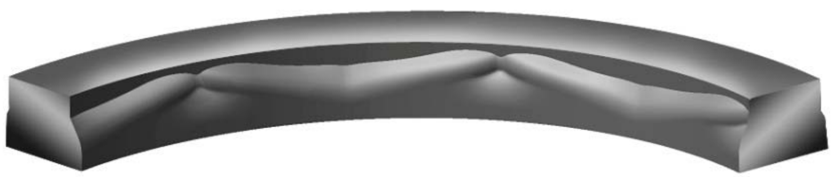
Chapter C5

Enhanced Lubrication Kalsi Seals



Revision 11 April 4, 2022

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

1. Introduction to Enhanced Lubrication Seals

Enhanced Lubrication Seals[1] (Figure 1) are a family of elastomeric high-performance rotary seals for either direction of rotation. They use an advanced hydrodynamic wave that reduces running torque and seal generated heat by providing a more aggressive hydrodynamic pumping action. This allows the use of wider sealing lips that offer more resistance to common seal damage mechanisms, and allows the use of lower viscosity lubricants, compared to more conventional Kalsi Seals.

Enhanced Lubrication Seals are used as high-pressure oil seals and are also used as process fluid-to-lubricant partitioning seals[2] in equipment where the lubricant is maintained at a pressure that is greater than the pressure of the process fluid.

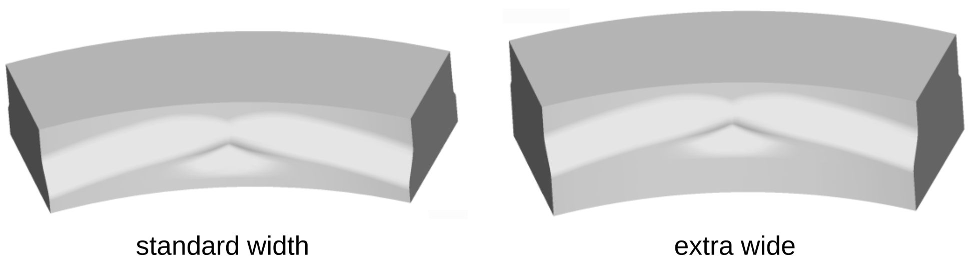


Figure 1

Enhanced Lubrication Seals

The Enhanced Lubrication Seal is an elastomeric high-performance rotary shaft seal that uses advanced hydrodynamic wave geometry to reduce running torque and seal-generated heat, even in high differential pressure conditions. Seal performance can be designed for specific operating conditions and application constraints. Various widths of dynamic sealing lips are available, ranging from narrow to extremely wide.

The Enhanced Lubrication (EL) waves have geometry attributes that can be tailored to influence interfacial lubrication and related hydrodynamic pumping related leakage. Several wave variations have been developed to achieve different performance goals. All the EL wave types provide increased performance, compared to the more conventional sine wave and zigzag wave shapes used on other elastomeric high-pressure seal designs.

Because of the wide range of performance that can be achieved, seals with EL waves are applicable to a wide range of applications. Examples of relevant oilfield seal applications

1 "Enhanced Lubrication Seals" and "Enhanced Lubrication Seal" are trademarks of Kalsi Engineering, Inc. Covered by U.S. and foreign patents.

2 Partitioning seals are sometimes referred to as "mud seals".

include rotating control devices (RCDs), rotary steerable tools, mud motors, hydraulic swivels, coring swivels, cement swivels, and high-pressure washpipe assemblies.

2. Enhanced Lubrication wave options

The geometry attributes of EL waves can be varied to provide lubrication ranging from performance near that of conventional Kalsi Seals all the way up to performance near the theoretical limits of full film hydrodynamic lubrication. Hydrodynamic pumping related leakage increases with lower pressure or temperature; plan the size of your lubricant reservoir accordingly.

Four EL wave variations are available. The waves vary in pressure capacity and hydrodynamic pumping related leak rate (higher pressure capacity and lower torque with higher leakage). These EL wave types can be combined with more conventional zigzag waves to make Hybrid Seals. The inclusion of zigzag waves reduces the hydrodynamic pumping related leak rate further while still providing improved interfacial lubrication over a seal that only has zigzag waves. See Table 1 for the available EL wave types.

Wave Type	Leak Rate Order	Pressure Capacity Order	Seal Friction Order	Dynamic Lip Width Limit
A	highest ↑	highest ↑	lowest ↑	Super Wide
B				Super Wide
F				Super Wide
C	↓ lowest	↓ lowest	↓ highest	Extra Wide

Table 1

Available Enhanced Lubrication wave types and their relative hydrodynamic pumping related leak rates with seals constructed entirely from elastomer (not applicable to plastic lined Kalsi Seals).

Identifying Wave Type

Enhanced Lubrication and Hybrid seals are marked with the wave type on the inside diameter of the seal body, as shown in Figure 2. Verification of the wave type marking should be performed during seal installation, because EL and Hybrid Seals available in several wave types for some shaft diameters.

Figure 2

EL wave types are identified with the corresponding letter on the inner body surface of the rotary shaft seal. Sometimes this identification is on the lubricant end of the seal.

3. Dynamic lip width options

As shown by Figure 3, EL Kalsi Seals can be manufactured with various widths of dynamic sealing lips. In general, wider lip widths provide additional sacrificial material to accommodate abrasive wear and high-pressure extrusion damage, at the expense of increased breakout and running torque and seal-generated heat. Wider lips also provide more structural strength to resist high pressure extrusion damage, which makes them desirable for high pressure rotary shaft seal applications such as oilfield RCDs, where housing-to-shaft extrusion gaps tend to be relatively large.

The following list is intended to provide guidance in selecting the lip width that is best suited for your application. Contact our staff for additional assistance.

- *Standard Lip Width* – The standard lip width is intended for applications that require less breakout torque than is possible with wider lips.
- *Wide Footprint Lip Width* – Wide Footprint EL seals are intended for general lubricant pressure retention and partitioning seal service.
- *Extra Wide Lip Width* – The extra wide EL seal (Figure 4) has a dynamic lip that is significantly wider than that of Wide Footprint EL seals. Extra wide seals are recommended as high-pressure oil seals — particularly in applications such as RCDs that may have larger than desirable housing-to-shaft extrusion gap clearance. These heavy-duty seals are also recommended as partitioning seals. Moderate viscosity lubricants are required in rotary shaft seal assemblies that combine high pressure sealing with higher speed.
- *Super Wide Lip Width* – The super wide EL seal has a dynamic lip that is significantly wider than that of Extra Wide EL seals. Super Wide seals are

recommended as partitioning seals in slower speed applications, such as oilfield power swivels.

Figure 3

Available dynamic lip widths

Enhanced Lubrication Seals are available in most wave types with the lip widths that are illustrated here. Wider dynamic lips provide more sacrificial material to accommodate common axially acting seal wear mechanisms.

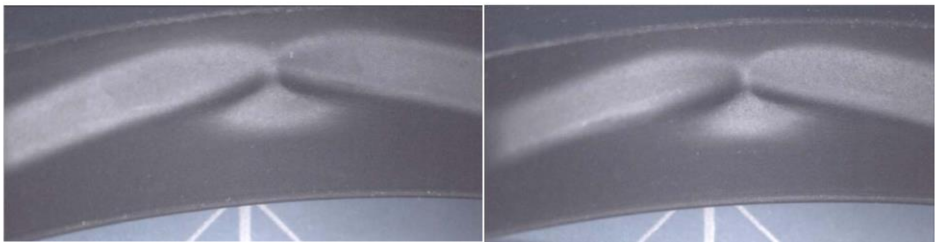


Figure 4

Used extra-wide Enhanced Lubrication Seals

These 655-4-11 seals are from the un-cooled test "568 Evaluation #61". They were tested at 34.56 ft/minute (.18 m/s) with an ISO 32 viscosity grade lubricant at pressures from 16 to 1760 psi (0.11 to 12.1 MPa), for a total of 137.8 hours. Despite the thin lubricant and slow speed, seal lubrication was excellent.

For available seal sizes, visit kalsiseals.com.

4. Seal construction options

When Enhanced Lubrication Seals are used to partition a process fluid from a lubricant, single durometer construction is recommended. Dual durometer construction (Figure 5) is desirable when Enhanced Lubrication Seals are used as high-pressure oil seals.

The outer part of a dual durometer seal is made from a relatively soft elastomer. The inner part of the seal is lined with a harder, more extrusion resistant elastomer. This high-performance shaft seal design provides the extrusion resistance benefit of the harder material, without a corresponding increase in interfacial contact pressure.

The as-molded diameter of a dual durometer seal depends on the molding shrinkage characteristics of the selected material combination, and the shrinkage correction factor a specific mold has been designed for. At present, most EL tooling is designed for -10 and -11 materials. Dedicated tooling for a specific diameter and material combination can be built if necessary.

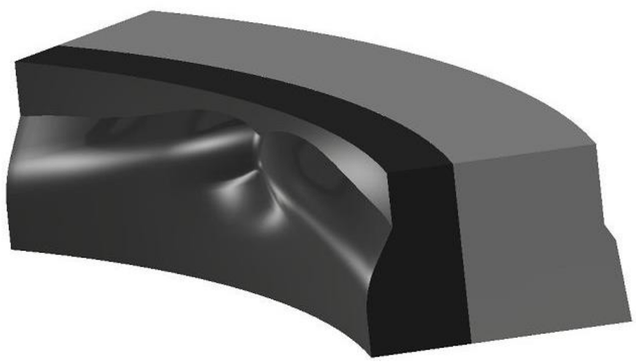


Figure 5
Dual Durometer Seals

The Dual Durometer Kalsi Seal employs composite construction. The outer material is softer than the inner material, to reduce interfacial contact pressure. This high-pressure seal design reduces torque and seal generated heat and improves extrusion resistance.

5. Cross-sectional size options

Enhanced Lubrication Seals are manufactured in a variety of radial cross-sectional sizes. Larger cross-sectional sizes have performance advantages over smaller cross-sectional sizes. For example, larger cross-sectional sizes:

- Have less contact pressure when used at the same dimensional compression as a smaller cross-section seal, for less breakout torque.
- Have more dimensional compression when compressed to the same contact pressure as a smaller cross-section seal. This extra compression is useful in accommodating wear and shaft deflection.
- Have more circumferential strength, which means less risk of breakage in large diameter seal applications.

6. Introduction to Kalsi Seal torque and rotary leakage test results

The rotary seal tests reported in this section were designed to capture the upper bound hydrodynamic pumping related leakage (lower temperature testing) and seal lubrication and pressure sealing capability (higher temperature, higher pressure testing). The range of test parameters such as temperature, pressure, speed, and lubricant were selected to be applicable to a wide set of applications. However, we are not able to test for every set of rotary shaft seal operating conditions. For applications that are not bracketed by the testing presented, or for applications that require accurate hydrodynamic pumping related leakage prediction, contact Kalsi Engineering for input or additional test data.

A list of the EL seals tested, and their basic dimensions, are given in Table 2. The hydrodynamic pumping related leakage of the EL seal is sensitive to wave type and number, seal material, temperature, surface speed, pressure, extrusion gap size, and dynamic lip width. A 0.02-inch diametric extrusion gap was used in the tests reported in this chapter unless otherwise noted. The number of EL waves increases with seal diameter and is determined by dividing the seal inside diameter in inches by 0.3125.

Seal Part No.	Radial Cross-Section (CS) inch	EL Wave Type	Footprint width
568-24-11 & 106	0.335	A	Standard
568-39-11	0.335	B	Standard
568-43-10, 11, 15	0.335	C	Standard
568-152-30	0.186	A	Standard
568-156-30	0.145	A	Standard
641-7-11	0.345	F	Wide Footprint
655-4-11	0.335	A	Extra Wide
655-29-11	0.335	F	Extra Wide
655-7-11	0.335	F	Extra Wide
660-1-11	0.345	C	Wide Footprint (1.75X)
739-1-11	0.335	F	Super Wide
655-37-11	0.345	C	Extra Wide

Table 2

This table shows the part numbers of the rotary shaft seals that were tested to obtain the data presented in this chapter.

7. Standard width and Wide Footprint single durometer test results

Single durometer construction is normally recommended when the seal is running directly against an abrasive media such as drilling mud.

Type A wave

Figures 6 through 10 show the hydrodynamic performance of the Type A EL Seal at various operating conditions. From Figures 6 through 8 it is clear that the leakage is sensitive to changes in temperature (lubricant viscosity) and velocity.

The leakage, per EL wave, between a 50% wider Wide Footprint Hybrid and standard width Hybrid Seal, and between 0.335 inch (8.51 mm) and 0.305 inch (7.75 mm) radial CS seals does not vary significantly, therefore, the same leakage bound, used for predicting EL leakage, is appropriate for EL/Hybrid seals of lip widths and radial cross-sections within this range.

For 85 durometer HNBR seals (-11 material) one can see (Figure 9) that with an ISO 320 VG lubricant at low to moderate pressure, the hydrodynamic leakage varies significantly. The hydrodynamic leakage tapers off dramatically at pressures above 1,000 psi (6.9 MPa).

Figure 10 shows the hydrodynamic pumping related leakage for the type A wave with a -11 HNBR seal material tested at 345 ft/minute (1.75 m/s) at 162°F (72.2°C) using an ISO 32 viscosity grade lubricant.

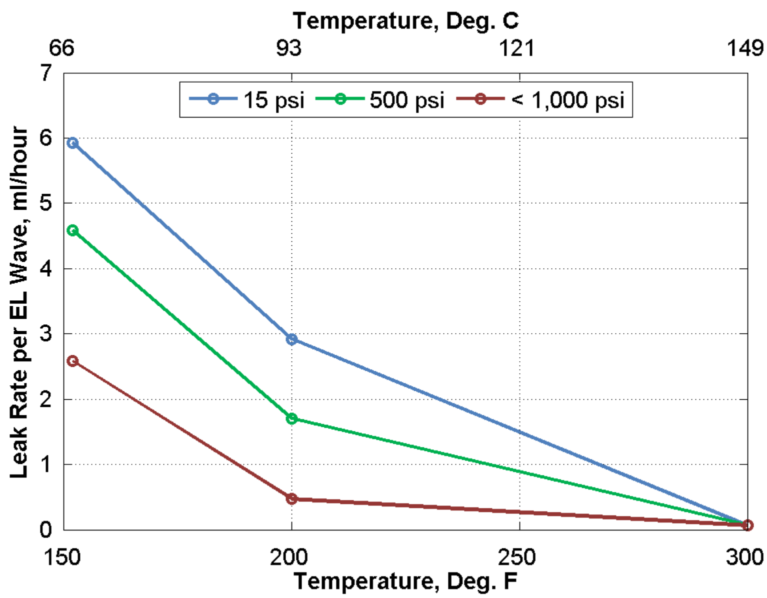


Figure 6

Upper bound hydrodynamic leakage characteristics for a type A wave with a -11 HNBR seal material tested at 346 ft/minute (1.76 m/s) using an ISO 320 VG lubricant. The number of EL waves varies with seal diameter.

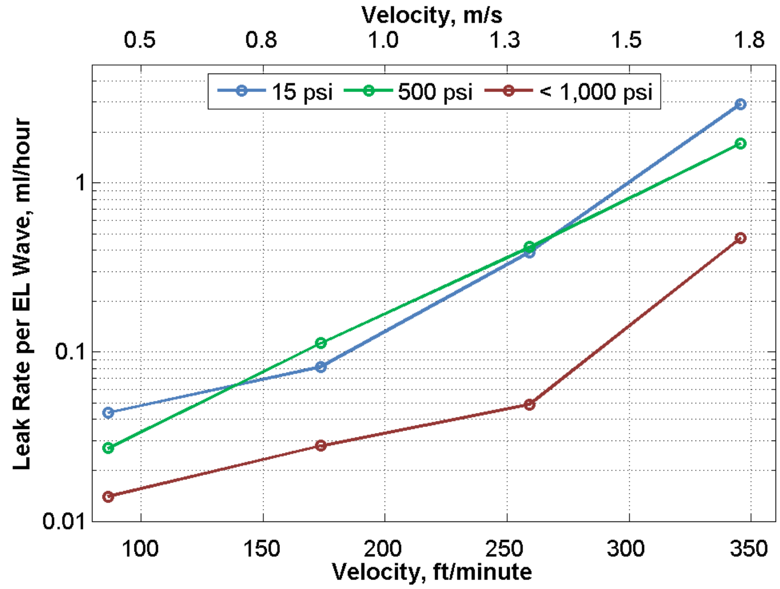


Figure 7

Upper bound hydrodynamic leakage characteristics for a type A wave with a -11 HNBR seal material tested at 200°F (93.33°C) using an ISO 320 VG lubricant. The number of EL waves varies with seal diameter.

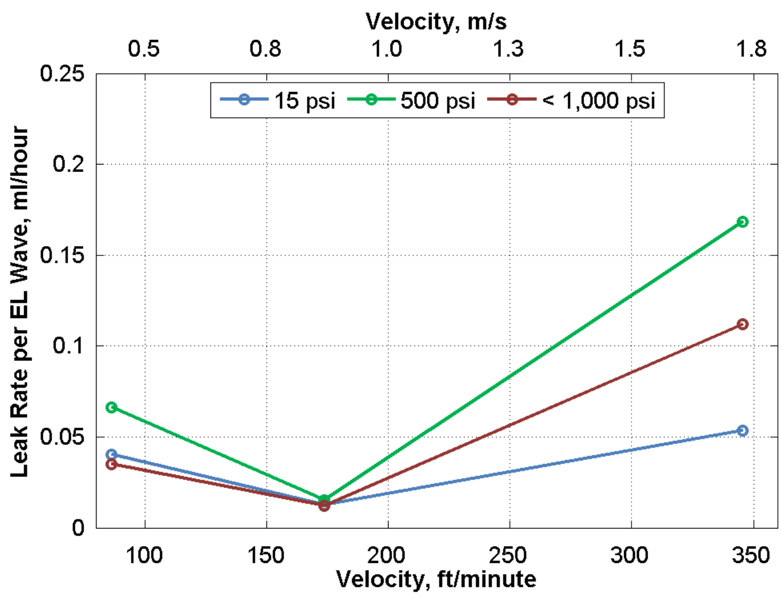


Figure 8

Upper bound hydrodynamic leakage characteristics for a type A wave with a -11 HNBR seal material tested at 300°F (149°C) using an ISO 320 VG lubricant. The dip in leak rate at 173 ft/minute is due to the test set up. The number of EL waves varies with seal diameter.

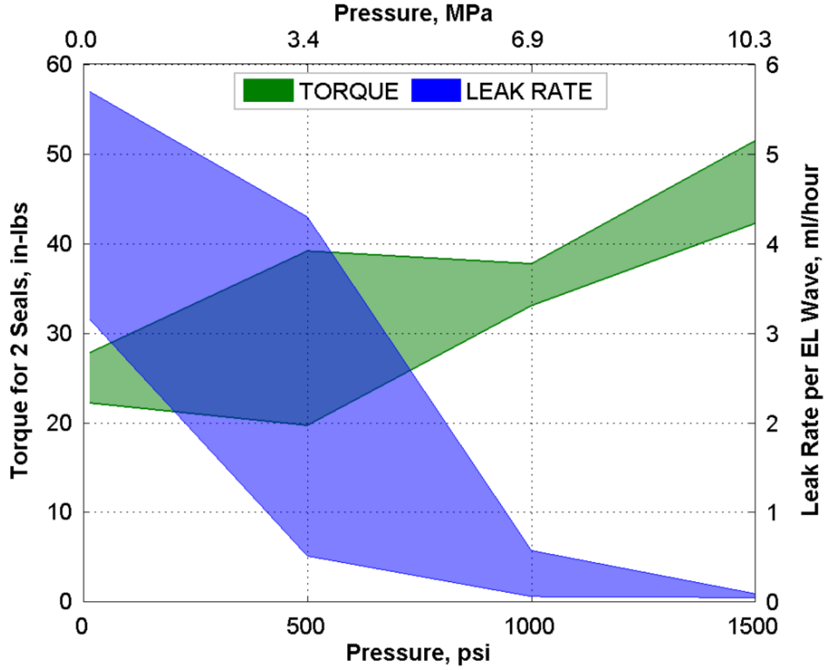


Figure 9

Hydrodynamic torque and leakage characteristics for a pair of 2.75" (69.85 mm) ID, PN 568-24-11 type A EL seals tested at 346 ft/minute (1.76 m/s) using an ISO 320 VG lubricant at 162ºF (72.2ºC).

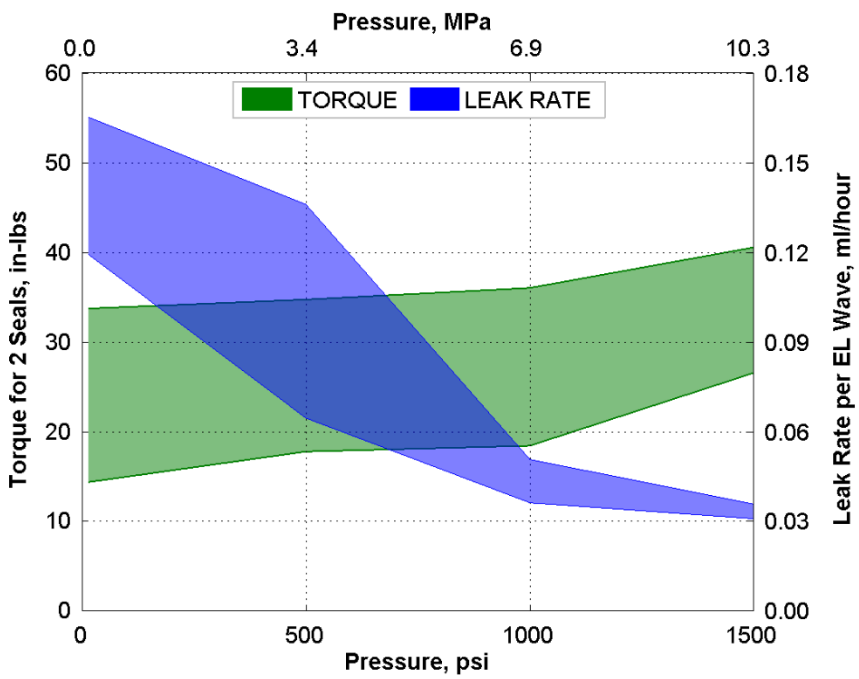


Figure 10

Hydrodynamic torque and leakage characteristics for a pair of 2.75" (69.85 mm) ID, PN 568-24-11 type A EL seals tested at 346 ft/minute (1.76 m/s) using an ISO 32 VG lubricant at 162ºF (72.2ºC).

For available seal sizes, visit kalsiseals.com.

Type B wave

Figure 11 shows the leakage for the type B wave with a -11 HNBR seal material tested at 346 ft/minute (1.76 m/s) using an ISO 320 VG lubricant at various temperatures. For this condition, the Type B hydrodynamic pumping related leakage is one third that of the Type A wave.

Type F wave

In a 300 psi (2.07 MPa) 252 ft/minute (1.28 m/s) test of -11 Type F Wide Footprint Enhanced Lubrication seals with an ISO 150 viscosity grade lubricant at 120°F (48.9°C), leakage was 0.52 ml/hr per wave. This test was done to evaluate the use of such seals as partitioning seals in lower operating temperature conditions.

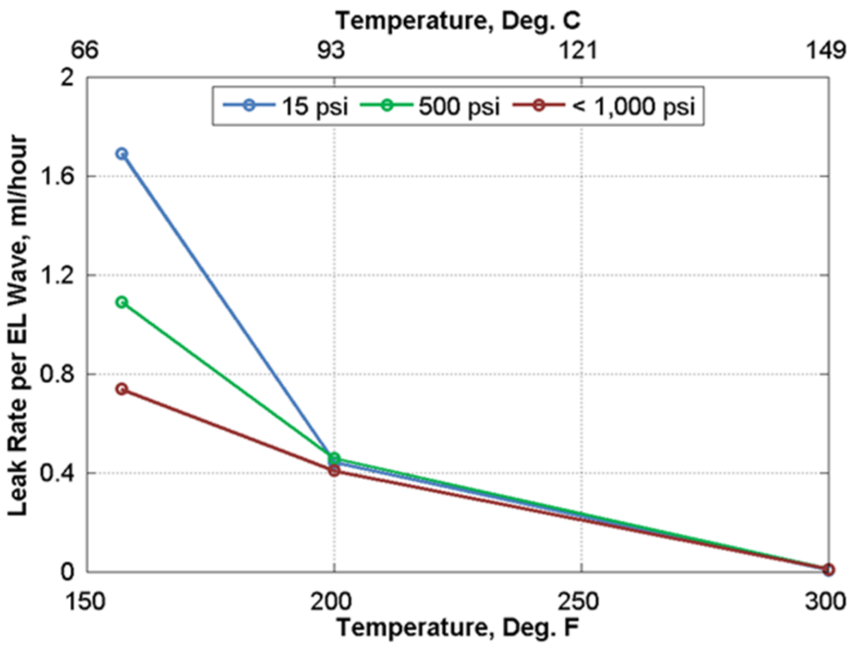


Figure 11

Hydrodynamic leakage characteristics for a type B wave with a -11 HNBR seal material tested at 346 ft/minute (1.76 m/s) using an ISO 320 VG lubricant. The number of EL waves varies with seal diameter.

Type C wave

The Type C wave has the lowest hydrodynamic pumping related leakage of the various EL types and lubricates significantly better than the sine wave and zigzag wave patterns. This increase in lubrication allows the Type C EL Seal to operate in conditions that a zigzag seal cannot. It was developed to have a leak rate that is compatible with practical reservoir sizing in oilfield downhole drilling tools. For reservoir sizing purposes, use the leakage data for the lowest anticipated long-term operating temperature.

Figures 12 through 23 show the hydrodynamic performance of the EL Seal with a Type C wave at various operating conditions.

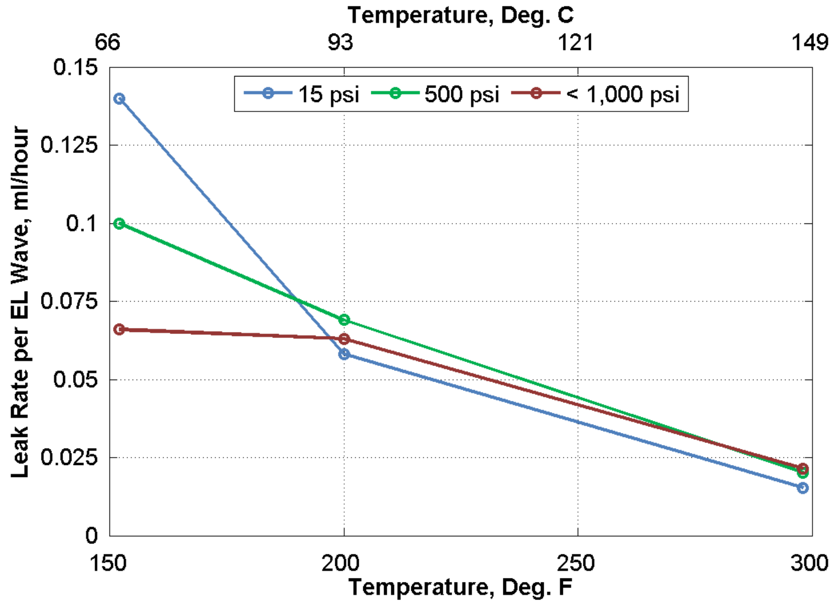


Figure 12

Hydrodynamic leakage characteristics for a type C wave with a -11 HNBR seal material tested at 346 ft/minute (1.76 m/s) using an ISO 320 VG lubricant. The number of EL waves varies with seal diameter.

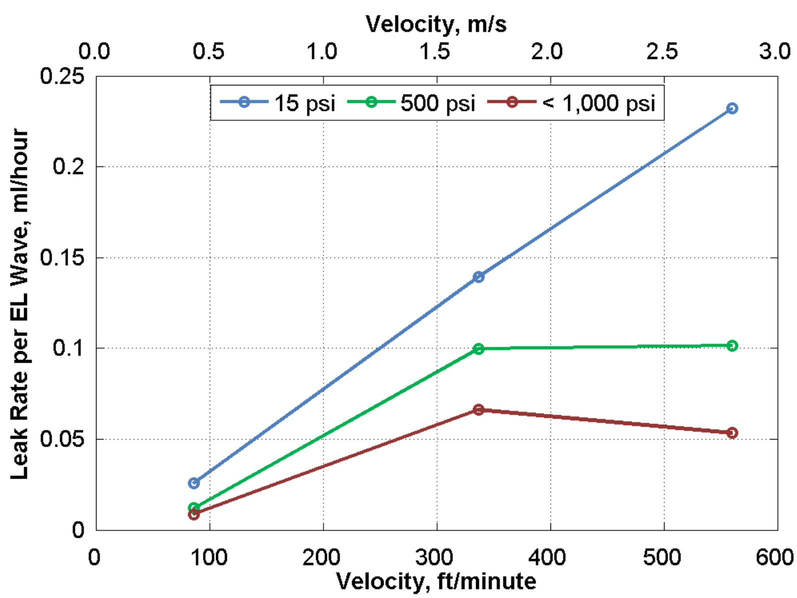


Figure 13

Hydrodynamic leakage characteristics for a type C wave with a -11 HNBR seal material tested at 155°F (68.3°C) using an ISO 320 VG lubricant. The number of EL waves varies with seal diameter.

For available seal sizes, visit kalsiseals.com.

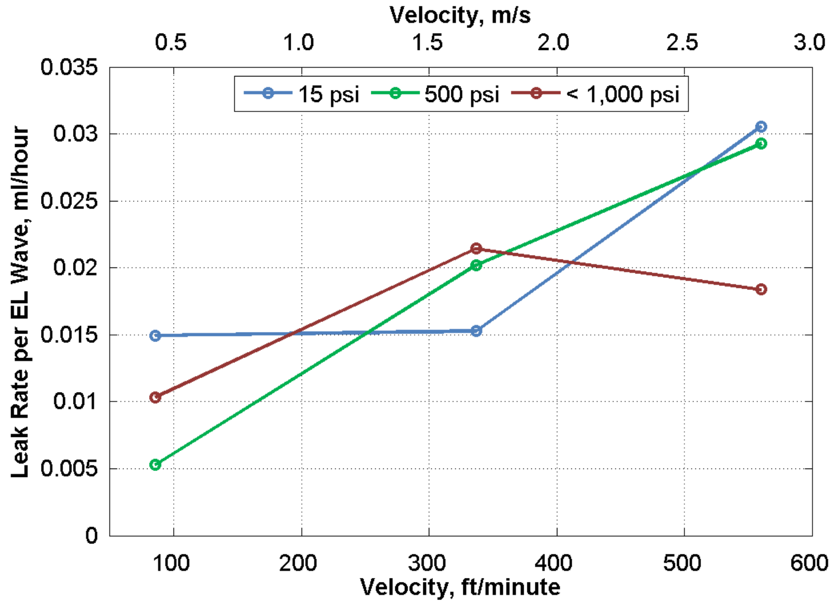


Figure 14

Hydrodynamic leakage characteristics for a type C wave with a -11 HNBR seal material tested at 300°F (149°C) using an ISO 320 VG lubricant. The number of EL waves varies with seal diameter.

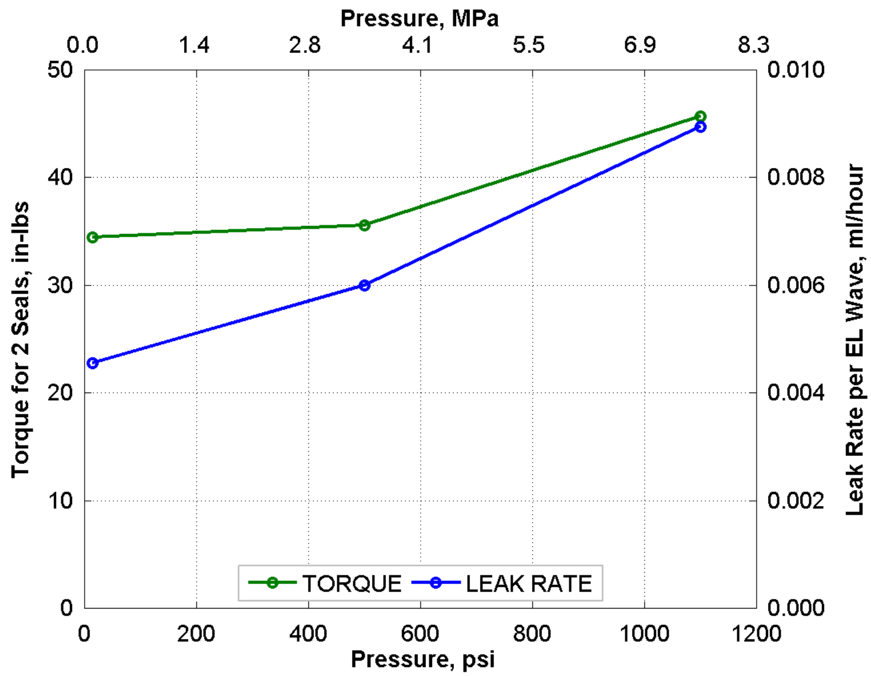


Figure 15

Hydrodynamic torque and leakage characteristics for a pair of 2.75" (69.85 mm) ID, PN 568-43-11 type C EL seals tested at 264 ft/minute (1.34 m/s) with an ISO 32 VG lubricant at 250ºF (121ºC).

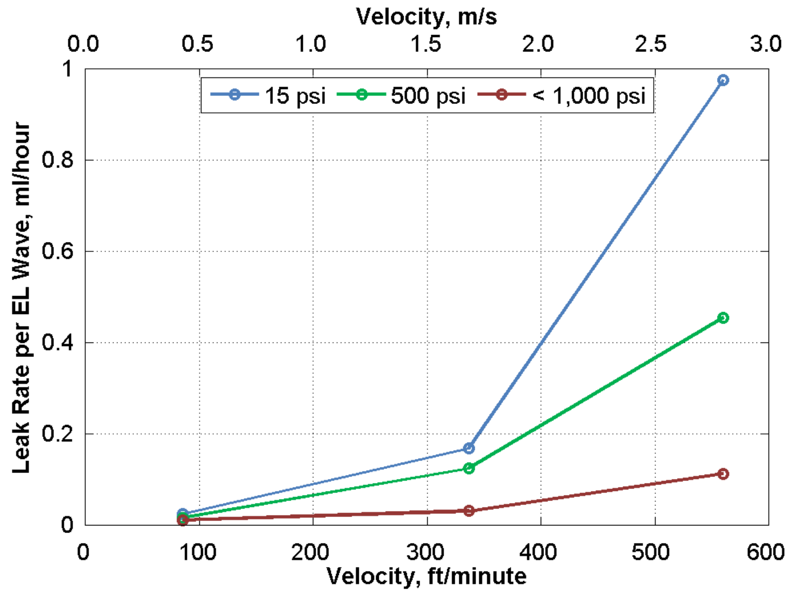


Figure 16

Hydrodynamic leakage characteristics for a type C wave with a -11 HNBR seal material tested at 150°F (65.6°C) using an ISO 460 VG lubricant. The number of EL waves varies with seal diameter.

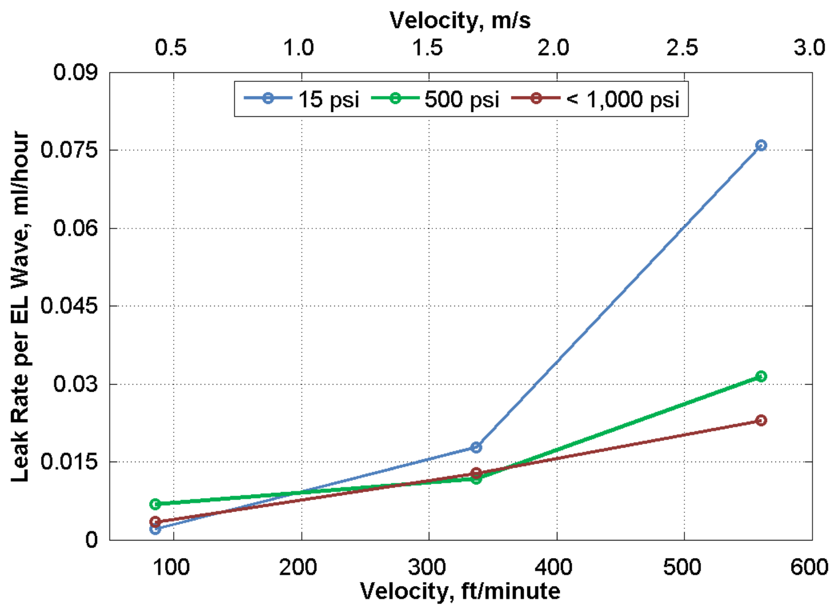


Figure 17

Hydrodynamic leakage characteristics for a type C wave with a -11 HNBR seal material tested at 155°F (68.3°C) using an ISO 32 VG lubricant. The number of EL waves varies with seal diameter.

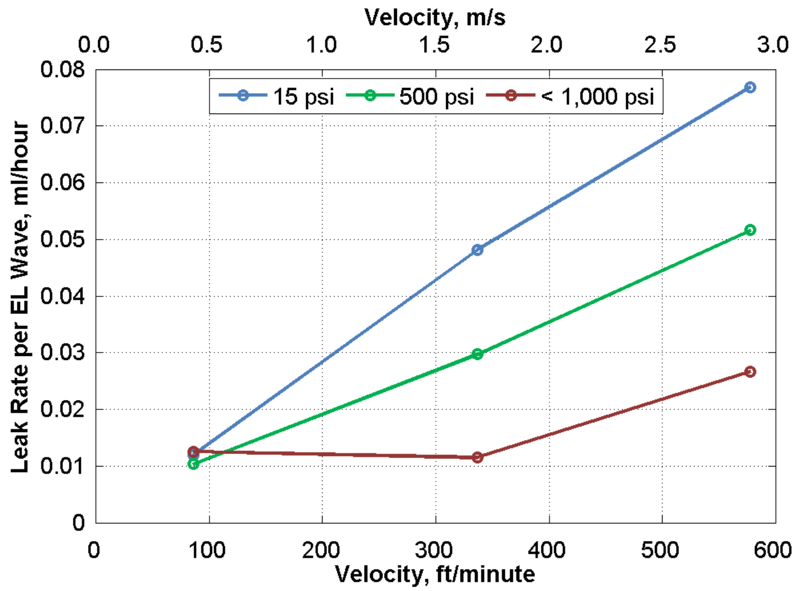


Figure 18

Hydrodynamic leakage characteristics for a type C wave with a -11 HNBR seal material tested at 155°F (68.3°C) using an ISO 150 VG lubricant. The number of EL waves varies with seal diameter.

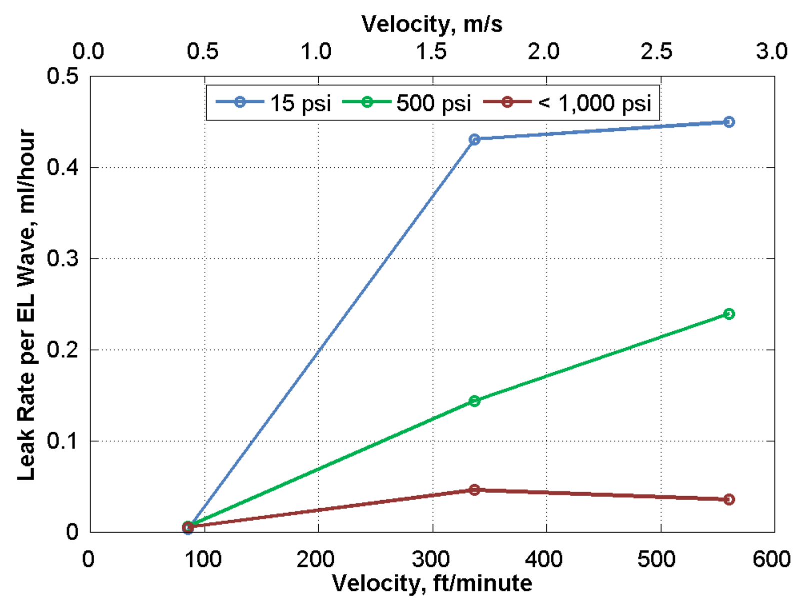


Figure 19

Hydrodynamic leakage characteristics for a type C wave with a -11 HNBR seal material tested at 160°F (71.1°C) using an ISO 680 VG lubricant. The number of EL waves varies with seal diameter.

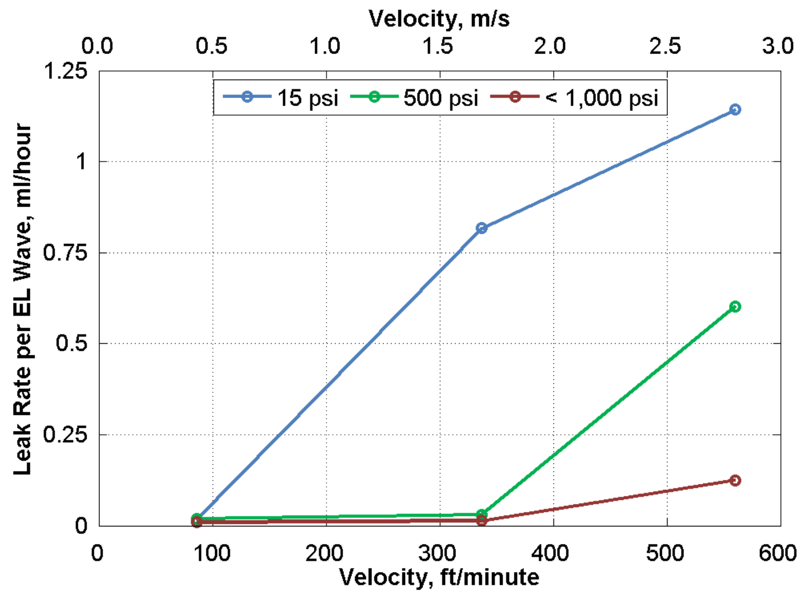


Figure 20

Hydrodynamic leakage characteristics for a type C wave with a -11 HNBR seal material tested at 155°F (68.3°C) using an ISO 1000 VG lubricant. The number of EL waves varies with seal diameter.

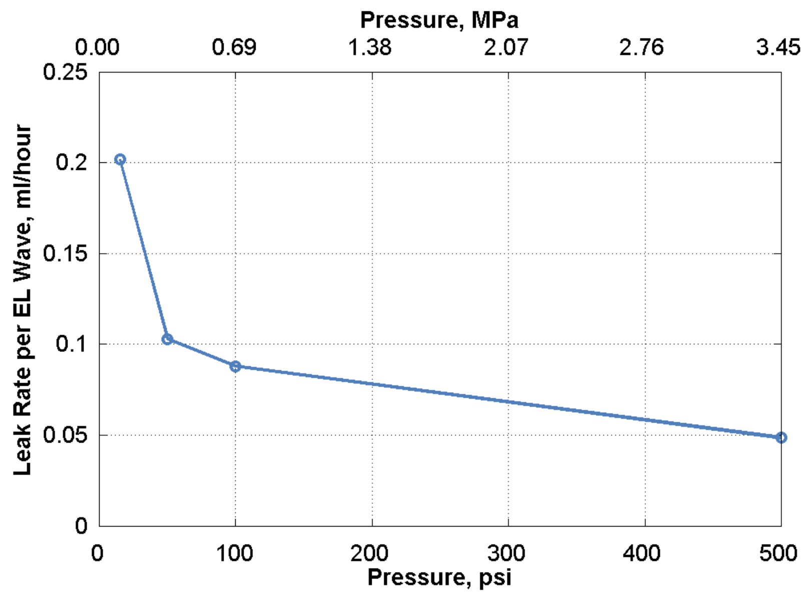


Figure 21

Hydrodynamic leakage characteristics for a type C wave with a -10 HNBR seal material tested at 346 ft/minute (1.76 m/s) using an ISO 150 VG lubricant at 155°F (68.3°C). The number of EL waves varies with seal diameter.

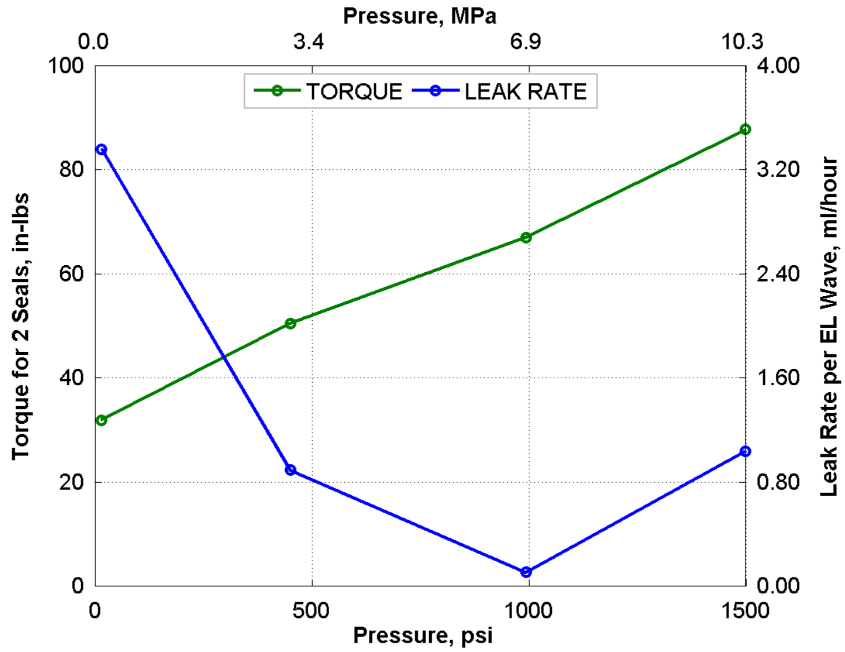


Figure 22

Hydrodynamic torque and leakage characteristics for a type C wave with a -15 HNBR seal material tested at 346 ft/minute (1.76 m/s) using an ISO 320 VG lubricant at 155°F (68.3°C). The number of EL waves varies with seal diameter.

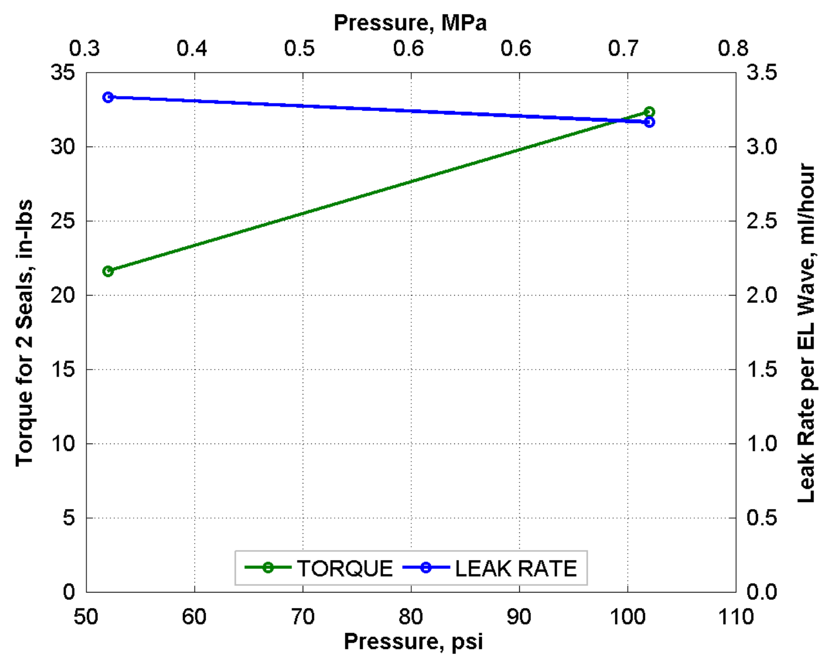


Figure 23

Hydrodynamic torque and leakage characteristics for a type C wave with a -30 FKM seal material tested at 346 ft/minute (1.76 m/s) using an ISO 680 VG lubricant at 155°F (68.3°C). The number of EL waves varies with seal diameter.

For available seal sizes, visit kalsiseals.com.

8. Standard width dual durometer test results

Type A wave

Figures 24 through 28 show the average running torque and leakage range for a pair of 2.75" (69.85 mm) ID, 0.335" (8.51 mm) radial cross-section dual durometer Kalsi Seals (-106 material) at various operating conditions.

The hydrodynamic leakage for dual durometer -106 seals, which have a higher modulus inner material than a -11 seal, does not taper off for higher viscosity lubricants at pressures above 1,000 psi (6.9 MPa) as dramatically as with the -11 EL seals.

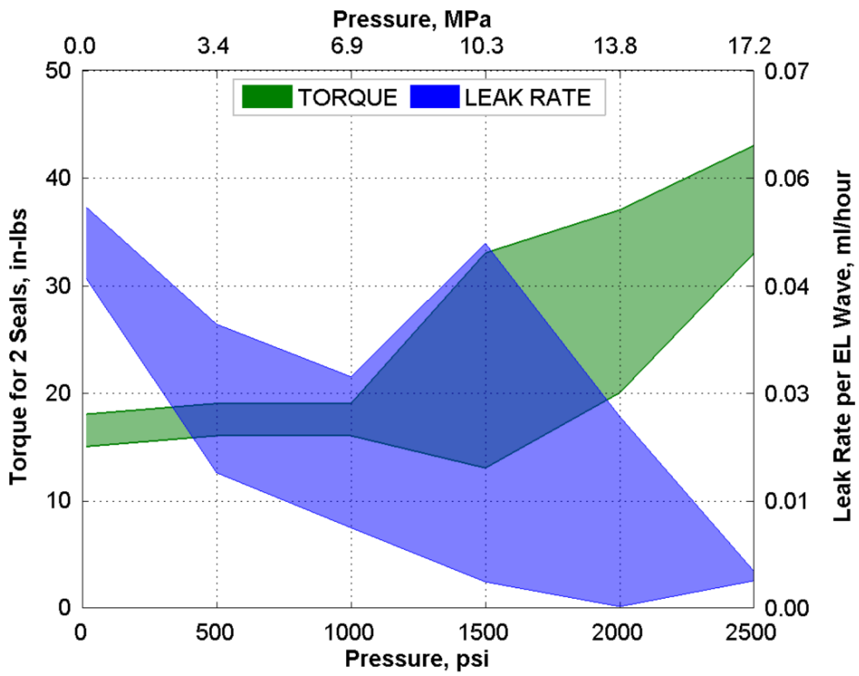


Figure 24

Hydrodynamic torque and leakage characteristics for a pair of 2.75" (69.85 mm) ID, PN 568-24-106 dual durometer type A EL seals tested at 39 ft/minute (0.2 m/s) using an ISO 32 VG lubricant at 162ºF (72.2ºC).

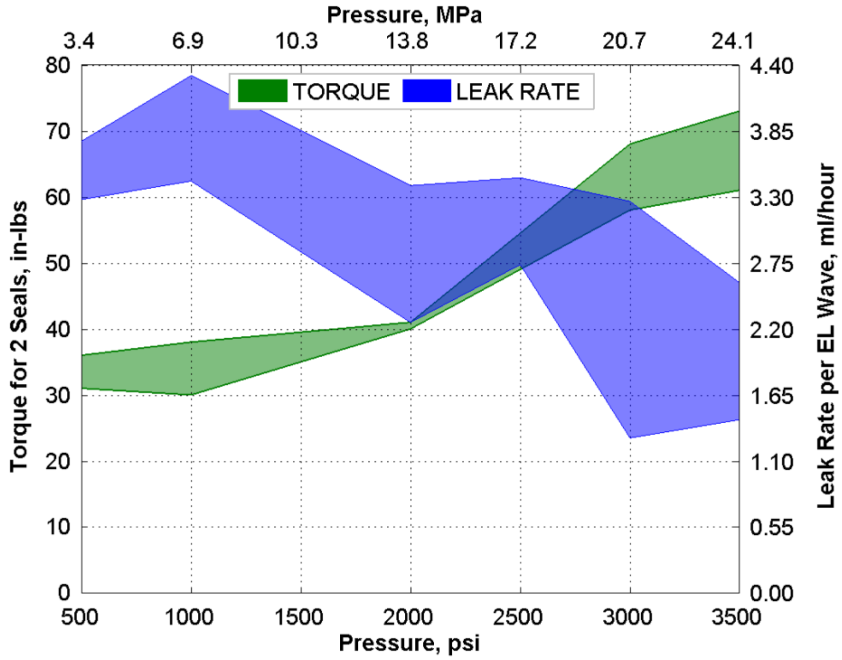


Figure 25

Hydrodynamic torque and leakage characteristics for a pair of 2.75" (69.85 mm) ID, PN 568-24-106 dual durometer type A EL seals tested at 576 ft/minute (2.93 m/s) with an ISO 220 VG lubricant at 162ºF (72.2ºC).

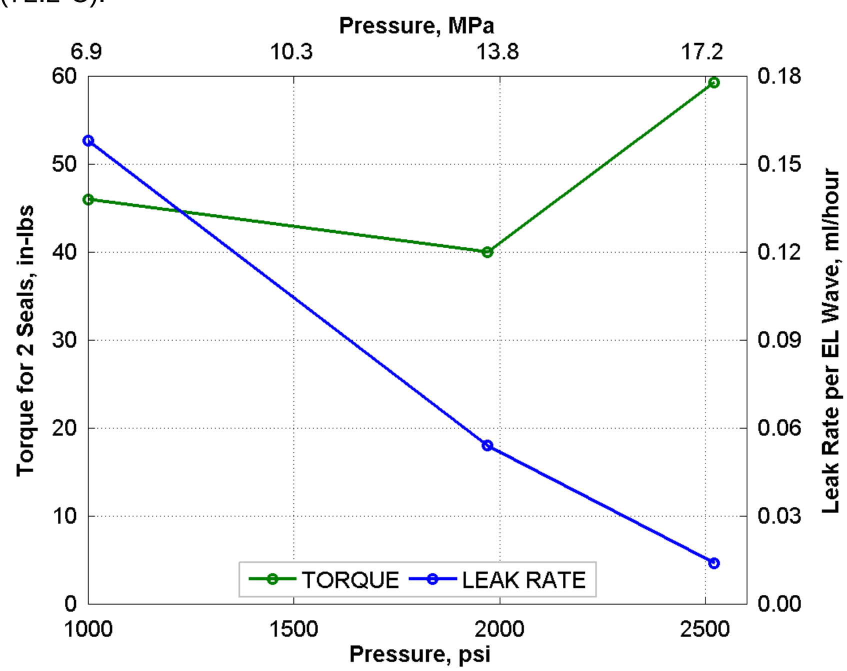


Figure 26

Hydrodynamic torque and leakage characteristics for a pair of 2.75" (69.85 mm) ID, PN 568-24-106 dual durometer type A EL seals tested at 576 ft/minute (2.93 m/s) with an ISO 32 VG lubricant at 162ºF (72.2ºC).

For available seal sizes, visit kalsiseals.com.

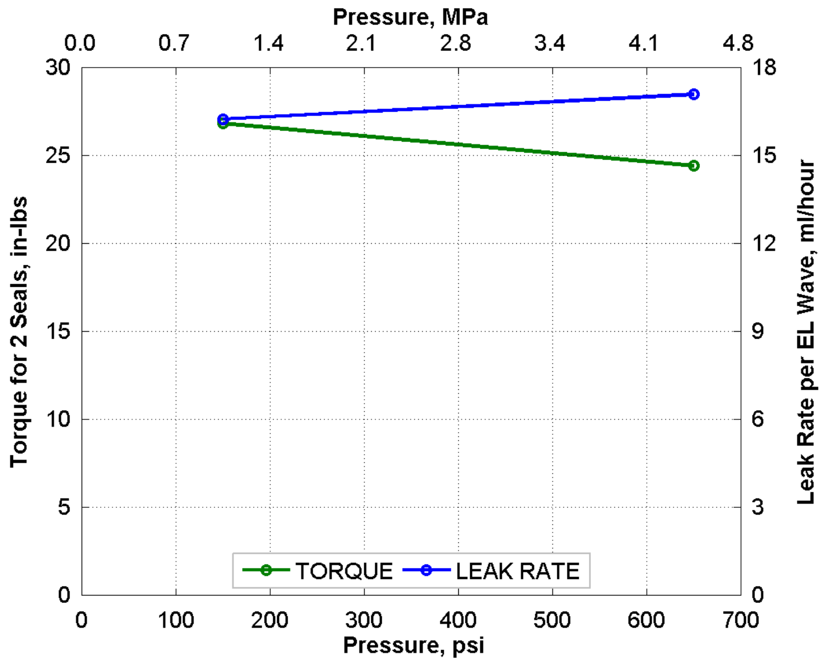


Figure 27

Hydrodynamic torque and leakage characteristics for a pair of 2.75" (69.85 mm) ID, PN 568-24-106 dual durometer type A EL seals tested at 576 ft/minute (2.93 m/s) with an ISO 320 VG lubricant at 155ºF (68.3°C).

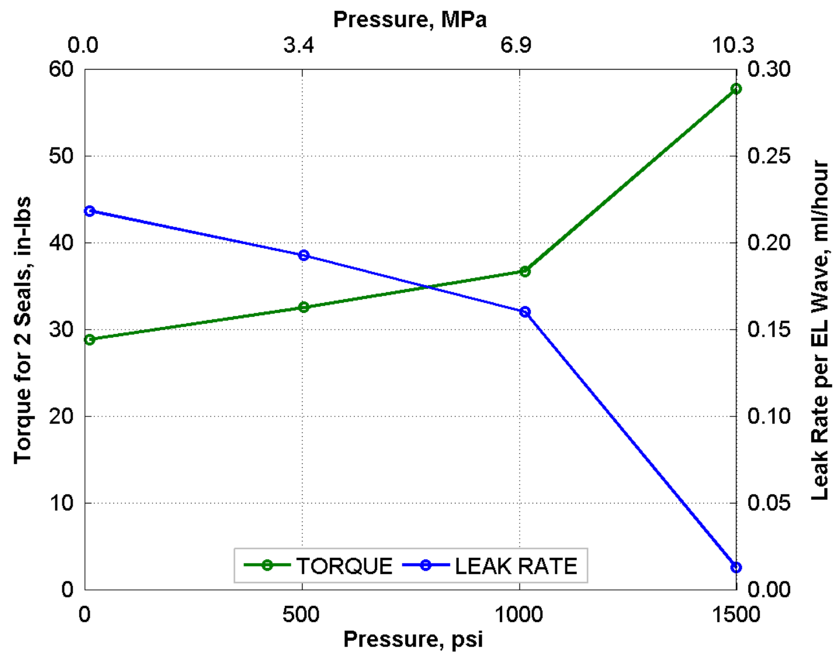


Figure 28

Hydrodynamic torque and leakage characteristics for a pair of 2.75" (69.85 mm) ID, PN 568-24-106 dual durometer type A EL seals tested at 86.4 ft/minute (0.439 m/s) with an ISO 1000 VG lubricant at 145ºF (62.8°C).

For available seal sizes, visit kalsiseals.com.

660 Series single durometer test results

The 660-series seal has the widest dynamic lip that fits on a 0.240" wide seal body – a lip width that is moderately but usefully wider than that of our wide footprint seals. The Type C wave lubricates the wider dynamic interface of the 660 series Wide Footprint Seal sufficiently for many high-pressure shaft seal operating conditions. It has less leakage than Type A or F Extra Wide seals. Although it does not have as much sacrificial material as the Extra Wide Seal it still has more than the standard width or typical Wide Footprint Seal.

Figure 29 shows the maximum recorded running torque and per wave leakage for a pair of 2.75" (69.85 mm) ID, 0.345" (8.51 mm) radial cross-section 660-1-11 seals at various operating conditions.

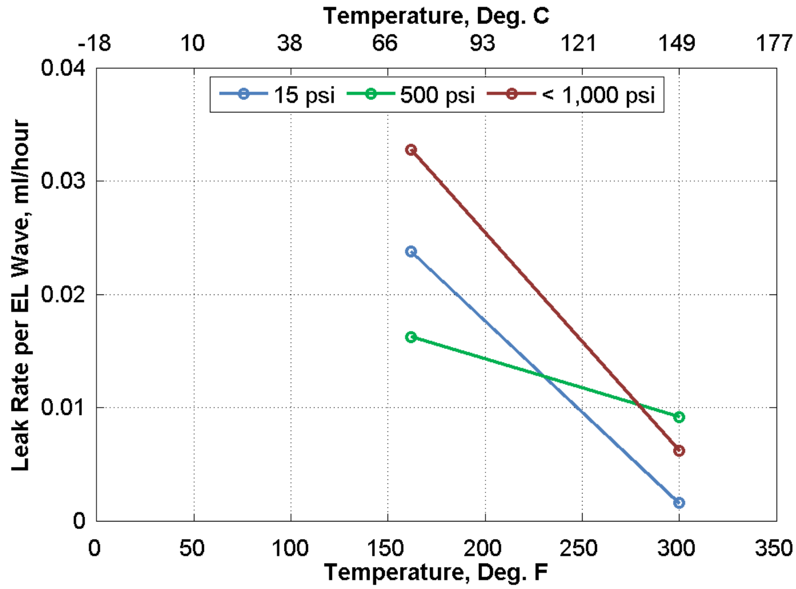


Figure 29

Hydrodynamic torque and leakage characteristics for a pair of 2.75" (69.85 mm) ID, PN 660-1-11 Wide Footprint Type C EL seals tested at 346 ft/minute (1.76 m/s) using an ISO 320 VG lubricant at a bulk temperature of 162°F (72.22°C) and 300°F (148.89°C).

9. Extra wide single durometer test results

The extra wide footprint configuration provides better extrusion damage resistance at high pressures or in rotary shaft seal assemblies where the extrusion gap is larger than ordinarily recommended. In addition to improved resistance to extrusion damage, there is 2.4 times more sacrificial material to tolerate other mechanisms that lead to seal failure. Applications with higher speed combined with high pressure require more cooling to dissipate the additional seal generated heat associated with the wider dynamic interface.

Type A wave

Figures 30 through 34 show the average running torque and leakage range for a pair of 2.75" (69.85 mm) ID, 0.335" (8.51 mm) radial cross-section extra wide Type A EL seals at various operating conditions.

Leakage increases at lower temperatures due to increased lubricant viscosity. In a 300 psi (2.07 MPa) 252 ft/minute (1.28 m/s) test of -11 Type A extra wide seals with an ISO 150 viscosity grade lubricant at 120°F (48.9°C), leakage was 3.67 ml/hr per wave. These results suggest that lower viscosity lubricants should be considered for cooler operating conditions, that wave types with lower leakage may be preferable for partitioning seals, and that reservoir size should take startup leakage into consideration.

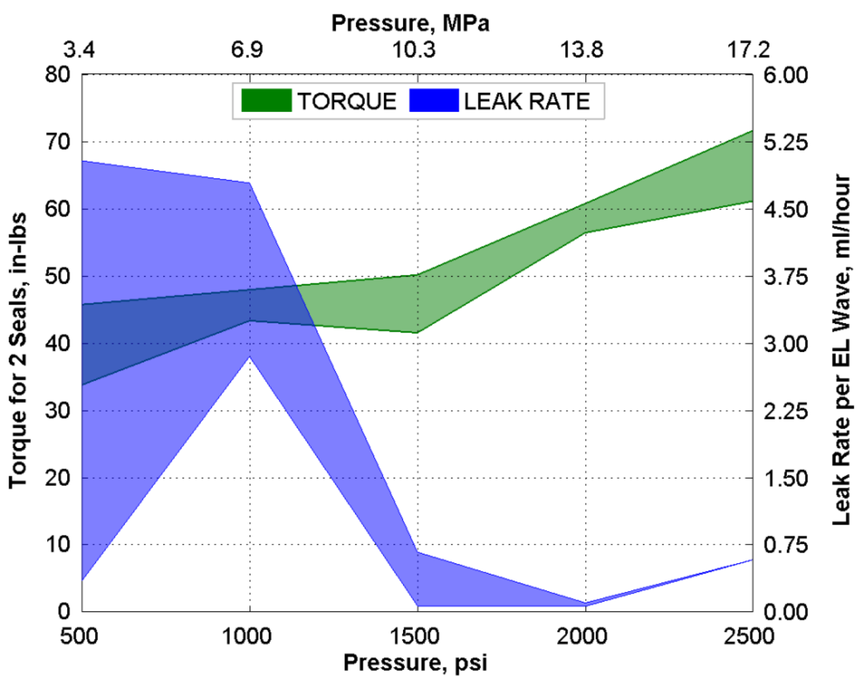


Figure 30

Hydrodynamic torque and leakage characteristics for a pair of 2.75" (69.85 mm) ID, PN 655-4-11 extra wide type A EL seals tested at 346 ft/minute (1.76 m/s) using an ISO 150 VG lubricant at 162ºF (72.2ºC).

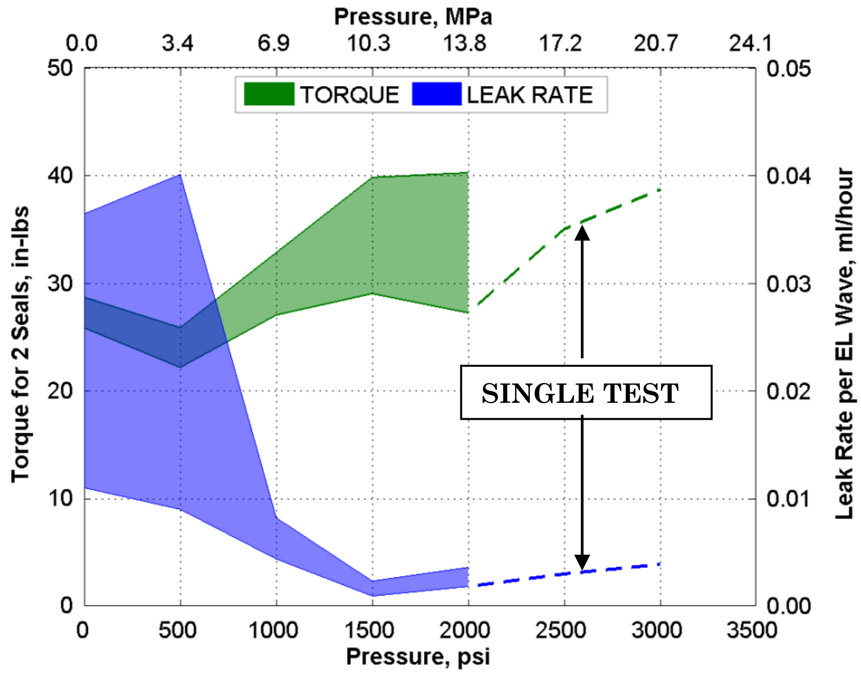


Figure 31

Hydrodynamic torque and leakage characteristics for a pair of 2.75" (69.85 mm) ID, PN 655-4-11 extra wide type A EL seals tested at 39 ft/minute (0.2 m/s) using an ISO 32 VG lubricant at 100ºF (37.8ºC).

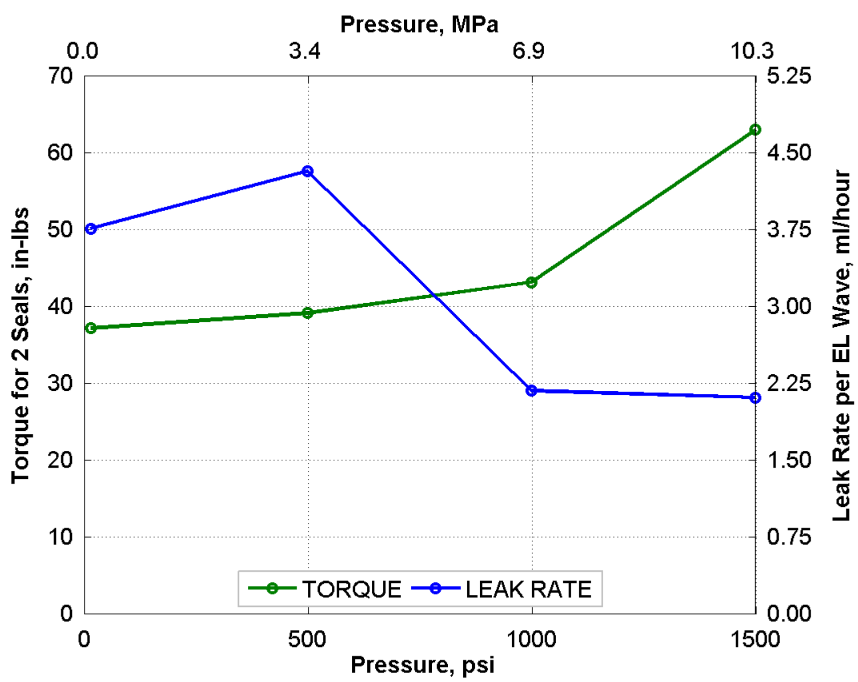


Figure 32

Hydrodynamic torque and leakage characteristics for a pair of 2.75" (69.85 mm) ID, PN 655-4-11 extra wide type A EL seals tested at 346 ft/minute (1.76 m/s) using an ISO 320 VG lubricant at 162ºF (72.2ºC).

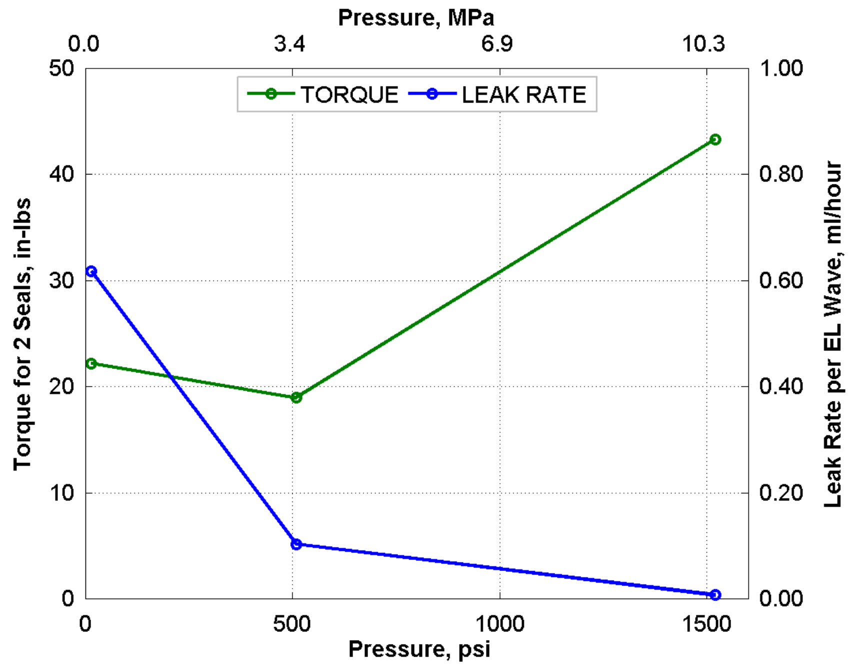


Figure 33

Hydrodynamic torque and leakage characteristics for a pair of 2.75" (69.85 mm) ID, PN 655-4-11 extra wide Type A EL seals tested at 46 ft/minute (.23 m/s) using an ISO 460 VG lubricant at 250ºF (121.1ºC).

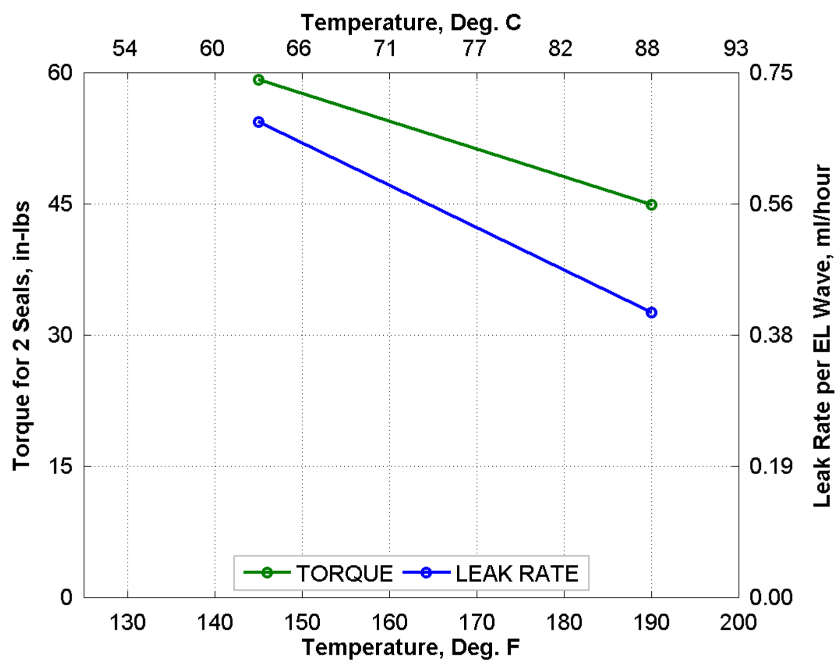


Figure 34

Hydrodynamic torque and leakage characteristics for a pair of 2.75" (69.85 mm) ID, PN 655-4-11 extra wide Type A EL seals tested at 252 ft/minute (1.28 m/s) and 300 psi (2.07 MPa) using an ISO 32 VG lubricant at various temperatures.

For available seal sizes, visit kalsiseals.com.

Type F wave

The Type F wave lubricates the 2.4 times wider dynamic interface of the Extra Wide Seal sufficiently for many high pressure shaft seal operating conditions. It has less seal leakage than Type A EL seals.

Figures 35 and 36 show the average running torque and leakage range for a pair of 2.75" (69.85 mm) ID, 0.335" (8.51 mm) radial cross-section extra wide Type F EL seals at various operating conditions.

Tests of Type F Extra Wide seals were also conducted at 144 ft/min with an ISO 68 viscosity grade lubricant maintained at 120°F and a drilling fluid environment. The radial extrusion gap clearance was 0.020". Leakage per wave was 0.09 ml/hr at 50 psi and 0.05 ml/hr at 200 psi.

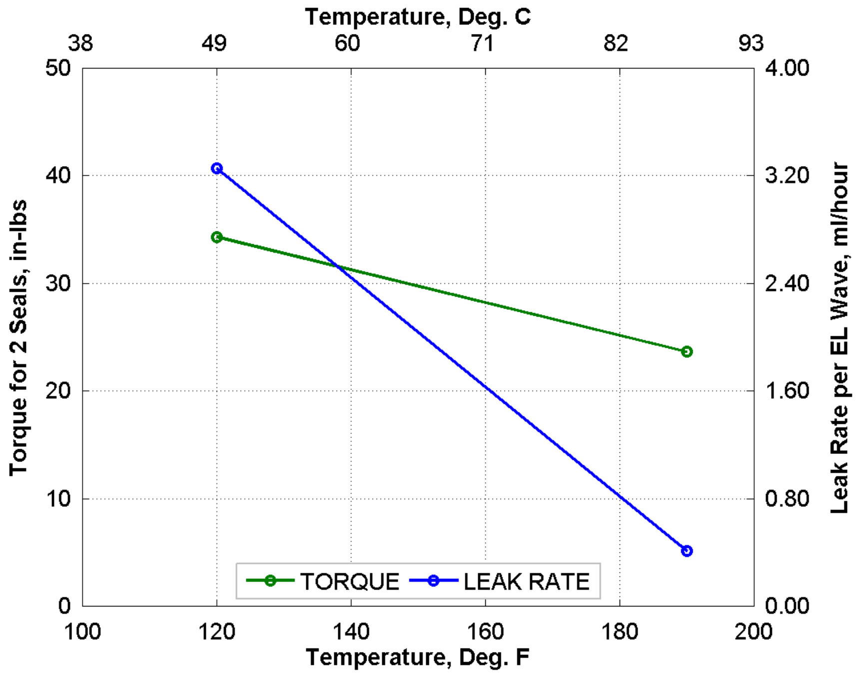


Figure 35

Hydrodynamic torque and leakage characteristics for a pair of 2.75" (69.85 mm) ID, PN 655-7-11 extra wide Type F EL seals tested at 252 ft/minute (1.28 m/s) and 300 psi (2.07 MPa) using an ISO 150 VG lubricant at various temperatures.

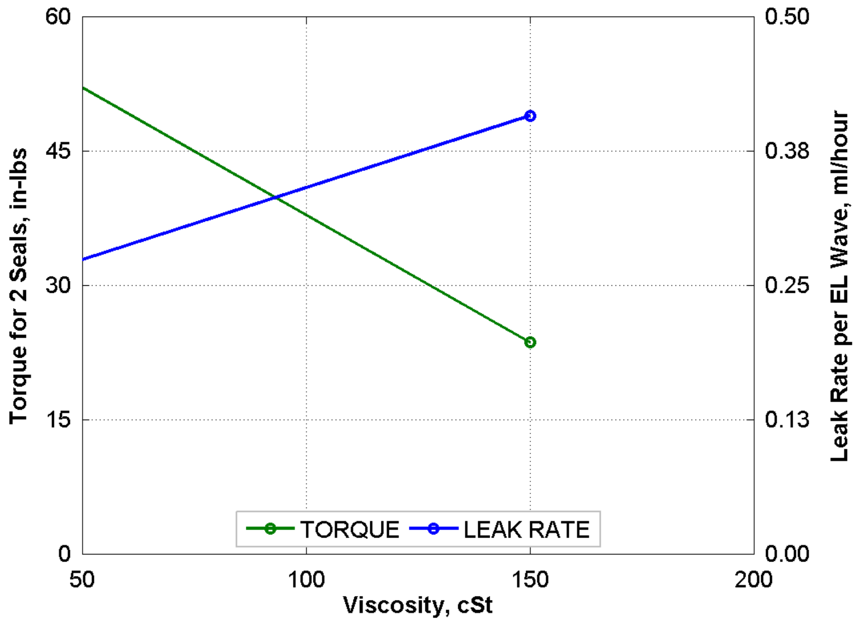


Figure 36

Hydrodynamic torque and leakage characteristics for a pair of 2.75" (69.85 mm) ID, PN 655-7-11 extra wide Type F EL seals tested at 252 ft/minute (1.28 m/s) and 300 psi (2.07 MPa) using an ISO 46 and 150 VG lubricant at a bulk temperature of 190°F (87.78°C).

Type C wave

The Type C wave sufficiently lubricates the 2.4 times wider dynamic interface of the Extra Wide Seal at mud motor seal conditions when used with lubricant viscosities common in sealed bearing mud motor assemblies.

Tests of Type C Extra Wide seals were conducted at a 345 ft/min surface speed with an ISO 460 viscosity grade lubricant maintained at 162°F. The radial extrusion gap clearance for the seal carrier was 0.020”. The shaft had 0.01” intentional runout. Leakage per wave was less than 0.055 ml/hr at pressures from 15 psi to 1,500 psi.

The wider dynamic lip width allowed the Extra Wide Seals to run more than 20X longer than Wide Footprint seals at 1,500 psi differential pressure and 300°F with the shaft rotating at 480 RPM (345 ft/min).

10. Super Wide Enhanced Lubrication Seal test results

Super Wide Enhanced Lubrication Seals with Type F waves (Figure 37) have been tested with an oilfield drilling fluid environment at surface speeds of 58 and 144 ft/min with an ISO 68 viscosity grade lubricant using a radial extrusion gap clearance of 0.020".

In the 144 ft/min test, the bulk lubricant temperature was maintained at 162°F (72.2°C). The hydrodynamic pumping related leakage per wave was .022 ml/hr at 15 psi, 0.45 ml/hr at 62 psi, and 0.67 to 1.08 ml/hr at 200 psi. In the 58 ft/min test, the bulk lubricant temperature averaged 102°F, and the leakage per wave was 0.25 to 0.30 ml/hr at 100 psi. These heavy duty seals were created as partitioning seals for slower speed applications. Evaluation of performance in high pressure sealing and higher speeds will be performed.

Figure 37

This PN 739-1-11 Super Wide Enhanced Lubrication Seal is in excellent condition after being tested for 305 hours at 144 ft/min and differential pressures typical to a partitioning seal using an ISO 68 viscosity grade lubricant maintained at 162°F and a 0.020" radial extrusion gap clearance. This testing included 284.27 hours with an oilfield drilling mud environment. The Super Wide shaft seal design was developed for partitioning service in slower speed applications, such as high-pressure power swivels.

11. Small cross-section high temperature test results

At elevated temperatures, lubricant viscosity decreases significantly. The EL Kalsi Seal geometry provides ample lubrication of high temperature seal materials in applications with low lubricant viscosity due to high temperature, even at low speeds. The -30 (80 Shore A) FKM seal material is rated to higher than 400°F (204°C) service.

Type A wave

Figure 38 shows the average running torque and leakage range for a pair of PN 568-152-30 (2.75" (69.85 mm) ID, 0.186" (4.72 mm) radial cross-section) type A EL seals tested at 54 RPM and 15 psi pressure with AeroShell 560 lubricant up to 350°F (177°C).

Figure 39 shows the running torque and leakage for a pair of PN 568-156-30 (2.75" (69.85 mm) ID, 0.145" (3.68 mm) radial cross-section) type A EL seals tested at 125 RPM and 15 psi (0.10 MPa) pressure with AeroShell 560 lubricant up to 350°F (177°C).

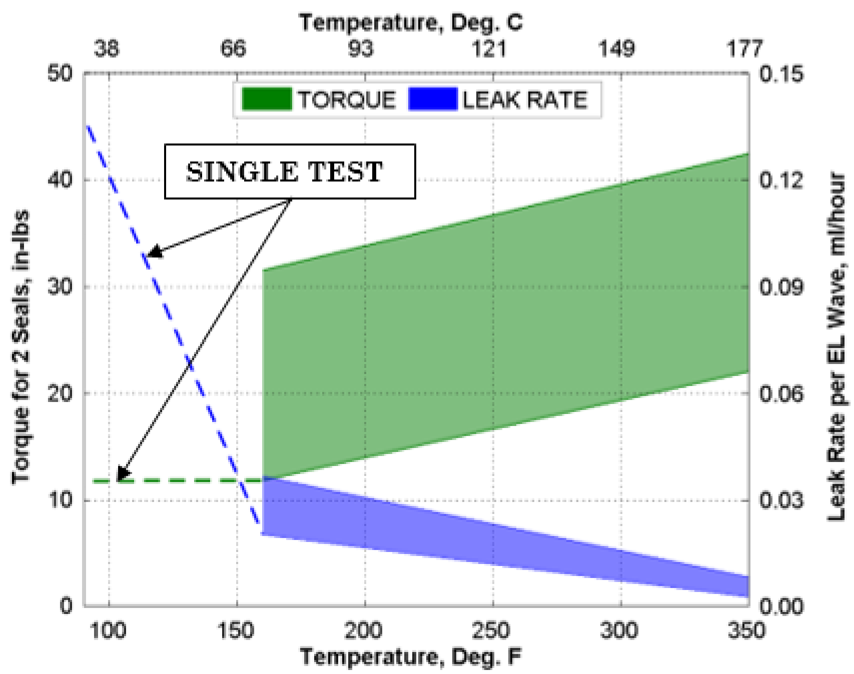


Figure 38

Hydrodynamic torque and leakage characteristics for a pair of 2.75" (69.85 mm) ID, 0.186 inch (4.72 mm) radial cross-section, PN 568-152-30 type A EL seals tested at 39 ft/minute (0.20 m/s), 15 psi (0.10 MPa) using AeroShell 560.

For available seal sizes, visit kalsiseals.com.

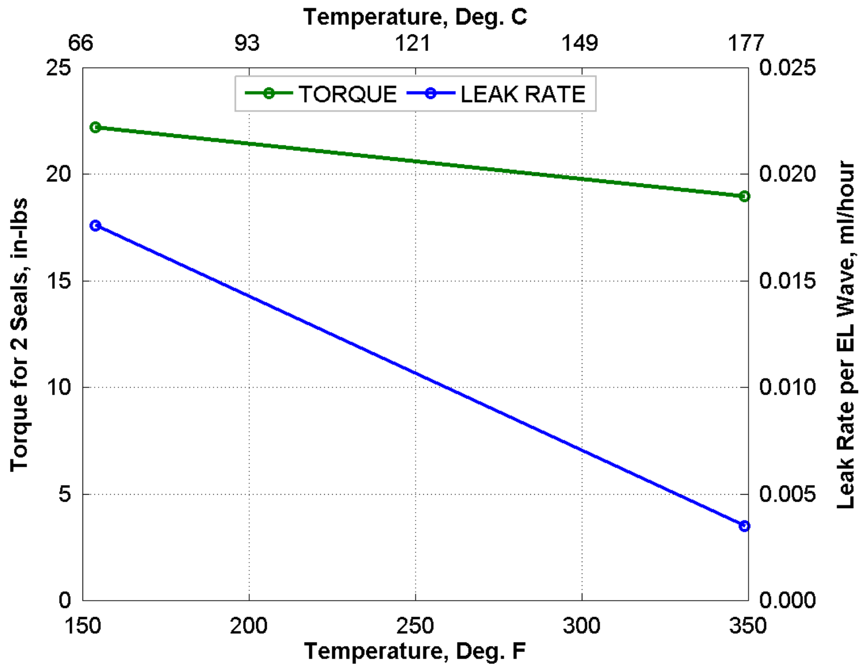


Figure 39

Hydrodynamic torque and leakage characteristics for a pair of 2.75" (69.85 mm) ID, 0.145 inch (3.68 mm) radial cross-section, PN 568-156-30 type A EL seals tested at 90 ft/minute (0.46 m/s), 15 psi (0.10 MPa) using AeroShell 560.