

Observation:

During seal face inspection, the seal ring and mating ring exhibit a **distinct tapered contact pattern** where the **inside diameter (ID)** of the sealing plane shows **noticeably higher wear** than the outer diameter (OD). Typical visual indicators observed on the seal ring and mating ring include:

- Seal ring shows heavy contact marks concentrated toward the ID, with contact gradually fading toward the OD.
- Mating ring displays a narrower contact band near the ID compared to the designed contact width.
- Possible edge chipping or micro-fractures at the ID of the seal ring due to localized overloading.
- Seal faces fail flatness verification during optical inspection.

These visual indicators suggest that the seal faces did not remain parallel during operation because of **non-uniform temperature distribution** across the seal face. Thermal gradients within the seal face body induce differential expansion, producing a conical face distortion known as **Thermal Distortion** or **Positive Coning**.

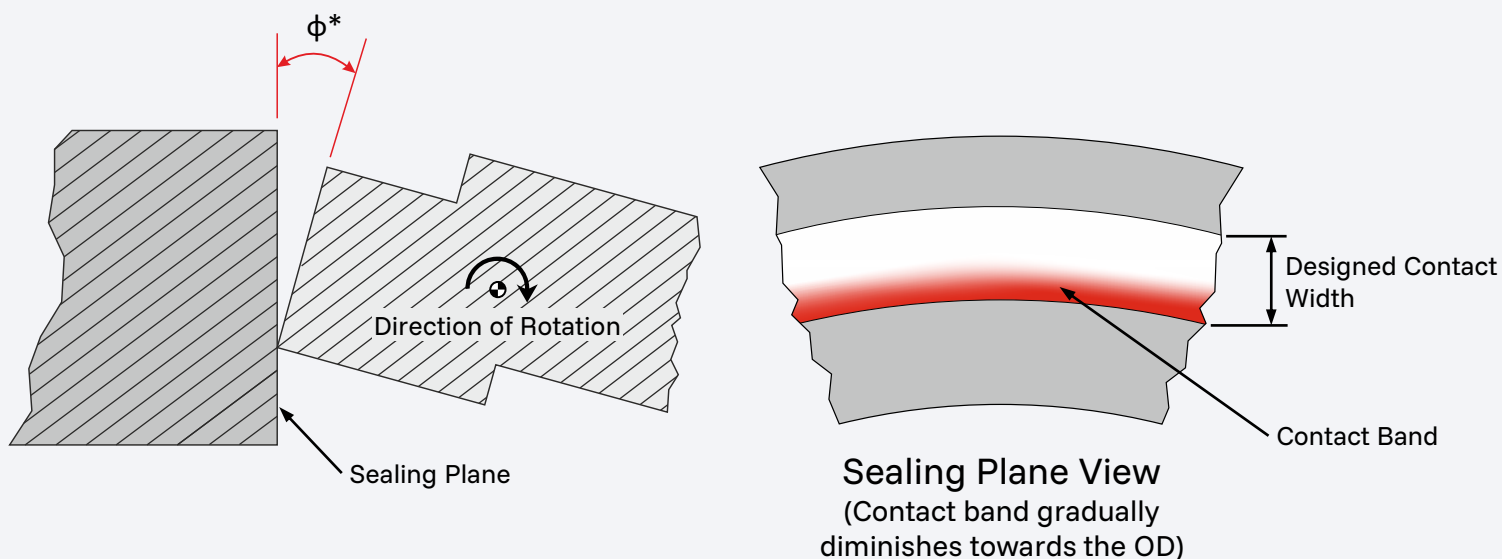


Figure 1: Illustration of Angular Rotation and Sealing Plane View

* Read Case #1: Heavy Outside Diameter Contact (Negative Coning) to understand ϕ .



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

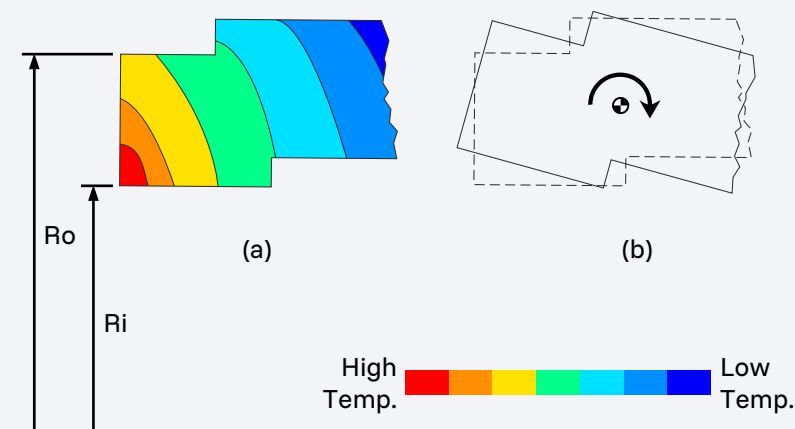


Figure 3: Thermally Induced Distortion:
a) Thermal gradient across seal ring,
b) Cross-sectional rotation (Positive Coning)

Symptoms:

- Seal leaks when the shaft is rotating and shows little or no leakage when stationary, as ID-dominant contact and associated thermal distortion develop only during dynamic operation.
- Leakage persists or progressively increases during operation, as thermally induced ID contact prevents stable film formation; changes in pressure may influence severity but do not eliminate leakage.

Root Cause

Positive coning is primarily driven by **thermally induced radial taper** resulting from **non-uniform temperature distribution** within the seal face. Frictional heat at the seal interface creates axial thermal gradients, with the face region operating hotter than the rear section (*Fig. 3*). The hotter face end expands more than the cooler back, causing cross-sectional rotation and a *radial taper* converging toward the inside diameter, leading to heavy ID contact, known as **Thermal Distortion** or **Positive Coning**.

However, improper face flatness due to **incorrect lapping** can be another possible contributing cause, where slight convexity of the seal face toward the inside diameter promotes ID-dominant contact.

Corrective Actions for Possible Root Causes:

Sr	Possible Cause	Corrective Action
1	Faces not flat due to thermal distortion	<ol style="list-style-type: none"> 1) Review seal thermal design against operating conditions. <ol style="list-style-type: none"> a) If the seal is not designed for the generated heat load (speed, face load, lubrication regime), select a design with higher thermal capacity, improved cooling features, or suitable face materials. b) If the seal is thermally rated for the application: <ol style="list-style-type: none"> i. Ensure there is no unintended heat buildup from inadequate flush flow; increase flush rate or review flush plan suitability if required. ii. Check seal chamber circulation to prevent hot fluid stagnation by reviewing chamber design, inlet/outlet locations, and flow paths. iii. Verify effectiveness of cooling arrangements (e.g., heat exchanger, jackets) and ensure coolant flow and temperature are within design limits. iv. Review face lubrication to ensure operation is not in mixed or boundary lubrication due to low pressure, poor fluid properties, or inadequate flush.
2	Faces not flat due to incorrect lapping (convexity 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.