heavy duty metal face seals

REFERENCE MANUAL &
INSTALLATION GUIDE

introduction

Heavy Duty Metal Face Seals, also known as Duo-Cone, Cat, or Toric Seals, consist of two mating seal halves. Typically each seal half incorporates a metal seal ring and an elastomeric (rubber) ring. The metal seal ring acts as the primary seal, and the rubber ring acts as the energizer and secondary (static) seal. These types of seals are designed to be installed in specially machined housings and are normally bathed in oil. Mechanical Face Seals are either of the O-ring style or square bore style configuration.

The cleaning and handling of both styles are identical, only the actual installation methods differ. It is strongly suggested this entire document be reviewed, regardless of the seal style being installed.

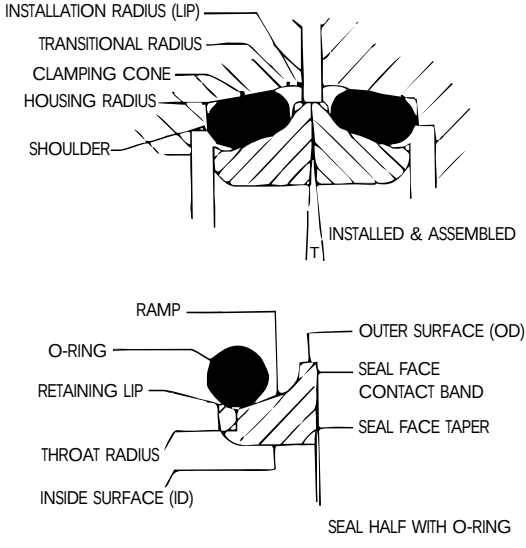
function of heavy duty face seals

The two halves of the seal are mounted in separate housings facing one another. The housing's bore, which locates the energizer, and the specified gap between the two housing halves, establish the required contact face pressure of the two metal rings.

The housing configuration, for the O-ring style seal, is tapered and increases with the depth of the bore. This area is known as the clamping clone. The metal ring also has a taper on its outside diameter, to locate the O-ring that is known as the ramp (Fig. 1).

The housing configuration, for the square bore style seal, is a “square” or 90 degree cut. The simple square cut in the housing bore has resulted in frequently using the term “square bore seal” for common identification (Fig. 2).

FIGURE 1



T. - TAPER FOR LUBRICATION TO FACES AND TO ENSURE
A CONSTANT CONTACT BAND

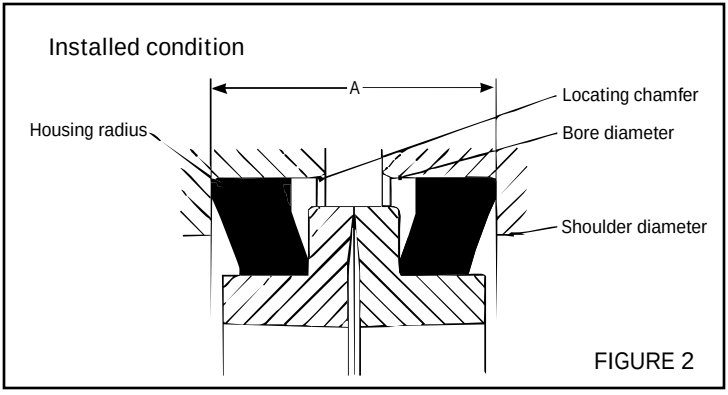


FIGURE 2

When the metal ring and energizer are axially compressed in the housing, the energizer is compressed between the housing and metal ring producing a radial and axial force. The axial component of this force can be calculated. It is this force, known as “Face Pressure”, which is most critical for proper seal operation.

The elastomeric energizers serve three functions:

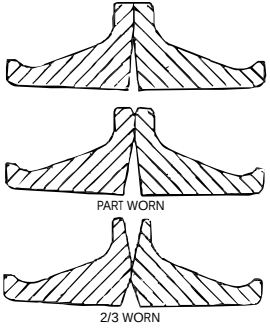
1. They generate axial face pressure because of their elasticity.
2. They act as a static seal between the outer diameter of the seal ring and the inner diameter of the housing.
3. They transmit torque from the rotating half of the assembly through the faces to the static half.

It is important to understand that only one of the seal halves rotates. The interface between the rotating and non-rotating half are the precision-lapped faces of the seal. The Seal Ring should never rotate relative to the energizer nor should the energizer rotate relative to the housing.

In order to obtain a “leak- free” seal, the contact band of the face is lapped with a surface finish of R max 1.8 micrometers. The tapered portion of the face forms a 1 – 3mm tapered gap at the ID of the seal set. The purpose of this tapered gap is to allow lubricant to feed the sealing faces. It also enables new faces to be continuously formed as wear takes place. This ability to form new faces considerably enhances the service life of the seal. The life of a seal is determined by the time it takes the sealing band to move from the OD to the ID of the face (Fig. 3). Special care should be taken not to damage the face area of the seal set.

GUIDE FOR FACE SEAL LIFE
The lapped face on the outer diameter of the seal is the initial contact band on a new seal.

As wear occurs this contact band will move inwards until approx 2/3 of the seal width has been worn. At this point, the seal should no longer be used.



The rubber o-rings should not be deformed or have tears on the surface.

Because face seals in operation find their own wear band, it is not recommended that seals be reinstalled.

FIGURE 3

face pressure & gap setting

Proper Face Pressure is extremely important to the function of the seal and is directly related to the “Gap Setting”. Just as in compressing a spring, the required force (Face Pressure) increases in proportion to the amount of compression (the energizer crush). As well, the Face Pressure increases more rapidly as maximum energizer compression is reached. The elastic quality of the energizer ensures that small

changes in the Gap Setting result in even smaller changes in the face pressure.

Figure 4 shows the load/deflection graph for a 150mm diameter seal with an 8.5mm diameter O-ring. The standard Gap Setting is 3mm.

The minimum face pressure is approximately 20N/cm² which in this example corresponds to a Gap Setting of approximately 6.4mm. This is how the Gap Setting tolerance is determined. Reducing the Gap Setting to less than 3mm is not desirable as the face pressure will begin to rise rapidly. Please note that the gap setting is not the same for all seals. Part drawings should be referenced for the individual specified gap.

lubrication

A constant supply of lubricant must be supplied to the faces of the seals in order for them to function properly. The lubrication serves two extremely important functions. It reduces the friction between the seal faces to allow for free rotation, and it serves as a cooling agent for the seal faces and seal rings. In fact, the lubricant serves to cool the entire seal/housing area, and it is often for this specific reason that engineers choose Heavy Duty Face Seals over conventional sealing systems for continuous load applications.

mechanical limits

Heavy Duty Face Seals manufactured of the standard material (Duronit) can be run at peripheral speeds of up to 10m/sec. Some alteration to the Gap Setting may be necessary for higher speeds. There are also specialized metal ring materials available, designed for high speed applications. It is necessary to use oil lubrication at speeds in excess of 3m/sec. Below this speed grease can be considered, although oil is always preferable. Lubrication by grease guns or

pressurized oiling systems should always be avoided. The internal pressures they cause can lead to misalignment of either the seal face or the O-ring, leading to rapid failure.

pressure limitations

Standard Heavy Duty Face Seal can withstand a positive hydraulic pressure of up to 43.5 PSI (3 bar). If necessary, higher pressures can be achieved but this normally means resorting to special seal designs to equalize the pressure.

introduction to installation

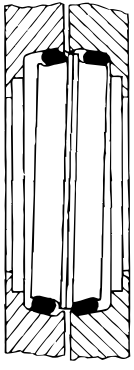
Heavy Duty Face Seals are normally considered to be a set consisting of two seal halves, but they are actually four separate parts which must be installed correctly in order to perform. To properly install these seals, always follow the instructions.

There are two distinct activities that make up the general procedures. The first is INSTALLATION, where the two halves of the seal set are inserted into their respective housings. The second is ASSEMBLY of the mechanical unit. This is where the housings (with their seal halves installed) are brought together, face to face, and are secured in their final assembled position. During the assembly portion of the procedure (as well as after assembly), no changes or adjustments can be made to the seal or its halves. Because of this, it is very important that the Installation portion of the procedure be understood and performed properly. The majority of premature seal failures are due to installation errors. Assembly instructions are normally specified by the equipment manufacturer. They are specific only to a particular application and will not be covered here.

Care should be taken, at all times, when handling these seals. Cast Seal Rings are made of an extremely hard grey iron alloy, engineered specifically for wear and corrosion resistance. As a result, the rings are very brittle and must be handled with care. All face seals should be regarded as precision elements, and the lapped faces must be protected at all times. WARNING: *Never place the seal halves face down on any surface!* Face seals can also be very sharp on the diameters of these lapped surfaces, so gloves should be worn when handling them. These seals have been specially packaged to protect the faces during shipments and storage. Similar care must be exercised during handling and installation. Improper handling and installation can result in leakage and/or reduced face life.

In order to get maximum service life out of Heavy Duty Face Seals, they must be seated in their housings symmetrically, resulting in a stable running position. If the seal halves are not installed accurately, misalignment or cocking of the seal can occur during the assembly procedure, resulting in nonuniform face loading and wobbling of the seal in its housing (Fig. 5).

FIGURE 5



COCKED SEAL AFTER ASSEMBLY

In the above example, an assembled unit may pass leak tests but would probably fail very quickly in the field as a result of uneven face wear, scoring and /or “pumping” of contaminants (debris) past the energizers. In extreme cases, immediate leakage or even breakage of the Seal Rings can occur. In order to ensure proper installation, always use an Installation Tool and carefully follow the instructions.

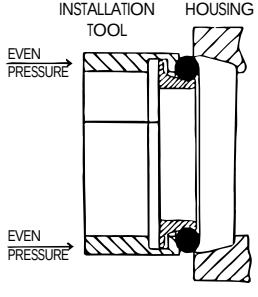
installation tools

For the “O-ring” style seal, the housing profile forms a lip on the outside known as the “Installation Radius”. This is necessary to hold the seal half in position prior to bringing the faces together and provides the starting point for the “rolling and compressing” of the O-ring during assembly. This lip presents an interference fit between the outer diameter of the O-ring and the inner diameter of the housing's “Transitional Radius”. The Transitional Radius is the area where the O-ring sits after it is installed but before it is “rolled and compressed” into its final assembled position (Fig. 1). During the installation process it is necessary to get the O-ring past the Installation Radius without rolling, twisting or changing its position on the Seal ring. This can only be accomplished by using an Installation Tool. WARNING: *The use of sharp instruments such as screw drivers can cause permanent damage to the O-ring and/or Seal Ring which may lead to rapid failure.*

The Installation Tool consists of a collar made from an impact resistant material which is profiled to suit a particular seal. The tool “clips” over the seal face, protecting the lapped surface and resting on the O-ring (Fig. 6).

Installation Tools are designed to locate on the O-ring so that as force is applied to the tool it bears only on the O-ring which will deform and slip past the Installation Radius and into position in the housing. The Seal Ring is actually “floating” in the Installation Tool, and it simply “rides” along with the O-ring into the housing.

FIGURE 6



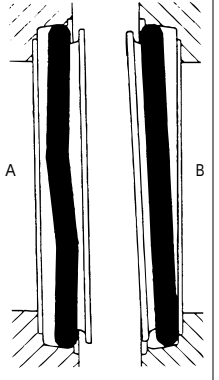
installation instructions

To begin the procedure, all of the sealing components; Seal Rings, energizers, housing and Installation Tool, must be clean and free of Oil, Grease, Dirt, or Dust. The presence of Oil, Grease or other lubricant in the housing or on the energizer can cause the O-ring to “slide” instead of “roll” into the housing during the assembly procedure. This is the leading cause of misaligned seal halves during installation (Fig. 7, “B”), as well as cocked seal sets during assembly (Fig. 5).

Always check to make sure that there are no nicks or burrs on the installation radius (housing lip) that could damage the O-ring during installation. The use of DENATURED ALCOHOL and a lint free cloth is recommended for cleaning all of these areas. NOTE: *Follow all* Material Safety Data Sheet *guide lines.*

After all components have been wiped clean and have dried, the O-rings should be placed back on the Seal Rings in their proper position. The O-rings must be seated in the “Throat Radius” just inside and touching the retaining lip (Fig. 1). WARNING: *Do not place the Seal Rings face down on any hard or abrasive surface to accomplish this!* Always make sure that the O-rings are not twisted or distorted by inspecting the mold flash (seam) on the outside diameter to see that it is running “true” with the circumference. Twisted O-rings are one of the common causes of the “Looped” effect after installation (Fig. 7, “A”). When assembled, this can result in either immediate leakage or

FIGURE 7



A = LOOPED
B = MISALIGNED

INCORRECT INSTALLED POSITIONS

reduced service life. Twist can be eliminated by gently pulling a section of the O-ring radially away from the Seal Ring and letting it “snap” back. Repeat this several times around the ring to make sure all twisting has relaxed.

Once the O-rings are back on the Seal Rings, place the Installation Tool around one half of the seal set and place it face up near the housing. WARNING: *Never place a seal half face down on any hard or abrasive surface!* Quickly swab out the housing with a clean lint free cloth generously soaked with Denatured Alcohol. This is to temporally lubricate the installation radius. Then, with the same cloth, quickly swab the outside (O-ring area) of the seal half in the Installation Tool to temporally lubricate the O-ring. Next, with both hands on the tool, quickly center the O-ring in the housing, and with a firm push, press the seal into the housing. NOTE: *It is important for the O-ring as well as the housing to be wet with Denatured Alcohol during the process.* Normally a “popping” sound will be heard as the Installation Tool comes in contact with housing. It is important to check that the tool is touching the housing all the way around its circumference.

Carefully remove the Installation Tool from the seal half and visually inspect the positioning of the O-ring and Seal Ring relative to each other, as well as relative to the housing. Always make sure that everything is seated symmetrically (Fig. 8).

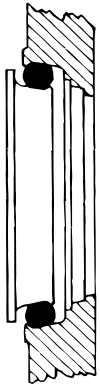
The seal may be adjusted by gently pushing the O-ring into position with your fingers from the inside or from the outside.

WARNING: *Never use sharp instruments such as screw drivers. They can cause permanent damage to the O-ring and/or Seal Ring which may lead to rapid failure.* For twists or obvious bulges in the O-ring, always remove the seal half and repeat the procedure beginning with the cleaning process.

After a successful installation, always wait a few minutes for the Denatured Alcohol to completely evaporate before assembling. The Alcohol is necessary as a lubricant during the installation process, but for assembly the area must be clean and dry in order for the O-ring to properly “roll” into its final compressed position.

If Denatured Alcohol cannot be used or if, because of assembly constraints, a lubricant with a faster rate of evaporation is required, an aerosol “Electrical Contact Cleaner” may be substituted. WARNING: *Never install seals with Oil, Grease or any solvent that can leave a residue.*

FIGURE 8



CORRECT INSTALLED POSITION

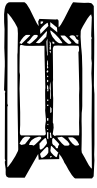
After the two seal halves have been installed in their respective housings and just prior to assembly, the faces should be thoroughly cleaned with Denatured Alcohol. Next, apply a thin film of clean motor oil (SAE 30-40) to only the faces with a clean lint free cloth. WARNING: *Be careful not to get any oil on the O-rings, seal ramp or the inside of the housing profile.* The seal set is now ready to be drawn together in the assembled unit.

Installation for the “square bore” style seal should incorporate all elements of seal handling and cleaning as detailed in the above O-ring style instructions. The simpler housing configuration allows for installation without assistance of an assembly tool. Each seal half can be installed by pushing the seal (energizer side first) into the machined housing. Special care needs to be taken not to damage or scratch the lapped surfaces during this process. Also, because a tool is not

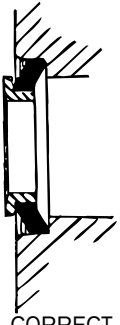
required and the seal is typically installed by hand, special care also needs to be taken with sharp edges of the seal so as not to cut your hands during the process. As noted above referencing installation of the O-ring style seals, clean gloves should be worn during this process.

The seal needs to be fully seated in the housing bore as shown in the illustration below (Fig. 9).

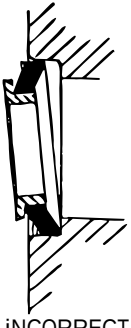
FIGURE 9



SEAL ASSEMBLY



CORRECT



iNCORRECT

run-in period

Some period of “Run-In” is required for most applications. The Run-In period is the amount of running time that is necessary for the faces to mate to each other to form a perfect seal. This period varies widely according to the specific application. It is normal in most applications for seals to “weep” a little oil during this period. If an artificial Run-In period (not in the field) is part of the assembly procedure, it is suggested that the seal set to be rotated in both directions during the Run-In period.

maintenance

For trouble-free function of the seal, adequate lubrication of the sealing faces is necessary at all times. A small amount of oil may be visible on the outer diameter of the seal when it is working. This is not a leak but only the seal faces being properly lubricated. If a seal is removed or the faces are separated after is has been Run-In, it should be replaced with a new set.

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