

## DRY GAS SEALS



**DRESSER-RAND®**

Bringing energy and the environment into harmony.®

# Dry gas seals

No one is better qualified to bring this superior technology to your equipment.



D-R's patented groove design on the rotating seal face optimizes seal performance and reliability under various operating conditions.

Because of their advantages, dry gas seals are installed on 95% of new compressors for varied services throughout the world. Thanks to our extensive experience, advanced designs, state-of-the-art manufacturing and testing, and ability to offer full-service solutions, D-R can bring these advantages to your existing centrifugal compressor.

Compared to conventional oil-lubricated seals, dry gas seals:

- eliminate the need for complex and costly seal oil systems, and the ongoing maintenance associated with them



- improve efficiency—sometimes dramatically—by eliminating the parasitic power losses caused by oil shear and drag
- eliminate contamination of process gas by seal lubricants
- eliminate contamination of seal oil by the process gas
- extend the life of lubricating oil
- retain pressure during shut-down even with the auxiliaries deactivated.

Upgrading the gas seals on your centrifugal compressors to Dresser-Rand dry gas seals will allow your operation to benefit from our product's unique anti-hang-up and high-reliability features.

## A TRACK RECORD OF SUCCESS

Our dry gas seal experience dates back to the 1970s when Ingersoll-Rand began applying the technology in natural gas lift compressors. In 1982 Ingersoll-Rand began using gas seals in process gas compressors.

Since 1996, more than 1200 Dresser-Rand gas seals have been delivered or are currently in production. Some D-R gas seals have been running continuously for more than 11 years. The total running experience now exceeds 10 million hours with no "hang-ups." That makes D-R one of the most experienced gas seal manufacturers in the industry.

## MAKING A GOOD IDEA EVEN BETTER

Not content with existing designs, we drew on our exten-

sive experience to develop our own gas seal technology. In 1995, using advanced engineering methods and tools such as CAD systems and finite element analysis, D-R created a special patented rotor groove pattern and carbon ring pusher design that maximize reliability in all operating conditions. This design has been proving itself ever since in various compressor sealing applications such as gas transmission, refineries, gas liquefaction, chemical plants, and gas production—both onshore and offshore. Close to 750 D-R gas seals are currently in operation.

D-R gas seals are available in a range of dimensions (2 in / 50.8 mm to 8 in / 203.2 mm), pressures (up to 2900 psi / 200 bar), and speeds (5,000 to 32,700 rpm), as well as various arrangements (single, tandem, double, etc.), to provide the best solution for each application. The standard materials accommodate a large range of conditions. When required, materials can be specially selected to comply with NACE standards.

## BUILT AND TESTED FOR OPTIMUM PERFORMANCE AND LONG LIFE

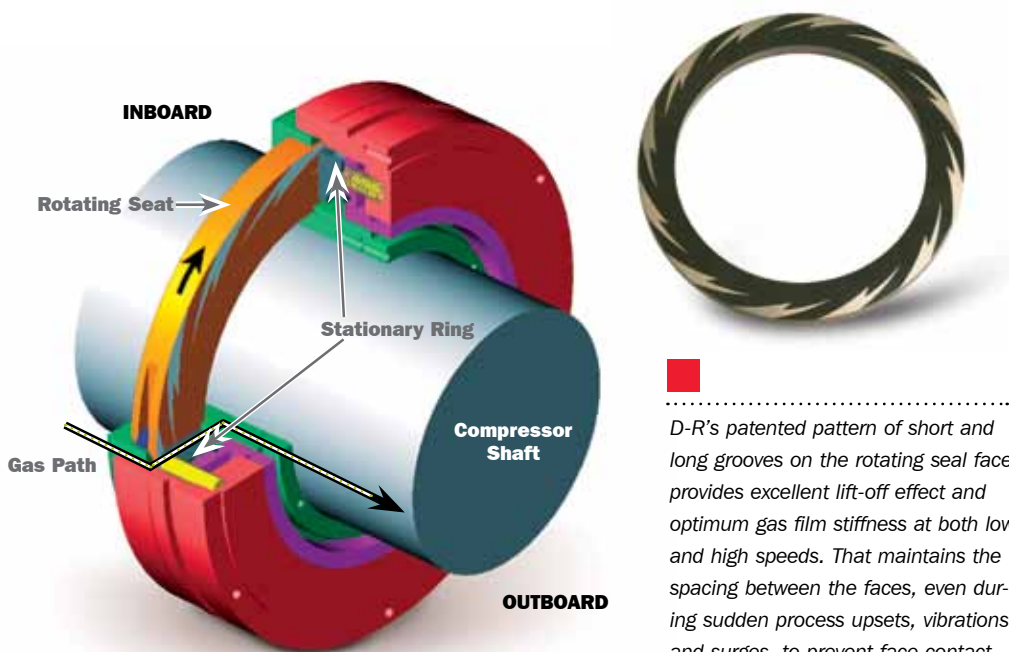
D-R gas seals are manufactured using the resources (procurement, manufacturing, quality inspection, etc.) of our ISO 9000-certified manufacturing and quality organizations. To ensure product performance and client satisfaction, a dedicated D-R Gas Seals Business Unit manages the complete production process, from initial consultation through final testing.

Every D-R gas seal is subjected to a complete set of tests. The fully equipped test rig includes a test vehicle in which a pair of gas seals (cw and ccw) is tested under real-world conditions. The temperature, pressure and flow rate at each seal connection are measured and recorded with calibrated instruments over the full range of rated operating speeds and pressures. The seals are then disassembled and inspected. After rebuild, a static test is performed.

### CUSTOM, FULL-SERVICE SOLUTIONS

Dresser-Rand is your single-source solution for dry gas seal upgrades. We provide experienced project management, engineering capabilities, and direct technical support. We handle total procurement, inspection, compressor modifications, installation and start-up supervision for all seal upgrades.

Centrifugal compressor seals are a critical subsystem that must be carefully integrated into the overall unit design. We take into account the crucial aspects of each application, including compression service, required physical characteristics, and fit for existing cavities. Safety, performance, and reliability are all carefully considered. D-R's experts in rotor dynamics, aerodynamics, thermodynamics, performance, and seal systems design/technology work closely together to optimize each system and ensure an efficient upgrade with minimal downtime.



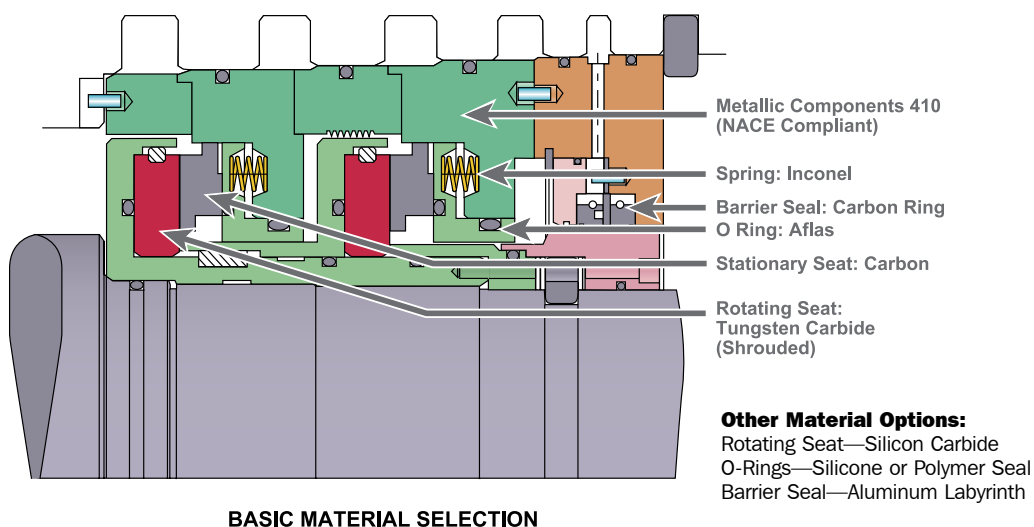
D-R's patented pattern of short and long grooves on the rotating seal face provides excellent lift-off effect and optimum gas film stiffness at both low and high speeds. That maintains the spacing between the faces, even during sudden process upsets, vibrations and surges, to prevent face contact and improve reliability.

## Designed for reliability

**D-R's patented innovations ensure consistent performance.**

At the heart of every gas seal is a pair of rings. A stationary ring, fixed to the case, is held against a rotating ring, fixed to the shaft by spring and pressure. The acting face of the rotating ring incorporates special grooves on the outer portion. Typically, filtered compressor discharge gas, reduced to a pressure slightly above that of the process gas to be contained, is introduced into the seal area.

As the shaft rotates, the grooves on the rotating ring create a dynamic gas pumping or "lifting" effect that pushes the spring-loaded stationary ring away from the rotating ring, creating a very small gap. The inner portion of the faces creates a "dam" region where the gas pressure is broken down to the flare or the vent pressure.



**BASIC MATERIAL SELECTION**

Metallic Components 410 (NACE Compliant)

Spring: Inconel

Barrier Seal: Carbon Ring  
O Ring: Aflas

Stationary Seat: Carbon

Rotating Seat: Tungsten Carbide (Shrouded)

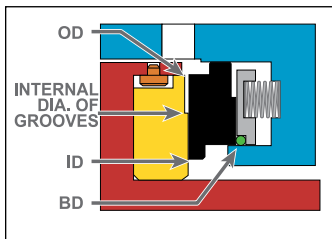
#### Other Material Options:

Rotating Seat—Silicon Carbide  
O-Rings—Silicone or Polymer Seal  
Barrier Seal—Aluminum Labyrinth

Other materials available on a case-by-case basis.

## LOW RISK OF “HANG-UPS”

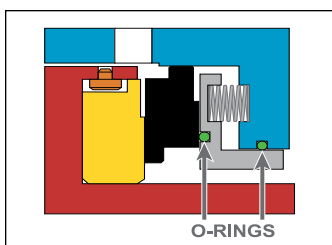
As elegant as the gas seal solution is, in actual applications it can develop a flaw: friction can cause the springs that push the stationary ring toward the rotating ring to stick, or “hang up,” resulting in too wide a gap between the rings and the potential for process gas leakage. D-R’s patented design solves this problem.



### Standard Dry Gas Seal Design: A Risk of “Hang-Up”

This design uses a single O-ring. In operating mode the closing forces (springs plus pressure between OD and balance diameter [BD]) equalize the opening forces

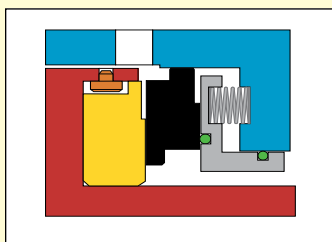
(pressure gradient between OD and ID in clearance gap). In the absence of pressure, only the spring force closes the seal. If O-ring friction prevents the spring from functioning, the seal can remain open, a condition known as “hang-up.”



### Improved Design with L-Shaped Pushing Ring: Less Risk of “Hang-Up”

This design uses two O-rings. The first seal at the back of the carbon ring is in a relatively high-temperature environment. The second O-ring is fitted into the bore of the

seal cartridge in a lower-temperature location. Both the cartridge and L-ring are manufactured of steel (same thermal expansion coefficient and Young’s modulus). The radial clearance between the L-ring and cartridge does not change significantly with operating conditions, so there is less risk of a high-friction condition and “hang-up.”



### Dresser-Rand L-Ring Design: Lowest Risk of “Hang-Up”

Our patented design places the second O-ring in the L-ring instead of in the cartridge. This provides the advantages mentioned above plus an important benefit: if

the O-ring sticks to the housing, the sliding face of the O-ring is transferred to the bottom of the O-ring groove. The resulting increase in the closing force is generally sufficient to eliminate “hang-up.”

## WHY D-R’S UNIDIRECTIONAL SEALS BEAT BIDIRECTIONAL DESIGNS



Unless a given application absolutely requires reverse rotation, D-R recommends unidirectional seals because of their superior reliability and ability to resist external disturbances, compared to bidirectional designs.

### ■ When the seal is rotating, the gas film thickness defines the distance between the faces. A thicker gas film reduces the risk of contact

between the faces, thereby increasing reliability. However, increasing gas film thickness also increases the leakage rate. A good design will have sufficient film thickness to provide the best possible reliability while keeping the leakage rate at an acceptable level. Unidirectional seal groove patterns are known to provide greater gas film thickness and thus better reliability than bidirectional groove patterns.

■ **Even more important is the gas film stiffness.** The reliability of the seal depends upon its ability to accommodate sudden disturbances (vibrations, surge, shocks due to process upsets, etc.) without contact between the faces. High gas film stiffness enables the seal to better react to an externally imposed variation of the gap. For a given gap, unidirectional groove patterns provide three to five times greater gas film stiffness than bidirectional patterns.

■ **Although the first and most obvious advantage of a bidirectional seal is its ability to operate in either direction of rotation, this is seldom necessary.** Reverse rotation can often be avoided by the proper design and installation of process equipment (for instance, check valve position). It is also known from experience that check valve failure does not statistically result in major failures of unidirectional gas seals, regardless of the manufacturer.

■ **Despite the fact that bidirectional seals make it possible to use the same seal at both ends of the compressor (to prevent incorrect assembly), there are other simple means to guarantee that unidirectional seals are installed at the proper end of the machine (using two dowels for the clockwise seal and three dowels for the counterclockwise seal).**

■ **Having identical seals at both ends is often proposed as a commercial advantage because a single spare seal could be installed at either end of the compressor.** In reality, if and when a gas seal problem occurs, it usually affects both seals. So even if the seals are identical, having only one spare seal imposes additional operational risk.

**As we’ve shown, unidirectional seals offer superior performance over bidirectional seals in all cases except where there is an absolute necessity for rotating the machine in either direction. If reverse rotation cannot be avoided, then other elements (bearings, for instance) in the compressor train (including the driver and possibly the gear) will also have to accommodate that requirement.**



**C**omplete gas seal maintenance and testing available at U.S. and French facilities

*Le Havre, France gas seal repair and test facility.*



*Houston, Texas gas seal repair and test facility.*

*The gas seal repair and test facilities at the Dresser-Rand Service Centers in Houston, Texas, and Le Havre, France, stand ready to service D-R gas seals with authorized factory parts and testing to restore them to their original condition.*

*We recommend that each installation have a spare set of seals to ensure a quick change-out with minimal down time. Seals removed from service for any reason should be returned to the nearest service center for disassembly, clean-up and testing. Static testing is always performed on refurbished seals. Dynamic testing, simulating running conditions of pressure and speed, is performed when major parts are replaced.*

*The restored seals will be repackaged as an assembly in their original shipping container and returned, ready for the next change-out.*

# DRESSER-RAND®

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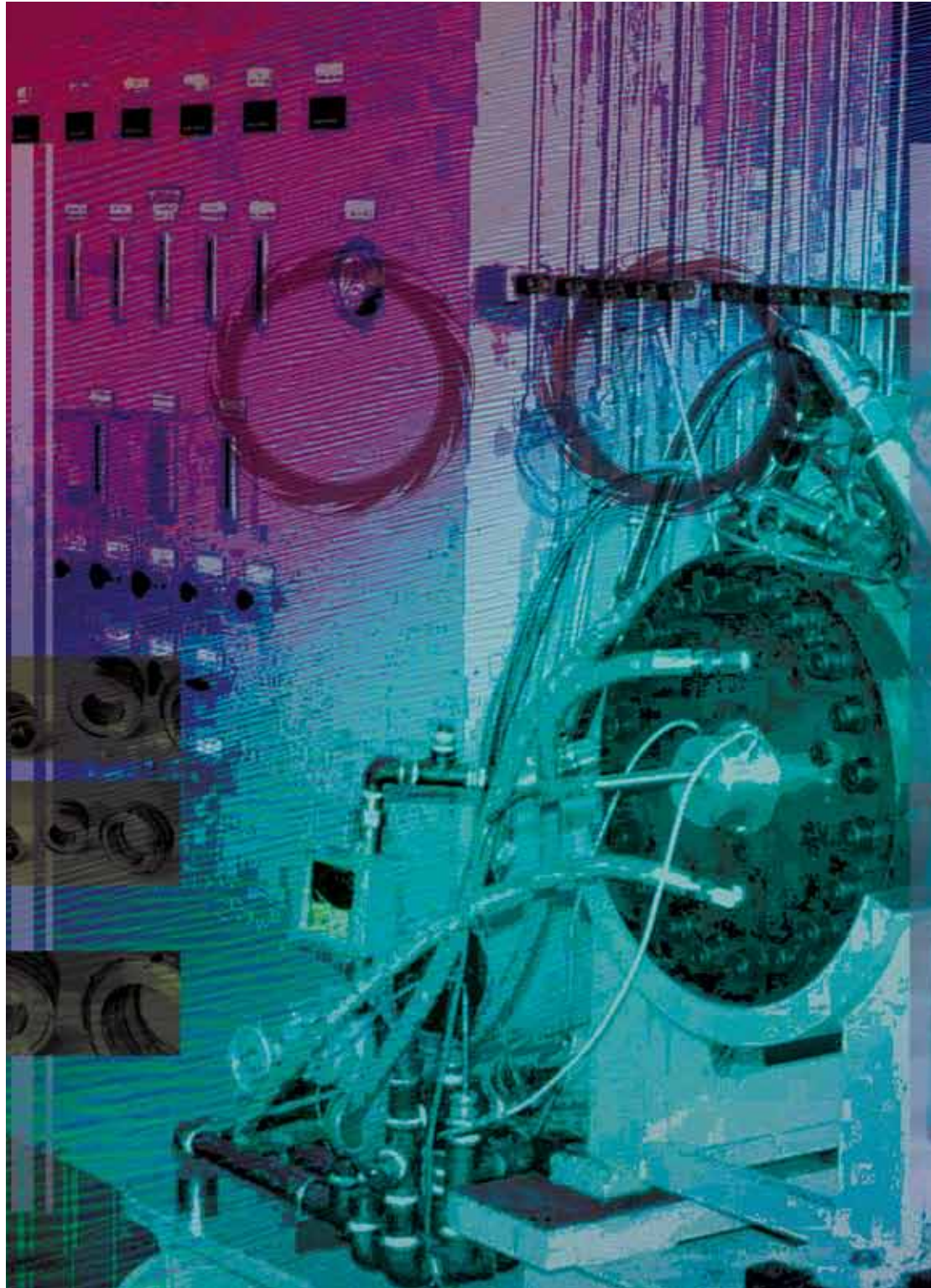
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