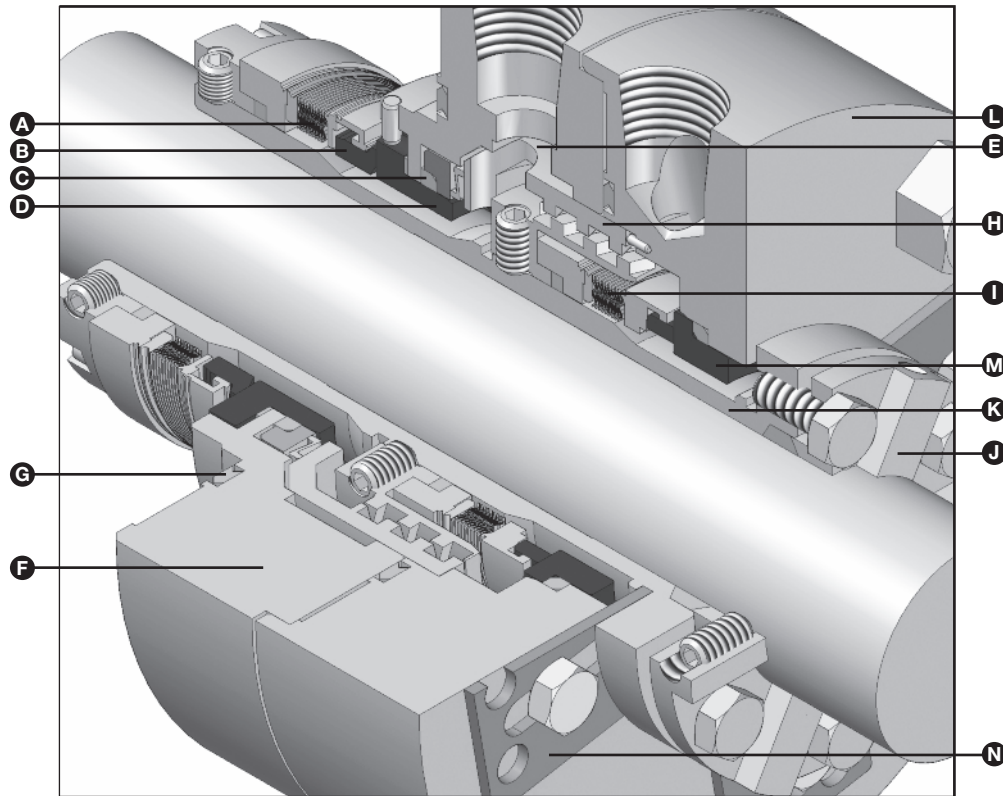
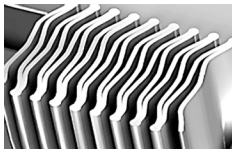


- A – Inner Bellows Assembly
- B – Primary Ring
- C – Packing
- D – Inner Mating Ring
- E – Flow Guide
- F – Inner Gland
- G – Spiral Wound Gasket
- H – Pumping Device
- I – Outer Bellows Assembly
- J – Packing Follower
- K – Sleeve
- L – Outer Gland
- M – Outer Mating Ring
- N – Setting Spacer



Type 2609HTC/3609HTC



Welded Metal Bellows

### Product Description

- Type 1604HTC - Single stationary bellows cartridge seal Type C, Arrangement 1
- Type 2609HTC - Dual unpressurized rotating bellows cartridge seal Type C, Arrangement 2
- Type 3609HTC - Dual pressurized rotating bellows cartridge seal Type C, Arrangement 3

These dependable API 682 cartridge seals utilize two impressive design innovations by incorporating high-temperature corrosion resistant sealing (HTC) and unique high-temperature live-loaded (HTL) mating ring technology in dual seal arrangements. This new design vastly enhances seal face stability over conventional designs and can extend mean time between repair (MTBR) in many services.

#### Exceptional Face Stability

The HTC primary seals, patent pending, incorporate specially designed pressure compensating seal faces and thermally compliant components that provide superior seal face stability at elevated temperatures. With advanced HTL mating ring design, patent pending, seal face stability is achieved by eliminating any thermal and mechanical forces that can contribute to seal face distortion. The sealing interface remains exceptionally stable in spite of thermal changes and adapts to the wide range of temperature excursions inherent in high-temperature applications.

#### Corrosion Resistance

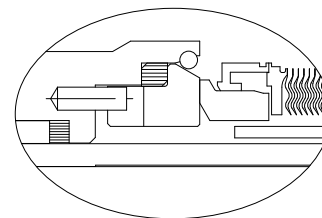
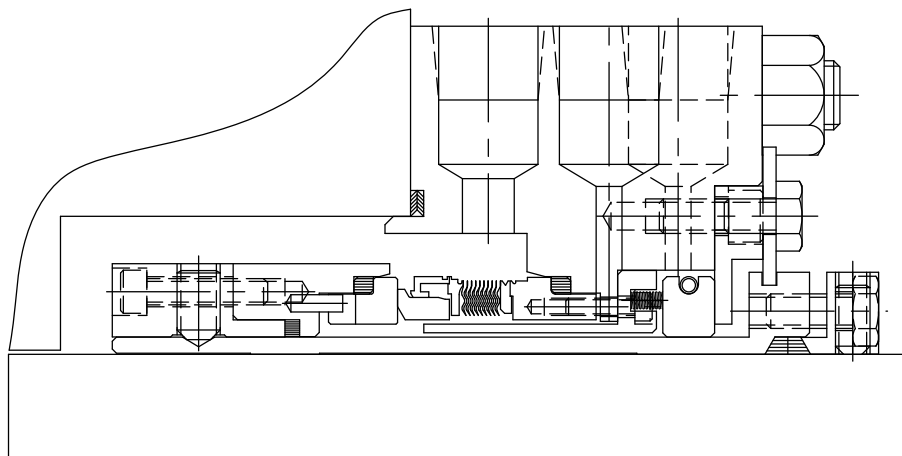
These all-Inconel® seals are ideally suited for applications that contain organic acids (naphthenic acids) and sulfur compounds that attack most other alloys at high temperatures.

### Performance Capabilities

- Temperature: -100°F to 800°F/-75°C to 425°C
- Pressure: vacuum to 300 psi(g)/20 bar(g)
- Speed: Type 1604HTC: up to 10,000 fpm/50 m/s  
Type 2609HTC/3609HTC: up to 5000 fpm/25 m/s
- Shaft size: 1.5" to 4.5"/30mm to 120mm

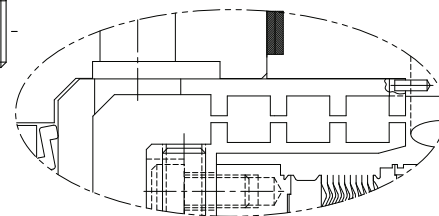
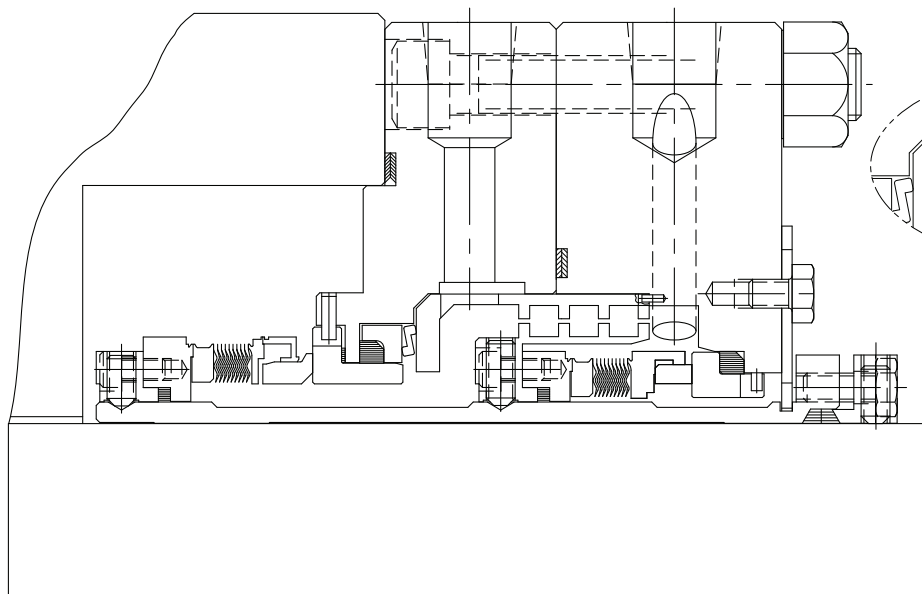
### Design Features

- API 682 qualified
- HTC technology
- HTL mating ring technology provides exceptional face stability
- Sealide-C\* advanced silicon carbide composite
- ID and OD pressure capability — withstands reverse pressurization (Type 2609HTC/3609HTC)
- All-Inconel metallurgy — meets NACE MR0175/MR0103
- Dual scroll pumping device standard
- Optional segmented spring-loaded carbon throttle bushing for effective containment (Type 1604HTC)
- Retained mating ring available for vacuum service (Type 1604HTC)

**Typical Type 1604HTC API Type C Arrangement 1 - Single Cartridge**

Retained Mating Ring for Vacuum Service

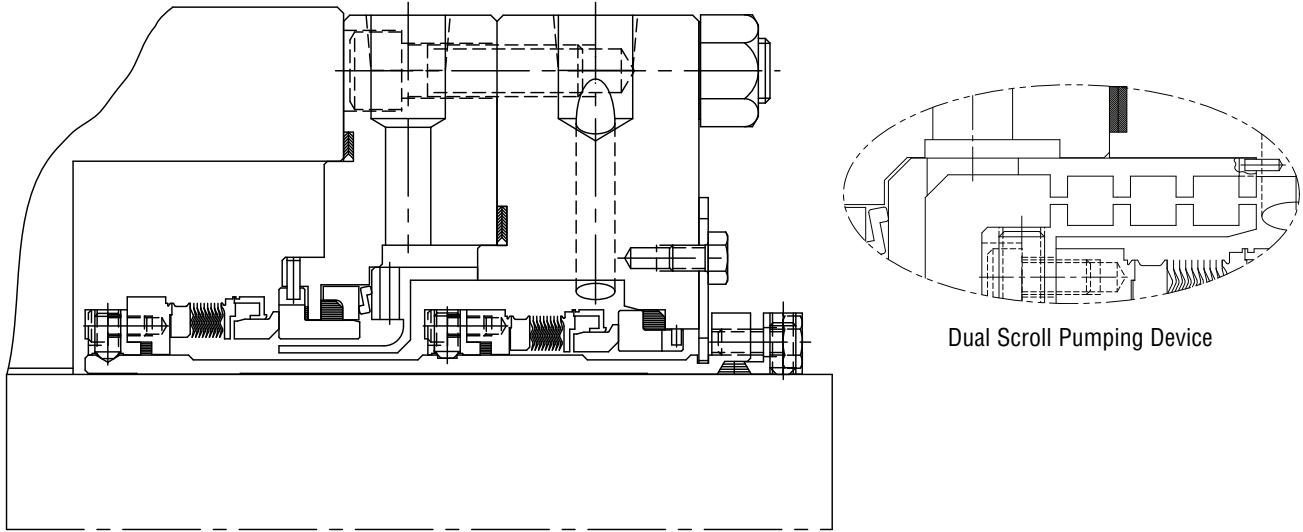
A single stationary Type 1604HTC seal that contains a steam guide (steam deflector or anti-coking baffle) which directs steam to the area where coke would tend to form and routes the steam to carry material away from the seal and seal faces.

**Typical Type 2609HTC/3609HTC API Type C Arrangements 2 and 3 - Dual Cartridge**

Dual Scroll Pumping Device

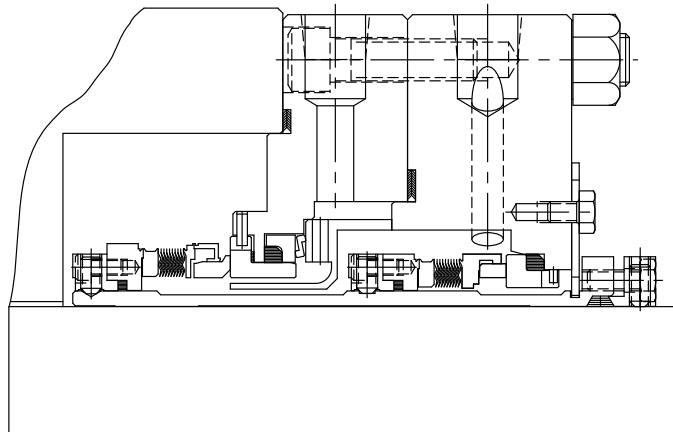
A dual seal with a Type 609HTC inner seal and Type 609 outer seal. Typically used with API Plan 52 or 53A/B/C.

### Typical Type 2609HTC/3609HTC API Type C Arrangements 2 and 3 - Dual Cartridge

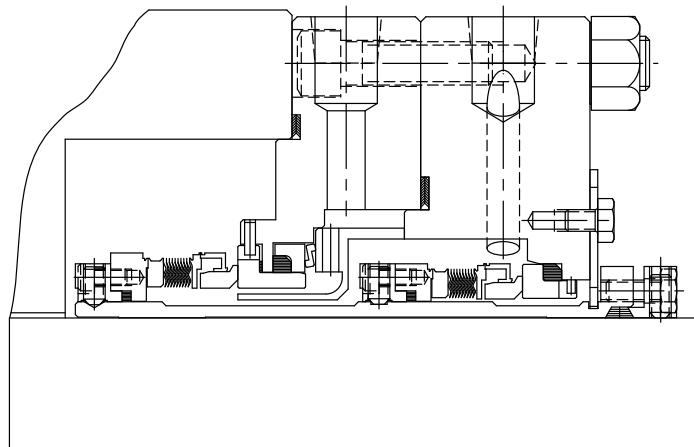


Dual Scroll Pumping Device

A dual seal with a Type 609HTC inner seal and 609HTC outer seal. Typically used with API Plan 52 or 53A/B/C.



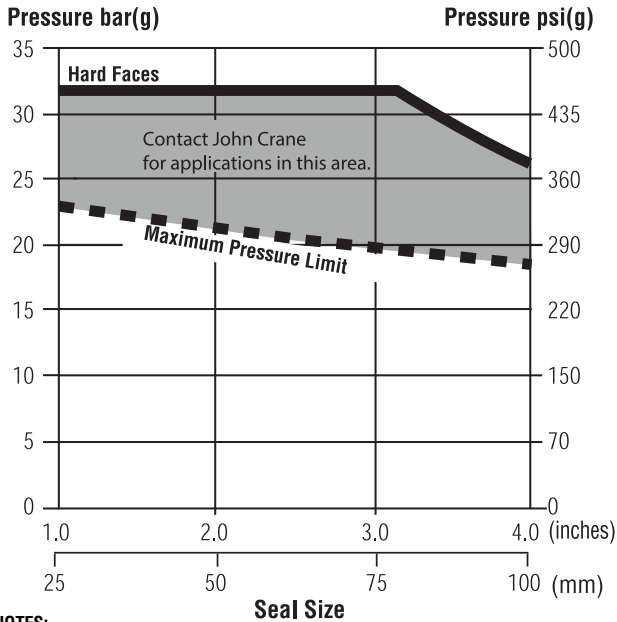
A dual seal arrangement with a diverter (option). Type 609HTC inner seal with a Type 609 outer seal. Typically used with API Plan 54.



A dual seal arrangement with a diverter (option). Type 609HTC inner seal with a Type 609HTC outer seal. Typically used with API Plan 54.

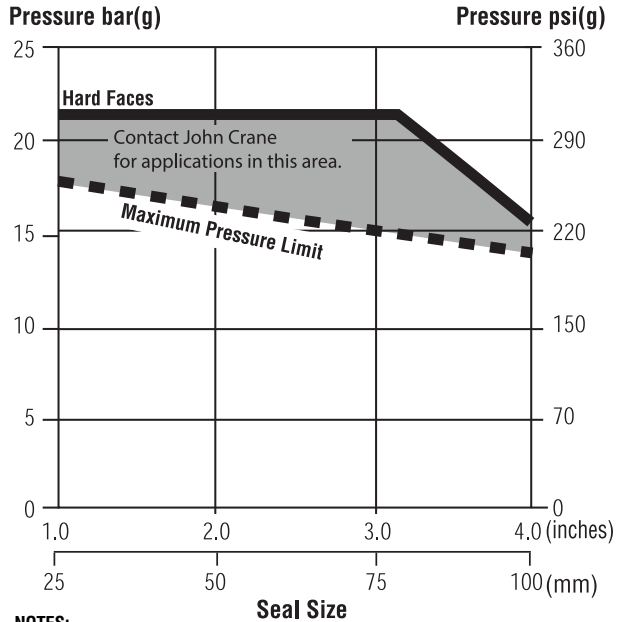
### Basic Pressure Rating

#### Type 1604HTC/2609HTC/3609HTC OD Pressure Rating



- NOTES:**  
 1. Basic pressure rating curve based on single-ply bellows.  
 2. Basic pressure rating curve is differential pressure applied to seal outside diameter.

#### Type 2609HTC/3609HTC ID Pressure Rating



- NOTES:**  
 1. basic pressure rating curve based on single-ply bellows.  
 2. For applications above 315°C/600°F and 13.8 barg/200 psig, consult John Crane.  
 3. For arrangement 3 seals, use differential pressure limits recommended in API 682/ISO 21049.  
 4. Consult John Crane for applications outside these limits.

The basic pressure rating is for a standard seal, as shown in the typical arrangement, when installed according to the criteria given in this data sheet and generally accepted industrial practices.

The basic pressure rating assumes stable operation at 3600 rpm in clean, cool, lubricating non-volatile liquid with an adequate flush rate. When used with the multiplier factors, the basic pressure rating can be adjusted to provide a conservative estimate of the dynamic pressure rating.

Contact John Crane for process services outside this range for a more specific assessment of the dynamic pressure rating.

### Multiplier Factors

	Selection Considerations	Multiplier Factors SiC vs. SiC T/C vs. SiC
<b>Speed</b>	Up to 3600 rpm Above 3600 rpm	x 1.00 X (3600/speed)
<b>Sealed Fluid Lubricity</b>	Petrol/Gasoline, Kerosene, or Better Water and Aqueous Solutions (<176°F/80°C) Flashing Hydrocarbons (see Note 1)	x 1.00 x 0.75 (see Note 2)
<b>Sealed Fluid Temperature (see Note 3)</b>	Up to 175°F/80°C Up to 250°F/120°C Up to 400°F/205°C Up to 600°F/315°C Above 600°F/315°C	x 1.00 x 1.00 x 1.00 x 1.00 (see Note 4)

#### Example for Determining Pressure Rating Limits:

Seal: Type 1604HTC  
 Size: 3.5"/89mm diameter  
 Product: high viscosity gas oil  
 Face material: sealide-C vs. silicon carbide  
 Operating temperature: 620°F/325°C  
 Operating speed: 3600 rpm

#### Example for Determining Dynamic Pressure Rating:

The maximum pressure for a particular application is the lesser of the maximum pressure limit curve or the pressure calculated when the multiplier factors are applied to the specific seal face material curve.

Maximum pressure limit curve:  
 283 psi(g)/19.5 bar(g) max. pressure

Hard face limit curve: 406 psi(g)/28 bar(g)

Calculated limit:

406 psi(g)/28 bar(g) x 1.00 x 1.00 = 406 psi(g)/28 bar(g).

At 3600 rpm with the service conditions noted, an 3.5"/89mm Type 1604HTC has a maximum operating OD pressure limit of 283 psi(g)/19.5 bar(g).

\*The ratio of sealed pressure to vapor pressure must be greater than 1.5, otherwise consult John Crane. If the specific gravity is less than 0.60, consult John Crane.

- NOTES:**  
 1. Specific gravity  $\geq 0.6$  and ratio of sealed pressure to vapor pressure  $> 1.5$ .  
 2. More details regarding the fluid and the operating conditions are required.  
 3. Temperature at the seal faces includes effects of flush, quench and cooling.  
 4. Contact John Crane for more information.

# BELLOWS SEALS

## 1604HTC/2609HTC/3609HTC

Technical Specification

### Materials of Construction 1604 and 1604HTC

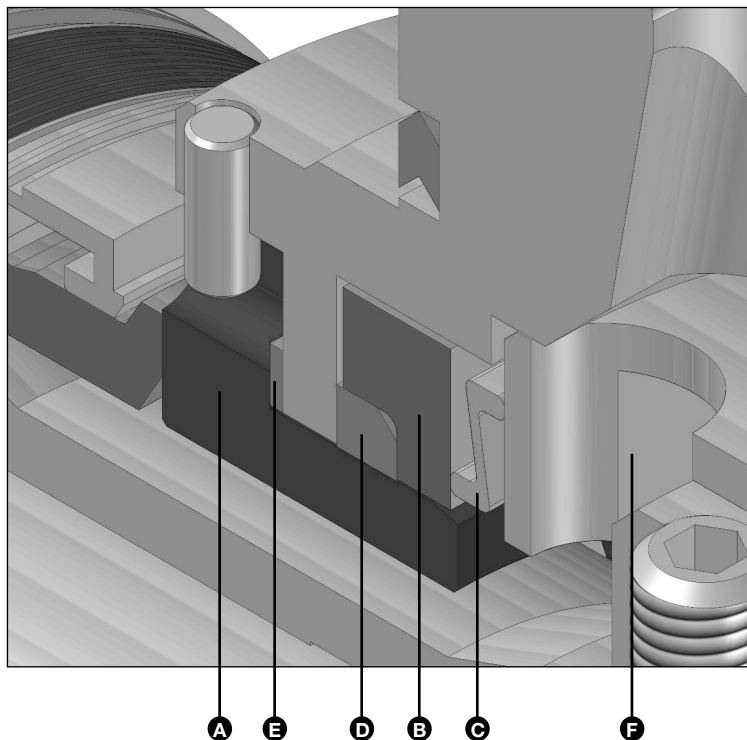
SEAL COMPONENTS	1604 MATERIALS	1604HTC MATERIALS
Description		
Mating Ring	Silicon Carbide Reaction Bonded	Silicon Carbide Reaction Bonded
Primary Ring	Premium Grade Carbon (Tungsten Carbide Nickel Bound Option)	Sealide-C (Tungsten Carbide Nickel Bound Option)
Primary Ring Adapter	Alloy 42 (UNS K94100)	Alloy 718 (UNS N07718)
Adapter	Alloy 625 (UNS N06625)	Alloy 718 (UNS N07718)
Bellows	Alloy 718 (UNS N07718)	Alloy 718 (UNS N07718)
Adaptive Hardware	316 Stainless Steel	316 Stainless Steel
Static Seals	Flexible Graphite	Flexible Graphite

### Materials of Construction 2609HTC and 3609HTC

SEAL COMPONENTS	2609HTC/3609HTC with TYPE 609 OUTER SEAL MATERIALS	2609HTC/3609HTC with TYPE 609HTC OUTER SEAL MATERIALS
Description		
Inner Mating Ring	Silicon Carbide Reaction Bonded	Silicon Carbide Reaction Bonded
Inner Primary Ring	Sealide-C (Tungsten Carbide Option)	Sealide-C (Tungsten Carbide Option)
Inner Primary Ring Adapter	Alloy 718 (UNS N07718)	Alloy 718 (UNS N07718)
Inner Adapter	Alloy 718 (UNS N07718)	Alloy 718 (UNS N07718)
Outer Mating Ring	Silicon Carbide Reaction Bonded	Silicon Carbide Reaction Bonded
Outer Primary Ring	Premium Grade Carbon	Sealide-C (609HTC)
Outer Primary Ring Adapter	Alloy 42 (UNS K94100)	Alloy 718 (UNS N07718)
Outer Adapter	Alloy 625 (UNS N06625)	Alloy 718 (UNS N07718)
Bellows	Alloy 718 (UNS N07718)	Alloy 718 (UNS N07718)
Adaptive Hardware	316 Stainless Steel	316 Stainless Steel
Static Seals	Flexible Graphite	Flexible Graphite

### HTL Mating Ring (High-Temperature Live-Loaded)

COMPONENTS	MATERIALS
Description	Standard
<b>A</b> Mating Ring	Reaction Bonded Silicon Carbide
<b>B</b> Compression Ring	Silicon Carbide
<b>C</b> Z-Spring	Alloy 718
<b>D</b> Packing	Flexible Graphite
<b>E</b> Gasket	Flexible Graphite
<b>F</b> Flow Guide	316 Stainless Steel



### HTL Mating Ring Technology

HTL technology utilizes a specially shaped mating ring, compression ring, and energized Z-Spring to “live-load” the secondary flexible graphite packing and to control any radial and axial forces that may be imparted to the mating ring. By utilizing components with similar coefficients of thermal expansion and by eliminating contact with metal surfaces, the HTL mating ring design minimizes and/or eliminates face distortion due to the relative differences in the thermal growth between components and by eliminating contact with metal surfaces. There are no forces transferred from the gland to the mating ring ensuring face stability and face flatness.

The mating ring has dual pressure capability which enables it to operate dependably with either a higher pressure process or barrier liquid at the outside or inside diameter location.

### HTC Technology

The HTC seal provides an effective solution in sealing corrosive fluids at elevated temperatures by utilizing a complete all-Inconel metallurgy and unique face seal technology that provides exceptional stability across a wide range of pressure/temperature conditions.

An effective means of ensuring seal reliability is by controlling seal face distortion, which directly affects the operating conditions at the sealing surface. The HTC incorporates pressure compensating seal faces and thermally compliant components that ensure exceptional seal face flatness stability which resists any compromising effects from temperature and pressure. Such exceptional face stability can result in reduced leakage and longer seal life.

In dual seal arrangements, this rugged seal is capable of handling reverse pressurization. In a dual unpressurized bellows arrangement, the primary seal is designed to contain a buffer reverse pressure. In a pressurized dual seal arrangement, the primary seal is normally operating with reverse barrier pressure and is designed to contain the process pressure in the event of loss of barrier pressure.

The HTC has proven to be a superior design for high temperature, corrosive applications up to 800°F/425°C.

### Sealide-C Advanced Silicon Carbide Composite Primary Ring

Sealide-C is a state-of-the-art, sintered silicon carbide with low friction and the inherent lubricity of free graphite. This silicon carbide is a tough, hard, heat resistant, long wearing, inert seal face material. When compared with other face materials, Sealide-C provides improved corrosion resistance, improved thermal shock resistance, and lower running face temperatures.

### Sealol Welded Metal Bellows

**Design Features:**

- Optimum 45° tilt angle
- Three-sweep radius
- nesting ripple plate design
- static secondary seal
- light spring loads

**Sealol Bellows Benefits:**

- Uniform plate rigidity and stress distribution
- Enhanced fatigue strength
- Pressure-balanced by design
- Less heat
- Lower power consumption

### Inconel

- Inconel 718 nickel-chromium iron alloy is excellent for use in corrosive environments at elevated temperatures.
- This heat-treatable alloy retains excellent mechanical properties over a wide temperature range. Alloy 718 is utilized for the bellows plates and unique shell design and is the highest strength bellows material available.
- Meets NACE MR0175/MR0103 requirements.

### Recommendations for Viscous Fluids

0 - 3500 cSt: Hard face material

3500 - 10,500 cSt: Consult John Crane

**NOTE:** SSU (Saybolt Universal Seconds) approximately equals cSt (centistoke)  
x 4.6347cP (centipoise) = cSt (centistoke) x specific gravity.

### Typical Applications

- Hydrocarbons
- Aromatic fractionation products (benzene, toluene, solvents, etc.)
- Crude oil fractionation products (fuel oil, lubricating oil, gasoline, etc.)
- Chemicals, caustics, some acids, aqueous solutions, lubricating liquids
- Heat transfer fluids

### Angular and Radial Movement

Excessive runout will have a detrimental effect on seal performance in the form of component wear or excessive leakage. API 682 limits runout as follows:

- Centering of the seal is to be by a register fit. The register fit surface shall be concentric to the shaft and have a total indicated runout (FIM) of not more than 0.005"/125 micrometers.
- Squareness of the seal chamber face to the shaft shall not exceed 0.0005" per inch of seal chamber bore (15 micrometers per cm).
- Runout of the sleeve outer diameter to the inner diameter shall be 0.001"/25 micrometers FIM.
- Shaft-to-sleeve diametrical clearance shall be 0.001" to 0.003"/25 to 75 micrometers.





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