

Observation:

During seal face inspection, the seal ring and mating ring exhibits a **distinct tapered contact pattern**, where the outer diameter (OD) of the sealing plane shows **significantly higher wear** compared to the inner diameter (ID). The following indicators are typically visible:

- Seal ring shows heavy, concentrated contact marks toward the OD, with contact gradually diminishing toward the ID.
- Mating ring displays a noticeably narrower contact band compared to the designed contact width
- Possible edge chipping or micro-fractures at the OD of the seal ring due to localized overloading.
- Loss of flatness becomes evident when the faces are checked on a lapping plate.

These visual indicators confirm that the seal faces did not remain parallel during operation, resulting in a coning of a seal ring, commonly referred to as **Negative Coning** or **Negative Rotation**.

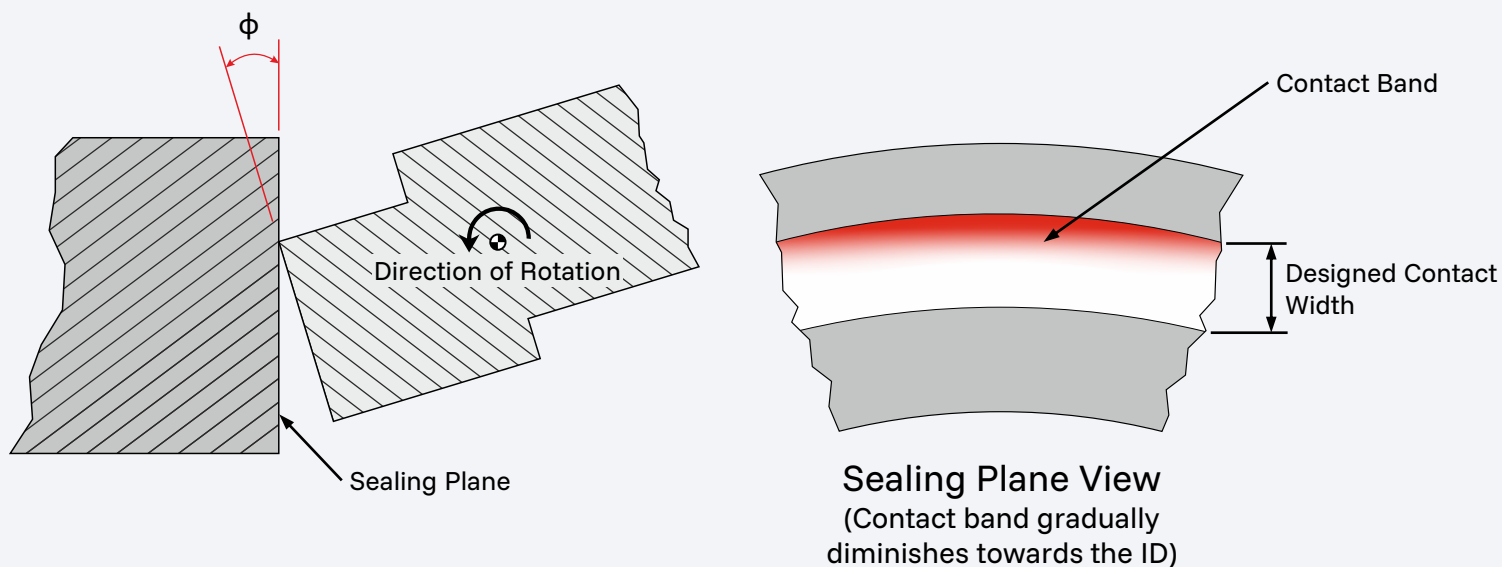


Image 1: Illustration of Angular Rotation and Sealing Plane View

What is ϕ ?

It is the **angular rotation** of the seal ring cross-section that produces seal face tilt, resulting in increased contact pressure toward either the outer diameter or inner diameter.



Image 2: Narrow Contact Band on Sealing Surface (Mating Ring)

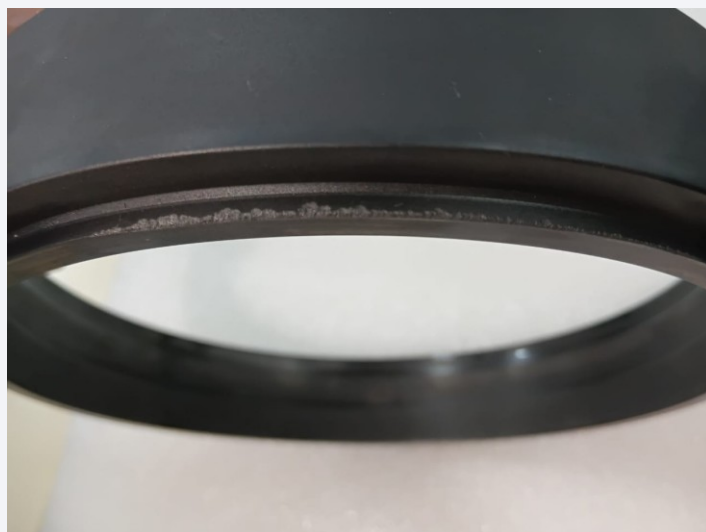


Image 3: Edge Chipping at OD of the Seal Ring.

Symptoms:

- **Steady leakage at low pressure**, caused by loss of parallelism and poor sealing at the inner diameter.
- **Little or no leakage at higher pressure**, as increased hydraulic closing force pushes the seal faces tighter at the outer diameter, temporarily masking the leakage.

Root Cause

Negative coning is primarily caused by **over-pressurization**, where excessive hydraulic load distorts the **seal ring cross-section** into a slight **conical shape**, resulting in heavier contact at the outer diameter of the sealing face.

However, it may also occur due to

- Faces not flat due to **incorrect lapping**, where a slight concavity of the seal face results in heavier contact at the OD.
- Excessive **swell** of **secondary seals**, which can push the seal ring unevenly and distort the sealing plane.
- **Improper** or **uneven** face **support surfaces**, causing the seal ring to deflect outward during operation.

Corrective Actions for Possible Root Causes:

Sr	Possible Cause	Corrective Action
1	Faces not flat due to over-pressurization	<ol style="list-style-type: none"> 1) Compare seal design pressure with operating pressure. <ol style="list-style-type: none"> a) If seal design pressure is lower, select a seal rated above the maximum operating pressure. b) If seal design pressure is higher, verify actual seal chamber pressure and pressure balance to ensure no unintended pressure amplification due to chamber configuration, balance ratio, pressure transients, or abnormal pressure buildup.
2	Faces not flat due to incorrect lapping (concavity of seal face)	<ol style="list-style-type: none"> 1) Re-lap seal faces to restore proper flatness. 2) Ensure proper lapping plate condition and procedure to avoid concavity or taper. 3) Verify final face geometry using optical flat or monochromatic light per manufacturer's guidelines; where unspecified, achieve a maximum of 2 light-bands.
3	Excessive swell of secondary seals	<ol style="list-style-type: none"> 1) Verify elastomer compatibility with process fluid and temperature; <ol style="list-style-type: none"> a) if compatible, check for excessive swell due to temperature excursions, contamination, aging, improper squeeze or over-constrained in their grooves. b) if incompatible, replace with a material with no or low-swell characteristics.
4	Improper or uneven face support surfaces	<ol style="list-style-type: none"> 1) Inspect seal ring support surfaces for flatness, cleanliness, and damage. 2) Correct machining errors, remove high spots, and ensure uniform face support to prevent localized deflection.