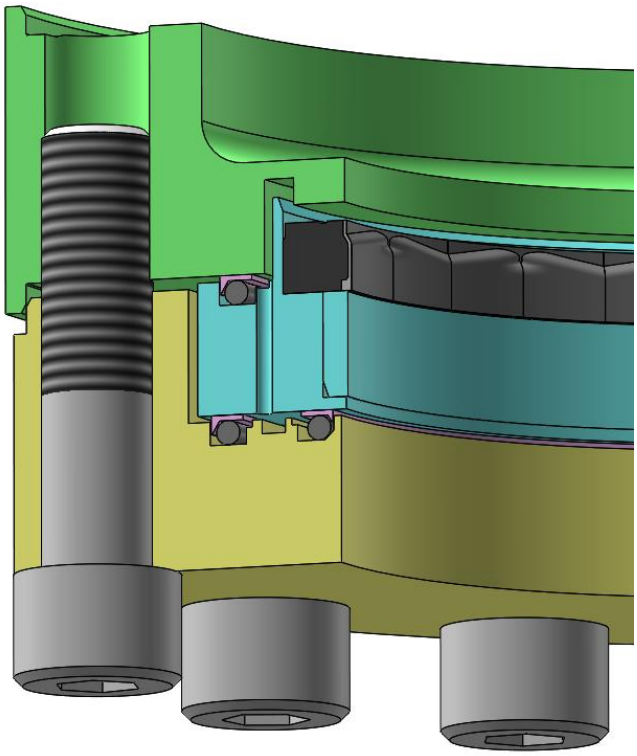
Chapter C19

Face sealing plastic backup rings



Revision 0 July 28, 2020

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.

NOTICE: The information in this chapter is provided under the terms and conditions of the Offer of Sale, Disclaimer, and other notices provided in the front matter of this seal handbook.

© 2020 Kalsi Engineering, Inc. All rights reserved.

1. Introduction

Kalsi-brand plastic backup rings[1] (Figure 1) are designed for use with floating metal backup rings[2] and plastic lined rotary shaft seals to assure reliable operation in extreme high pressure applications such as oilfield side entry cement heads and other high pressure side port swivels, oilfield washpipe assemblies, and high pressure hydraulic swivels. This chapter describes the features and benefits of the plastic backup rings and explains how they are used.

Figure 1

712-series plastic backup rings for high pressure face sealing applications

Kalsi-brand plastic backup rings were designed to allow face sealing O-rings to bridge the clearance that is necessary to accommodate runout-related oscillating motion between non-rotating machine components while sealing extreme high pressure.

2. Using plastic backup rings with floating metal backup rings

How the high pressure seal arrangement works

Figure 2 shows an assembled floating backup ring arrangement. A metal backup ring is located axially by and between a bulkhead housing and a retainer that are secured together with a pattern of bolts. The metal backup ring is radially pressure balanced for dimensional stability and has a journal bearing fit with a rotatable shaft. The journal bearing fit defines the smallest practicable extrusion gap clearance for a plastic lined Kalsi-brand rotary shaft seal, allowing the seal to operate at its highest pressure potential. The extrusion resistant plastic liner of the rotary shaft seal bridges the extrusion gap clearance between the metal backup ring and the shaft. The rotary shaft seal and three face sealing elements define sealed annular areas on opposite ends of the metal backup ring that are equal in size. Fluid pressure acting on these annular areas applies equal and oppositely acting hydraulic forces to the metal backup ring, leaving it axially force balanced. This axial force balance and the journal bearing fit allow the metal backup ring to "float" laterally to accommodate misalignment and runout. When a floating backup ring assembly is used to retain a non-lubricating high pressure fluid, a separate rotary shaft seal (not shown) partitions the seal lubricant from the non-lubricating fluid, and the seal lubricant is maintained at approximately the same pressure as the non-lubricating fluid.

---

1 U.S. Patent 10,330,203

2 U.S. Patents 10,330,203, 9,845,879, 9,429,238, 9,109,703.

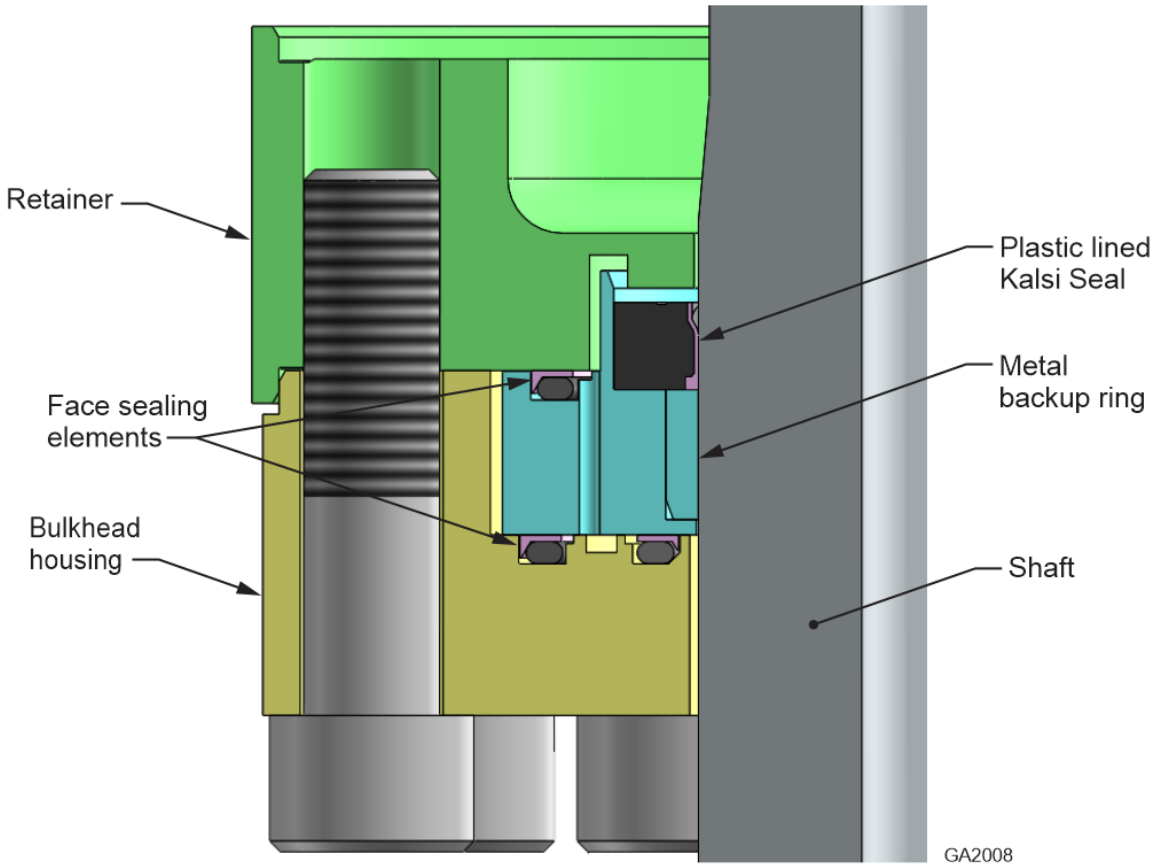


Figure 2

The high pressure seal arrangement incorporates three face sealing elements

The high pressure seal arrangement features a floating metal backup ring that defines the smallest practicable extrusion gap clearance with respect to the shaft. The small extrusion gap clearance allows the rotary shaft seal to perform at its highest pressure potential. The rotary shaft seal and three face sealing elements define sealed areas that apply equal and opposite axially acting hydraulic forces to the metal backup ring. Because of the resulting force balance, the metal backup ring is free to float laterally to accommodate shaft misalignment, runout, and deflection. The face sealing elements consist of O-rings and our patented extrusion resistant plastic backup rings that protect the O-rings from pressure-related damage.

How the high pressure rotary shaft seal works

The patented Kalsi-brand rotary shaft seal (Figure 3) incorporates hydrodynamic features that force a film of lubricant through the dynamic sealing interface, to reduce friction, wear, and seal generated heat. Hydrodynamic leakage from the rotary shaft seal lubricates the journal bearing interface between the metal backup ring and the shaft. The inner surface of the seal is lined with a high performance plastic that is resistant to pressure-induced damage. These features give our plastic lined seals the highest pressure capacity of any polymeric rotary shaft seal.

Figure 3
Working principles of the high pressure rotary shaft seal

Kalsi-brand plastic lined rotary shaft seals have a high performance plastic liner and our patented enhanced lubrication waves. The plastic liner bridges the extrusion gap clearance between the metal backup ring and the shaft, resisting high pressure extrusion damage much better than elastomeric seal materials. When the shaft rotates, the hydrodynamic waves pump a thin film of lubricant into the seal-to-shaft interface, causing the seal to hydroplane on the film. This interfacial lubrication reduces friction, wear, and associated seal-generated heat.

How the plastic backup rings work

Figure 4 is an enlargement of the assembled floating backup ring arrangement, to show more detail. The metal backup ring has a slight amount of axial clearance with respect to the bulkhead housing and retainer, to assure freedom of lateral motion. When O-rings alone are used as the face sealing elements, they are prone to pressure related failure when exposed to extreme high pressure due to the magnitude of the pressure and resulting pressure-related component deformation.

Each of the three face sealing elements consist of an O-ring and a plastic backup ring. The plastic backup rings have L-shaped cross-sections. The short legs of the plastic backup rings ensure that the annular gaps between the plastic backup rings and the radially facing groove walls close when the O-rings are exposed to lubricant pressure. The plastic backup rings bridge the axial clearance between the metal backup ring and the mating surfaces of the bulkhead and retainer, protecting the O-rings from high pressure extrusion damage, and ensuring the O-rings don’t become the weak point of the assembly.

The plastic backup rings have much lower friction than O-rings. This reduces the load on the journal bearing portion of the metal backup ring and reduces motional wear of the metal backup ring and the retainer.

Groove dimensions for existing sizes of plastic backup rings are provided by the seal catalog portion of our website. Additional backup ring sizes can be furnished upon request. For sales and technical support, contact our staff.

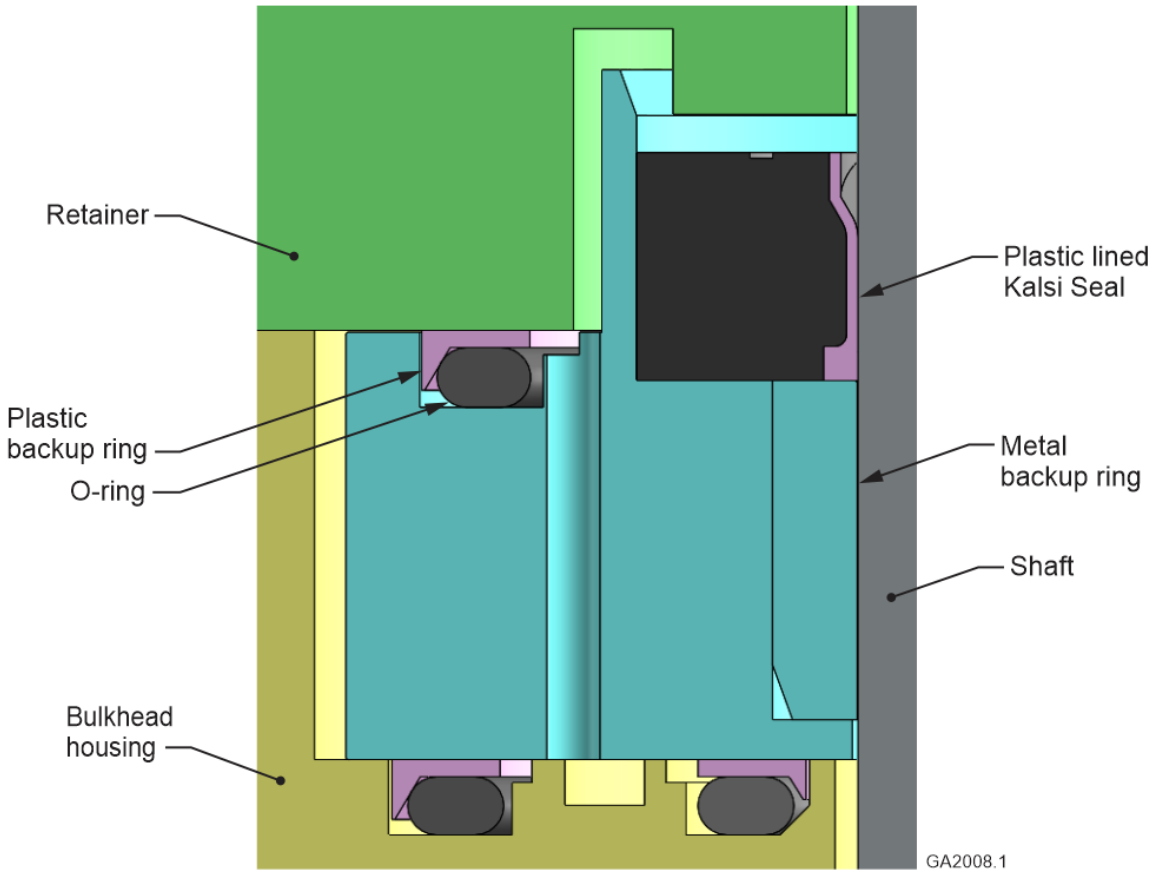


Figure 4

Enlargement of the high pressure seal arrangement

This enlargement of the assembled high pressure seal arrangement shows that the short legs of the plastic backup rings are interposed between the O-rings and the axial component clearances that are being bridged. Pressure acting through the O-rings deflects the short legs of the plastic backup rings against the mating groove walls, eliminating clearances and preventing O-ring extrusion damage.

Assembly of the high pressure seal arrangement

Figure 5 is an enlargement of the high pressure sealing arrangement during assembly, before the housing bolts are tightened and compress the O-rings. At this point of the assembly, the short legs of the L-shaped cross-sections keeps the backup rings aligned with the grooves.

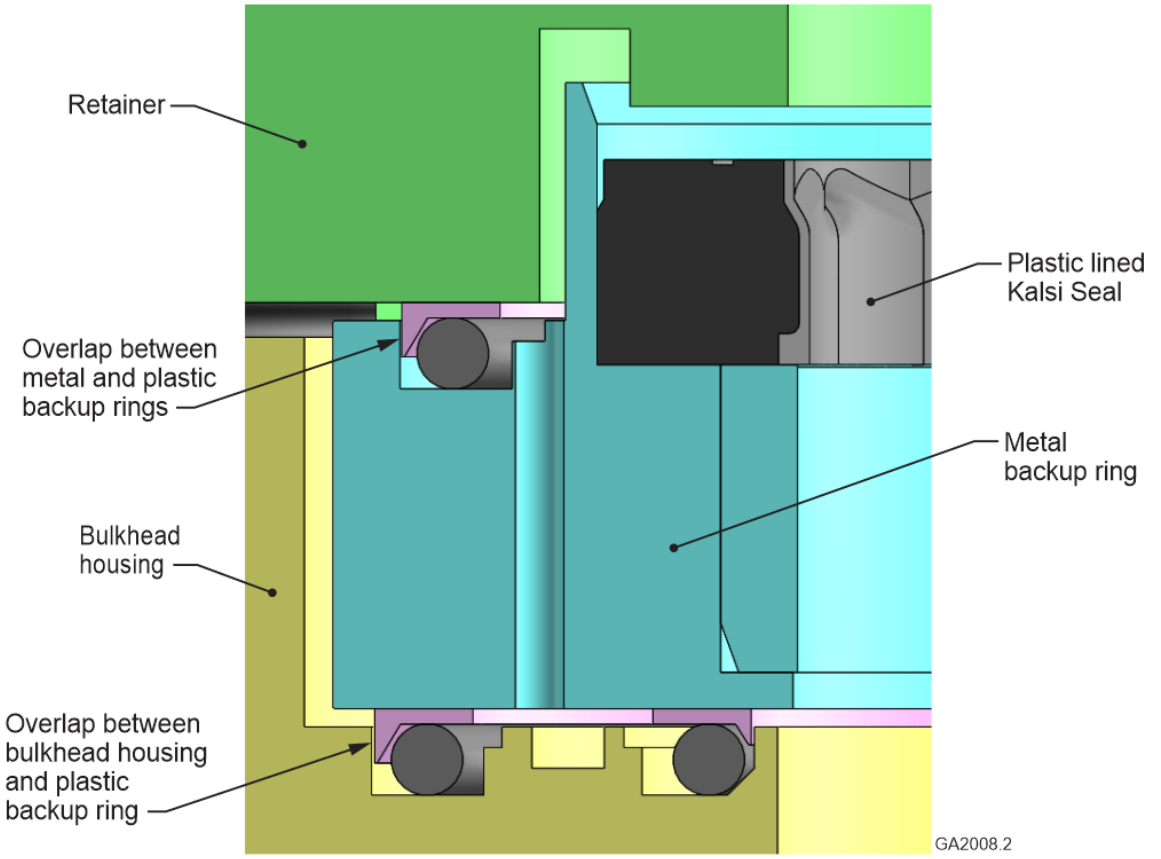


Figure 5

Assembly of the high pressure seal arrangement

This is an enlargement of the high pressure seal arrangement during assembly. The short legs of the plastic backup rings overlap with and engage the seal grooves when the O-rings are uncompressed. This engagement keeps the plastic backup rings aligned with the grooves during assembly, so they are not pinched between the metal backup ring and the mating surfaces of the bulkhead and retainer housings.