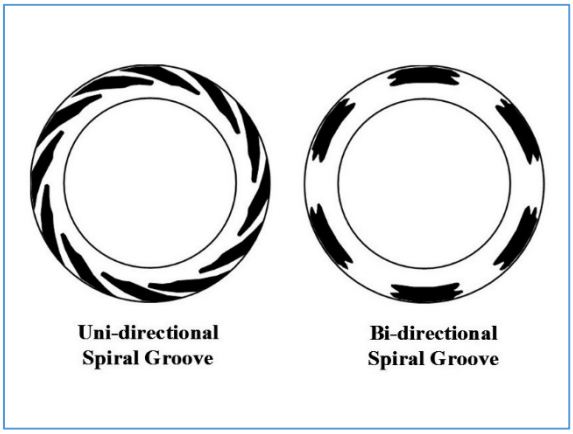
Centrifugal Compressor
Dry Gas Seals



Description

The dry gas seal is a non-contact end face seal which has become the industry standard for new-build centrifugal gas compressors. It essentially comprises a spring-loaded stationary (primary) ring which is forced against a rotating (mating) ring fixed to the rotor shaft. The two sealing surfaces are lapped to a high degree of flatness. The outer (sealing) surface of the mating ring has a series of very shallow spiral grooves laser-etched, spark-eroded or chemically milled into its face over its outer annular area. Seals may be either uni-directional or bi-directional. With uni-directional spiral groove designs, the seals on either end of the rotor shaft are mirror images of each other. They are not interchangeable and will be damaged if they are inadvertently installed the wrong way around or if the machine runs backwards. Bi-directional spiral groove seals are symmetrical so the seals on either end of the shaft are identical.

Tandem seals or tandem seals with intermediate labyrinths are often specified for process gas compressors in toxic or flammable gas service where minimal or zero process gas leakage to atmosphere is acceptable. A tandem seal consists of a primary seal and a secondary seal contained within a single cartridge. The secondary seal normally runs at a lower pressure but is rated for full pressure in case the primary seal fails. The seal gas injected between the seals is supplied at least 1.4 bar (20 psi) above the compressor suction pressure. Most of the seal gas leaks across the inboard labyrinth seal and back into the process cavity of the compressor. The rest leaks across the primary seal and vents to flare. In the tandem seal with intermediate labyrinths, seal gas and nitrogen are injected on opposite sides of the labyrinths.

Operating Principle

When the compressor shaft rotates, gas is forced inwards towards the root of the groove and against the ungrooved flat inner surface which forms a sealing dam. This restricts the flow and causes a rise in gas pressure which separates the faces and forms a gap of 3 to 4 µm (6×10^{-5} to 8×10^{-5} inches). If the gap gets any bigger, the pressure between the faces drops and the faces are closed by the spring and process forces. If the gap gets too small the increase in pressure created by the spiral grooves forces the faces apart. Extremely low wear of the seal faces is obtained and extremely low leakage of seal gas from the seal results both when the rotor is stationary or in motion. However, any ingress of foreign material (solid or liquid) into the running gap of the seal results in increased shear forces between the sealing surfaces. The seal components may then overheat and lead to a mechanical failure of the seal.

Auxiliary Equipment

Dry gas seals should only be used when the seal gas medium is clean and dry. If process gas is used as seal gas, a seal gas conditioning system is provided to prevent ingress of foreign material into the gap between the seal faces. The conditioning system incorporates a cooler, a coalescer, a filter and a heater. A chloride trap is added upstream of the filter if the seal gas contains hydrogen chloride (HCl). Careful monitoring and regular changeout of the chloride trap adsorbent is required to prevent green oil formation which can cause premature failure of the primary seal.

Liquid contamination of the seal gas can cause premature failure of the seal due to excessive heat generation of the seal and/or direct impingement of liquid droplets on the seal face causing the seal to shatter. Hence the coalescer is typically specified with a liquid removal rating of 1 µm absolute. The filter is typically rated for a particulate removal rating of 3 µm absolute. The heater typically maintains the gas at least 11 °C (20 °F) above its dew point temperature in order to avoid condensation and formation of aerosol droplets in the process gas.

Advantages and Disadvantages

Dry gas seals have several advantages over oil film seals; seal oil systems, oil degassing and compressor equipment access problems are eliminated and maintenance costs are considerably reduced. Power requirements (and hence operating costs) are also reduced. Disadvantages include higher seal cartridge cost and the need for a barrier seal with reliable nitrogen supply at the outboard end of the dry gas seal assembly to prevent bearing lube oil reaching the seals.