

Chapter C7

BDRP rotary shaft seals



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Individual chapters of the Kalsi Seals Handbook are periodically updated. To determine if a newer revision of this chapter exists, please visit www.kalsi.com/seal-handbook.htm.

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1. Introduction to BDRP rotary shaft seals

BDRP™ seals (Figure 1) are direct compression-type rotary seals developed specifically to be hydrodynamically lubricated when high differential pressure acts from either side. This feature makes it a candidate for use as a hydraulic swivel seal or as a rotary control device seal (RCD seal). This feature also allows it to be used with a simple gravity fed lubricant reservoir.

The acronym “*BDRP*” stands for Bi-Directional Rotation and Pressure. The seal is designed to accommodate either direction of rotation, and either direction of pressure. In one direction of differential pressure, the non-abrasive fluid can be up to 1,000 psi (6.89 MPa) greater than the pressure of the lubricant. In the opposite direction, the differential pressure can be much greater than 1,000 psi, with the actual pressure capacity dictated by extrusion gap clearance between the shaft and the seal housing. The qualification testing was performed at a surface speed of 466 feet per minute (2.37 m/s).



Figure 1
BDRP rotary shaft seals

The BDRP rotary seal is a composite direct compression seal for separating a lubricant from a non-abrasive fluid, with differential pressure acting in either direction. When used with a barrier seal, pressurized abrasive fluids can be retained. Because of the ability to withstand either direction of differential pressure, the lubricant can be supplied from an unpressurized reservoir. The seal also accommodates either direction of rotation.

2. Description of BDRP rotary shaft seals

BDRP seals have composite construction consisting of an elastomer seal body lined with a layer of plastic that forms the dynamic sealing surface. The plastic layer is loaded against the shaft by radial compression of the elastomer portion of the seal. The plastic layer is bonded to the elastomer portion. This prevents the damaging component slippage that is common to cap-type hydraulic swivel seals.

The plastic layer extends from one end of the seal to the other, and resists differential pressure-induced deformation. One side of the plastic layer incorporates hydrodynamic waves that face the lubricant. These waves are specially designed to resist differential pressure-related deformation, so they remain functional when the pressure of the lubricant is much less than the pressure of the non-abrasive fluid.

For available seal sizes, visit kalsiseals.com.

During rotation, the waves hydrodynamically wedge a lubricant film between the shaft and the plastic layer of the seal. This hydrodynamic interfacial lubrication reduces friction, wear, and friction-generated temperature, and enables the good high pressure performance of the BDRP seal.

3. Availability of BDRP seals

A table of available seal sizes and gland dimensions is provided on our website. Other seal sizes can be furnished, subject to a one-time tooling charge to help to defray associated engineering, machining and set-up expenses.

4. Removable gland walls will be required for some diameters

Smaller seal diameters will require a removable gland wall for assembly due to the stiffness of the plastic layer of the seal. We have not determined the minimum diameter that can be installed into a once-piece groove (i.e., no removable groove wall) without damaging the seals.

Based on experience with 681-series Plastic Lined seals, which are somewhat like BDRP seals, we believe that BDRP seals at least as small as 10.375” diameter can be installed into a one-piece groove without damaging the seal.

5. Using a BDRP seal as a hydraulic swivel seal

When using a BDRP seal as a hydraulic swivel seal, two seals are required to define a single hydraulic circuit, three seals are required to define two hydraulic circuits, four seals are used to define three hydraulic circuits, and so on. In other words, the same as when cap seals are used. (If pressures higher than 1,000 psi (6.89 MPa) are anticipated, two Kalsi Seals are required to define every hydraulic circuit, in order that the fluid pressure only acts from the wavy side of the dynamic sealing lip.)

When installing the BDRP seals, the waves of each seal should face a hydraulic fluid circuit. The swivel should be configured so that the waves of each seal are exposed to hydraulic fluid during rotation. When necessary, use check valves or a gravity-based fluid trap to accomplish this (Figure 2).

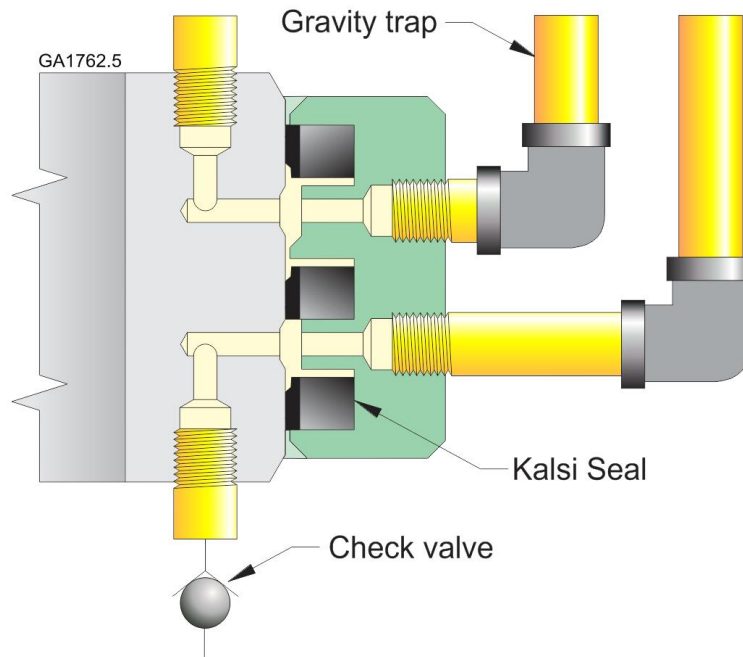


Figure 2

Keeping the waves of a hydraulic swivel seal exposed to lubricant

When using the BRDP as a hydraulic swivel seal, take steps to ensure that the wavy side of each dynamic lip is exposed to hydraulic fluid. As shown in this schematic of a hydraulic swivel, a gravity trap or a check valve can be used to achieve this objective.

6. Using a BDRP seal as an RCD seal

When using a BDRP seal as an RCD seal, an outboard barrier seal is required, with the region between the two seals being filled with a barrier lubricant that is balanced to the pressure of the well (Figure 3). The barrier seal excludes the abrasive drilling fluid but is exposed to zero differential pressure, and the BDRP seal retains the pressure of the barrier lubricant, but is isolated from the abrasive drilling fluid.

The seal lubricant can be gravity fed from a simple unpressurized lubricator. In an RCD, the seal could be mounted below the bearings and utilize the bearing lubricant to lubricate the interface between the BDRP seal and the rotating mandrel. No complicated lubricant overpressure system is required.

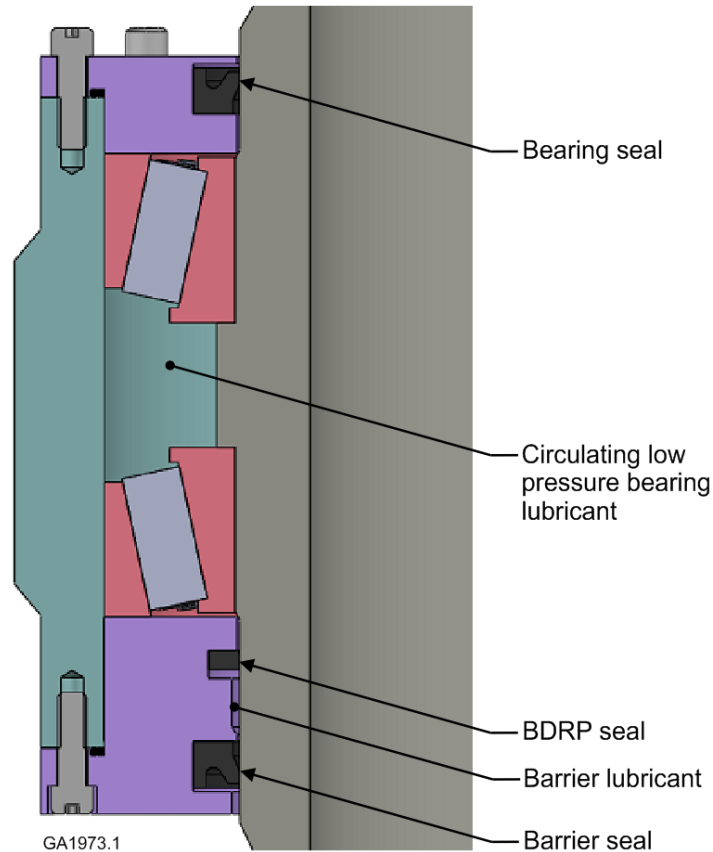


Figure 3

Using the BDRP as an RCD seal

When using the BRDP as an RCD seal, use an outboard barrier seal to separate the drilling fluid from a barrier lubricant, and pressure balance the barrier lubricant to the pressure of the drilling fluid.

An example of one of our full-scale RCD seal-related tests

With RCD sealing in mind, a 10.49" (266.45mm) diameter PN 717-1-318 BDRP seal was tested at 170 rpm (466 fpm) and 1,000 psi (6.89 MPa) for 179 hours. The test fixture, which is shown by Figure 4, was custom built to test seals for rotary control devices (RCDs).

The upper seal was a PN 717-1-318 BDRP seal, and the lower seal was a PN 682-12-318 Plastic Lined Kalsi Seal. Both seals were installed in non-floating seal carriers that define a radial extrusion gap clearance of 0.010" (0.25mm). The dynamic runout was 0.007" (0.18mm) FIM at the upper rotary seal, and 0.003" (0.08mm) FIM at the lower rotary seal.

For available seal sizes, visit kalsiseals.com.

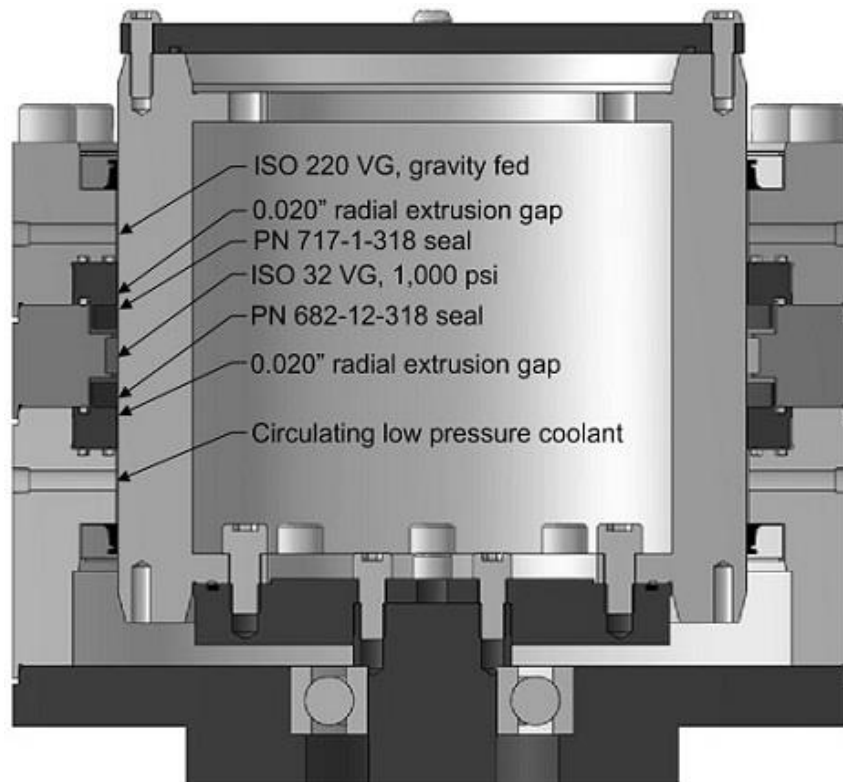


Figure 4

Kalsi Engineering has a dedicated fixture for testing high pressure RCD seals

To better understand the challenges faced by our customers, Kalsi Engineering designed and built a fixture to test the pressure-retaining seals of an RCD. The flexible design of the fixture allows different types of rotary seals and seal carriers to be tested.

The hydrodynamic waveforms of both seals were oriented upward. The lubricant for the BDRP seal was an ISO 220 viscosity grade lubricant that was unpressurized, and delivered to the seal by gravity. The 1,000 psi (6.89 MPa) test pressure was applied to the underside of the BDRP seal via an ISO 32 viscosity grade lubricant simulating a pressurized barrier lubricant. This lubricant also served to lubricate the lower rotary seal, which was used to retain the 1,000 psi (6.89 MPa) test pressure.

In an actual RCD, a portion of the lower end of the mandrel is exposed to the flowing drilling fluid, which has a cooling effect on the mandrel. In the test fixture, a 111 to 119°F (43.9 to 48.3°C) coolant was circulated under the lower seal at approximately 2 gpm to create a thermal environment at the upper seal that simulates an RCD that has no circulation of the bearing lubricant. No other circulation was provided during the test. The temperature immediately above the upper rotary seal ranged from about 136 to

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150°F (57.8 to 65.6°C), and the temperature between the seals ranged from about 152 to 170°F (66.7 to 76.7°C).

The test was stopped at 179 hours to make the fixture available for other pending tests. The BDRP seal was still in good condition, with very little detectible wear, showing that the seal can withstand a pressure differential of 1,000 psi (6.89 MPa) at 466 fpm (2.37 m/s) with only moderate cooling.

The lower seal was in excellent condition, with no detectible wear, easily withstanding the 1,000 psi (6.89 MPa) differential pressure at 466 sfpm (2.37 m/s) while experiencing excellent interfacial lubrication with a low viscosity (ISO 32 viscosity grade) lubricant.

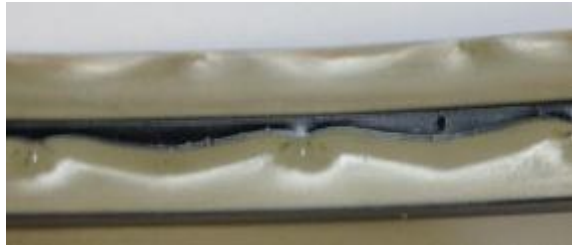


Figure 5

BDRP and plastic lined seals from a test simulating RCD sealing conditions

These are the 10.49" rotary seals from the 1,000 psi, 466 fpm test. The upper seal (the BDRP) received the pressure on the non-wavy lower side, and the lower seal received the pressure on its wavy upper side. After 179 hours of operation, both of these high pressure shaft seals are still in great condition.