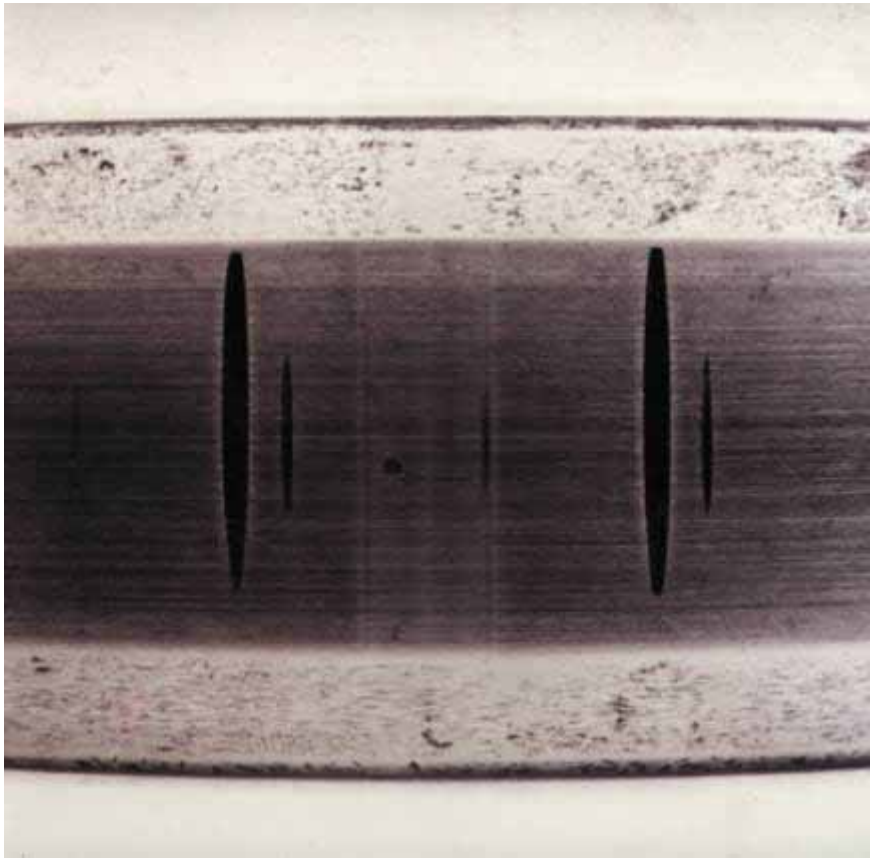
Lubrication

Bearing Failure Patterns and Trouble-shooting

Bearing Failure analysis

Symptoms
Causes
Remedies

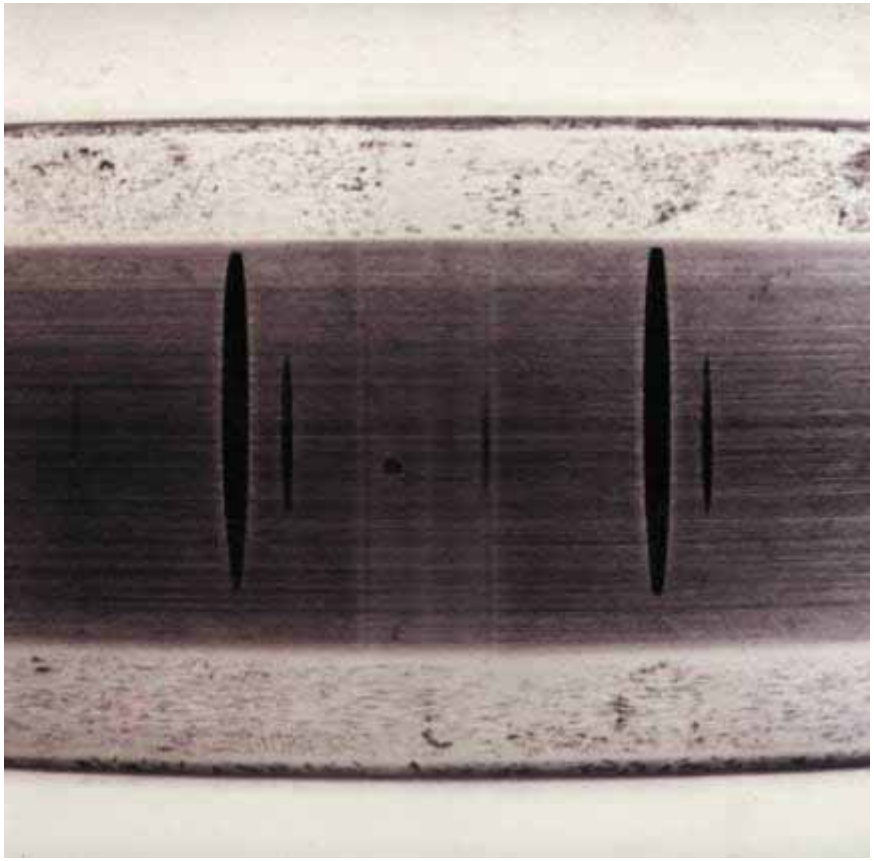
False Brinelling



Symptoms

- Elliptical wear marks in an axial direction at each ball position with a bright finish and sharp demarcation
- Often surrounded by a ring of brown debris

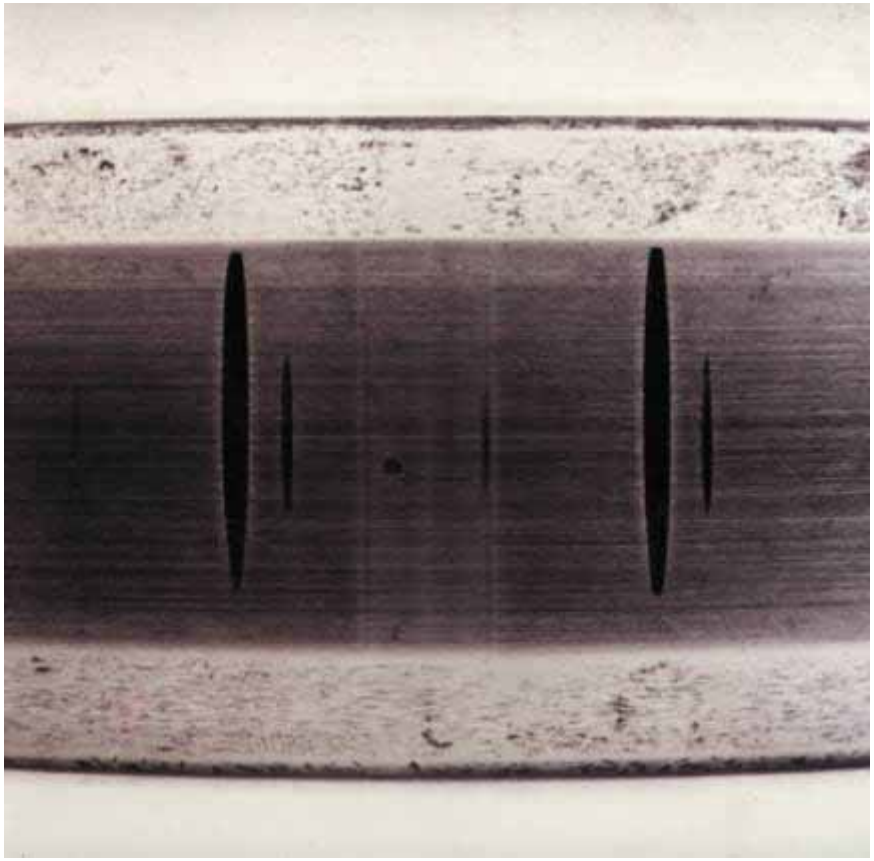
False Brinelling



Causes

- Vibrations in stationary machines leading to micro motion between rolling elements & raceways
- When the bearing is not turning, an oil film cannot be formed to prevent raceway wear

False Brinelling



Remedies

- eliminate or absorb external vibration
- use lubricants containing anti-wear additives

Overheating

Symptoms

- Discoloration of the rings, rolling elements and cages from gold to blue
- Temperatures in excess of 200°C can anneal ring and rolling element materials, reducing the bearing capacity and causing early failure

Overheating

Symptoms

- In extreme case, the bearing components will deform
- Temperature rise can also degrade or destroy lubricant

Overheating

Causes

- Heavy electrical heat loads
- Inadequate heat paths
- Insufficient cooling or lubrication when loads and speed are excessive

Overheating

Remedies

- Thermal or overload controls
- Adequate heat paths
- Supplemental cooling

Outer Ring Fracture

Symptoms

- Typically a crack spreads evenly in the circumferential direction, with several fractured pieces often originating
- With axial load, fractures usually occur a little beyond the middle of the raceway
- Outside outer ring shows irregular load pattern

Outer Ring Fracture

Causes

- Poor support of the rings in the bearing housing

Outer Ring Fracture

Remedies

- Improvement in bearing mounting
- Follow mounting instructions for appropriate recommendations

Misalignment

Symptoms

- A wear path not parallel to raceway edges on the raceway of the no rotating ring

Misalignment

Causes

- Bent shafts
- Burrs or dirt on shaft or housing shoulders
- Shaft threads that are not square with shaft seats
- Locking nuts with faces that are not square to the thread axis

Misalignment

Remedies

- Inspect shafts and housings for run-out of shoulders and bearing seats
- Use single point-turned or ground threads on non-hardened shafts and ground threads only on hardened shafts
- Use precision grade locknuts

Slippage Tracks

Symptoms

- Spotted smear marks
- Roughening of rolling elements or raceways

Slippage Tracks

Causes

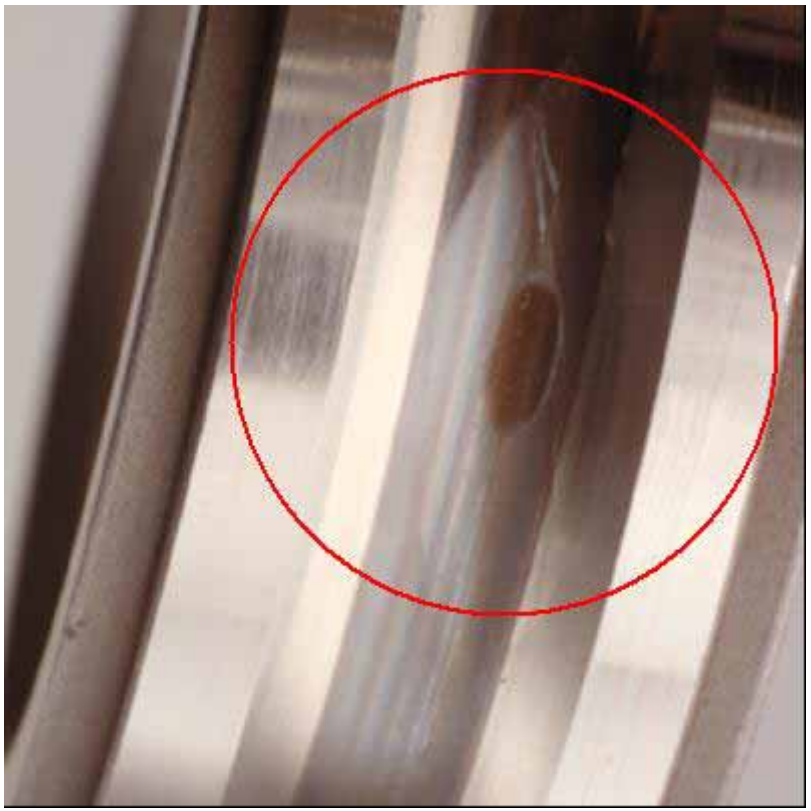
- Rolling elements slide on the raceways when the load is low and lubrication is poor
- Occasionally occurs if load zones are too short, causing rolling elements to
- Also, fast changes in speed brake in the unloaded zone and accelerate again when entering the load zone

Slippage Tracks

Remedies

- Select bearings with lower load carrying capacity
- Preload bearings
- Reduce bearing clearance
- Improve lubrication

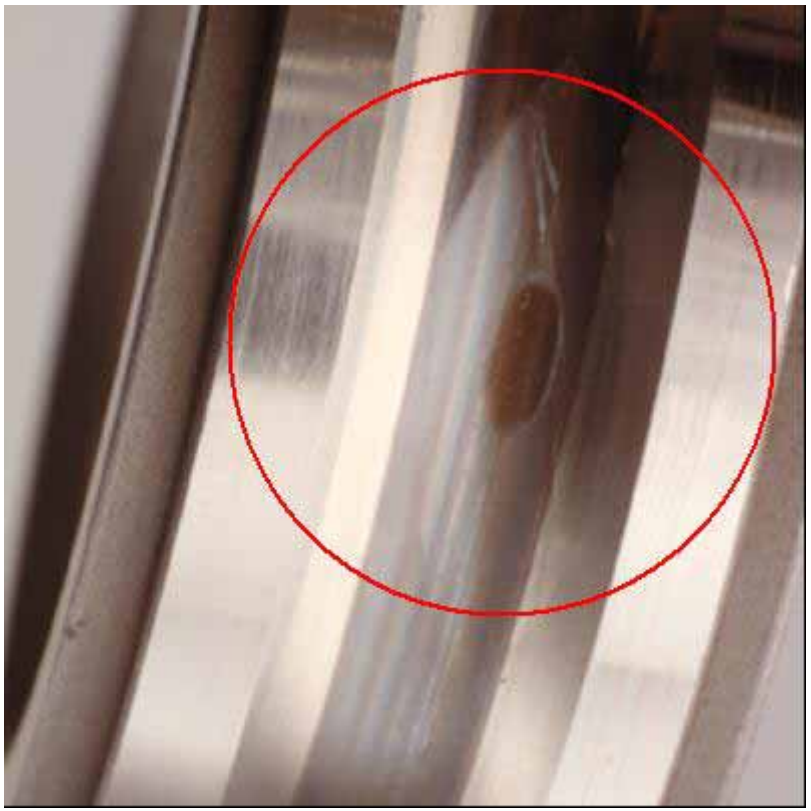
Tight Fits



Symptoms

- A heavy rolling element wear path in the bottom of the raceway

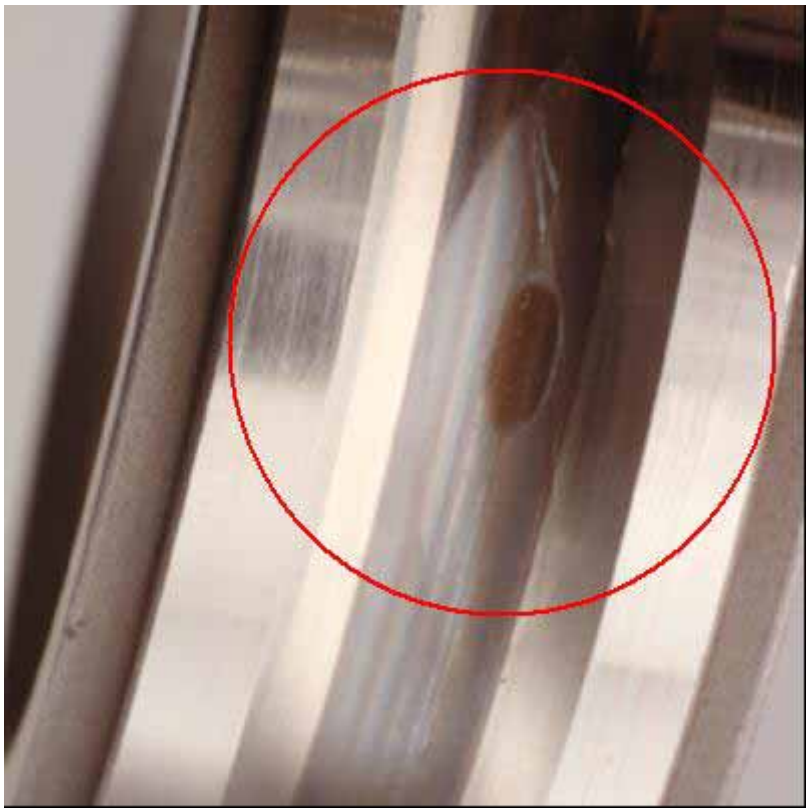
Tight Fits



Causes

- Excessive loading of the rolling elements when interference fits exceed the radial clearance at operating temperatures
- Continued operation under such conditions leads to rapid wear and fatigue

Tight Fits



Remedies

- Decrease total interference with better matching of bearings to shafts and housings
- Consider operating temperatures
- Increased radial clearance in bearing selection

Axial Cracks

Symptoms

- Inner ring partly or completely cracked in the axial direction
- Slightly rounded fractured edges indicate that the fracture originated during operation and was cycled (cracked edges may break off after prolonged operation)
- Sharp edged cracks indicate fracture during dismounting

Axial Cracks

Causes

- Bearing slippage
- Rotation of inner ring on the shaft
- Inadequate lubrication
- Too tight of fit to shaft
- Grooved shaft
- Out-of-roundness
- Grazing against surrounding parts

Axial Cracks

Remedies

- Improve lubrication with additives or increased oil quantities
- Select suitable fit
- Avoid grazing
- Provide for better seating conditions
- Consider special heat treatment for rings

Normal Fatigue

Symptoms

- Often referred to as spalling; indicated by the fracture of the running surfaces and subsequent removal of small discrete particles of material from the inner ring, outer ring or rolling elements
- Spalling is progressive, and once initiated will spread with continued operation
- Always accompanied by a noticeable increase in vibration

Normal Fatigue

Causes

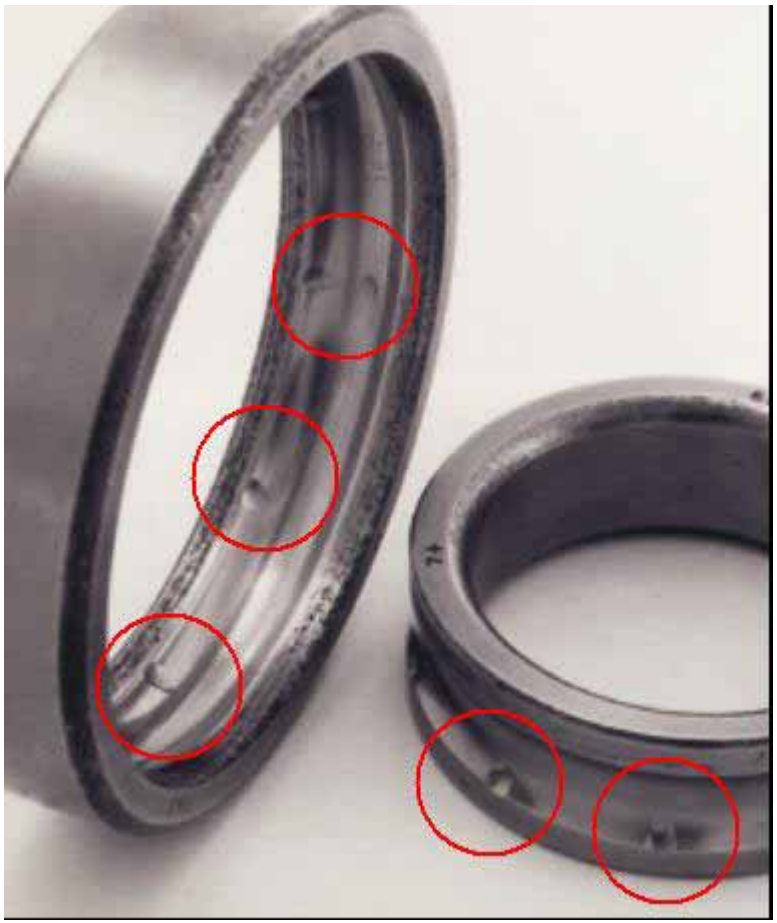
- Bearing has remained in operation beyond its calculated fatigue life

Normal Fatigue

Remedies

- Replace the bearing and/or consider redesigning to use a bearing with a greater calculated fatigue life

True Brinelling



Symptoms

- Brinell marks appear as indentations in the raceways, increasing bearing vibration (noise)
- Severe brinell marks can cause premature fatigue failure

True Brinelling

Causes

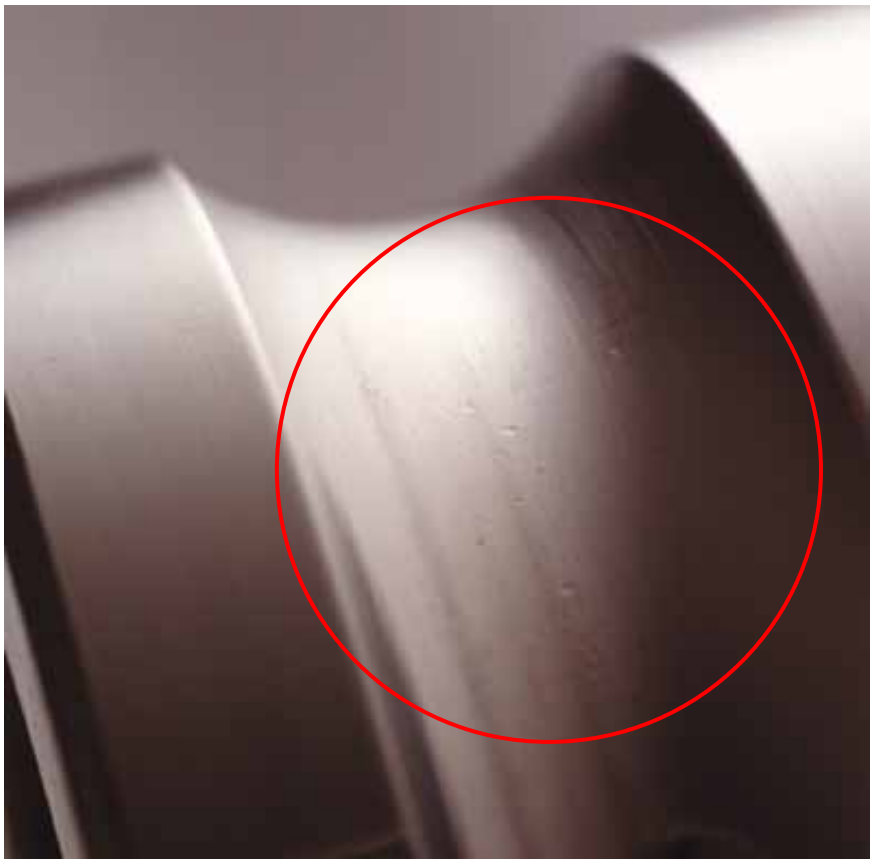
- Static overload of the bearing
- Severe impact to the bearing
- Using a hammer to install the bearing
- Dropping or striking assembled equipment
- Pressing a bearing onto the shaft by applying force to the outer ring

True Brinelling

Remedies

- Observe static load ratings in making bearing selection
- Install bearings using appropriate equipment and by applying force only to the ring being press-fitted

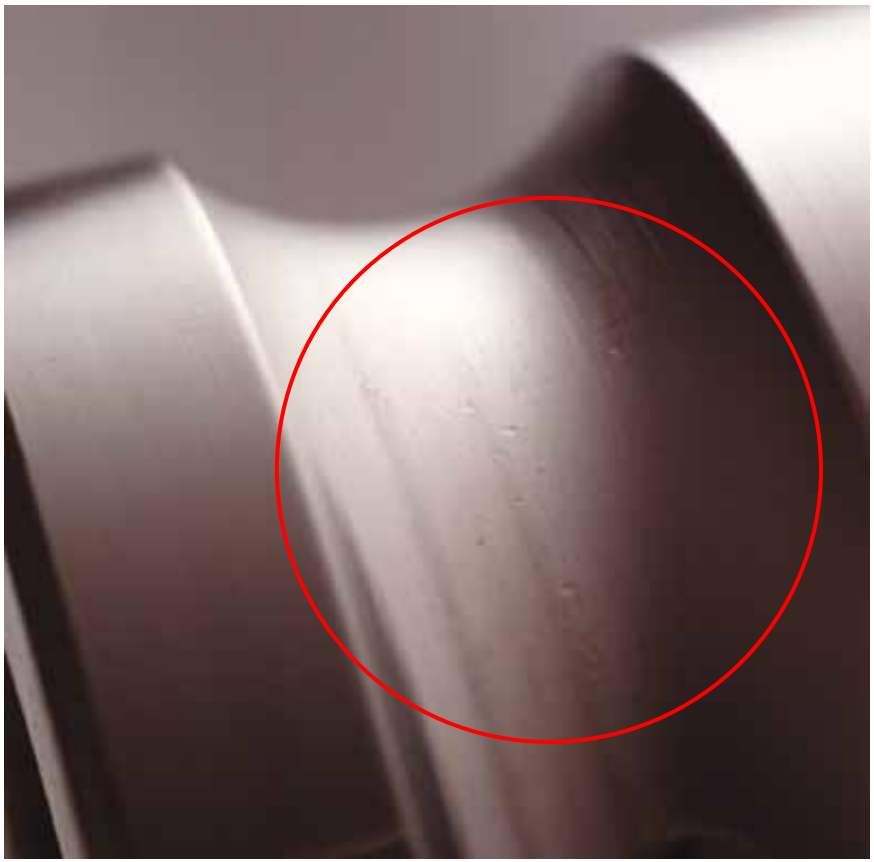
Contamination



Symptoms

- Denting of rolling elements and raceways, causing vibration

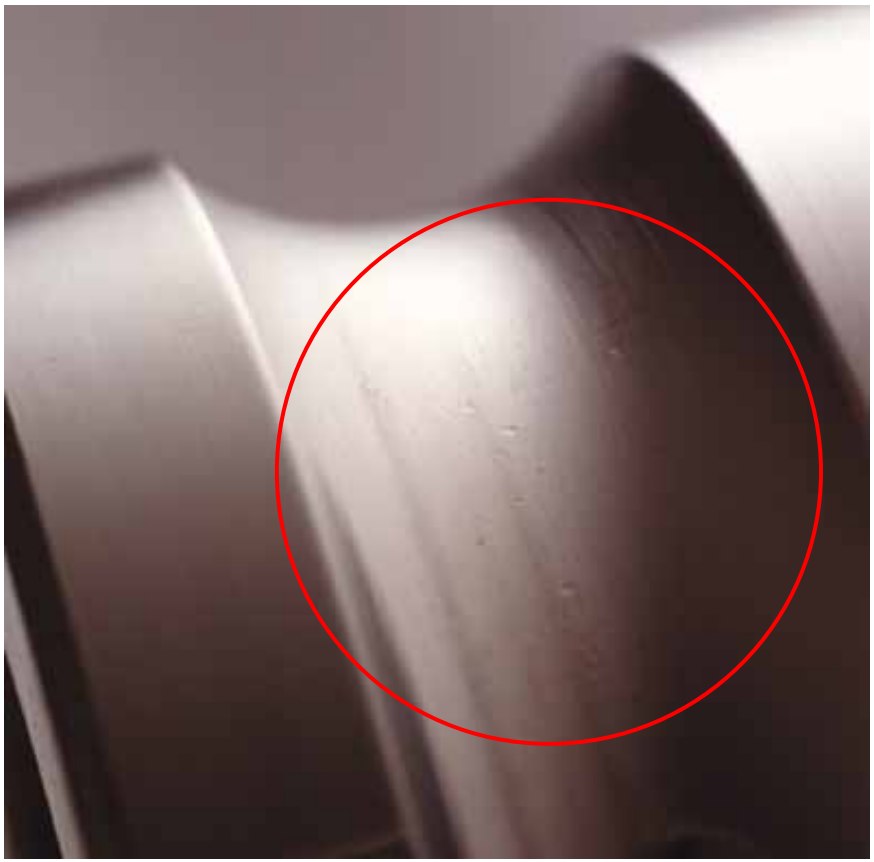
Contamination



Causes

- Air-born dust, dirt or abrasive substances from contaminated work areas
- Dirty hands or tools
- Foreign matter in lubricants or cleaning solutions

Contamination



Remedies

- Clean work areas, tools, fixtures and hands reduce the risks
- Isolate bearing assembly area from any grinding operations
- Leave bearings in their original packaging until time of installation
- For contaminated operating environments,sealing arrangements should be considered

Lubricant Failure

Symptoms

- Discolored rolling elements (blue/brown) and rolling element tracks
- Excessive wear of rolling elements, rings, and cages follow, resulting in overheating and catastrophic failure

Lubricant Failure

Causes

- Restricted lubricant flow
- Excessive temperatures that degrade the lubricant

Lubricant Failure

Remedies

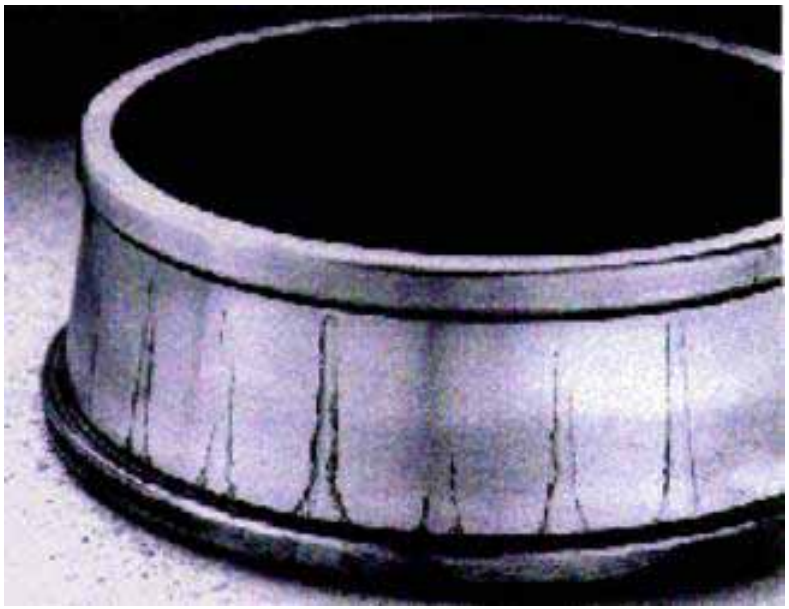
- Use of the appropriate and correct amount of lubricant
- Ensure proper bearing fit
- Control preload to reduce bearing temperatures

Corrosion

Symptoms

- Corrosion results from the chemical attack on bearing materials by hostile fluids or atmospheres
- Red/brown stains or deposits on rolling elements, raceways or cages
- Increased vibration followed by wear
- Increase in radial clearance or loss of preload

Corrosion



Causes

- Exposing bearings to corrosive fluids or atmospheres

Corrosion

Remedies

- Divert corrosive fluids away from bearing areas
- Use integrally sealed bearings
- Consider external seals for particularly hostile environments

Fluting

Symptoms

- Brownish marks parallel to the axis on a large part of the raceway, or covering the entire raceway circumference

Fluting

Causes

- Electrical Fluting occurs when a current is passed through the bearing, instead of to a grounded source.
- Constant passage of alternating or direct current
- Even low currents

Fluting

Remedies

- Prevent currents from flowing through the bearing by means of grounding or insulating
- Use current insulated bearings

Excessive Loads

Symptoms

- Heavy rolling element wear paths
- Evidence of overheating
- Widespread fatigue areas (spalling)
- Symptoms are the same as normal fatigue, although showing heavier ball wear paths, greater evidence of overheating, and a more widespread and deeper spalling (fatigue area)

Excessive Loads

Causes

- Excessive loading of the bearing

Excessive Loads

Remedies

- Reduce the load
- Redesign using a bearing with greater capacity

Lip Fractures

Symptoms

- Supporting lips are partly or completely broken off or cracked

Lip Fractures

Causes

- Axial load unacceptably high
- Lip insufficiently supported
- Axial shock load
- Mounting damage

Lip Fractures

Remedies

- Ensure good lip support design
- Keep load within specified limits
- Observe appropriate mounting instructions & procedures

Fretting

Symptoms

- Fretting, the generation of fine metal particles which oxidize, leaving a distinctive brown color
- Wear at the fitting surfaces causing noise & runout problems
- Possible fatigue fracture
- Possible disturbance of floating bearing function

Fretting

Causes

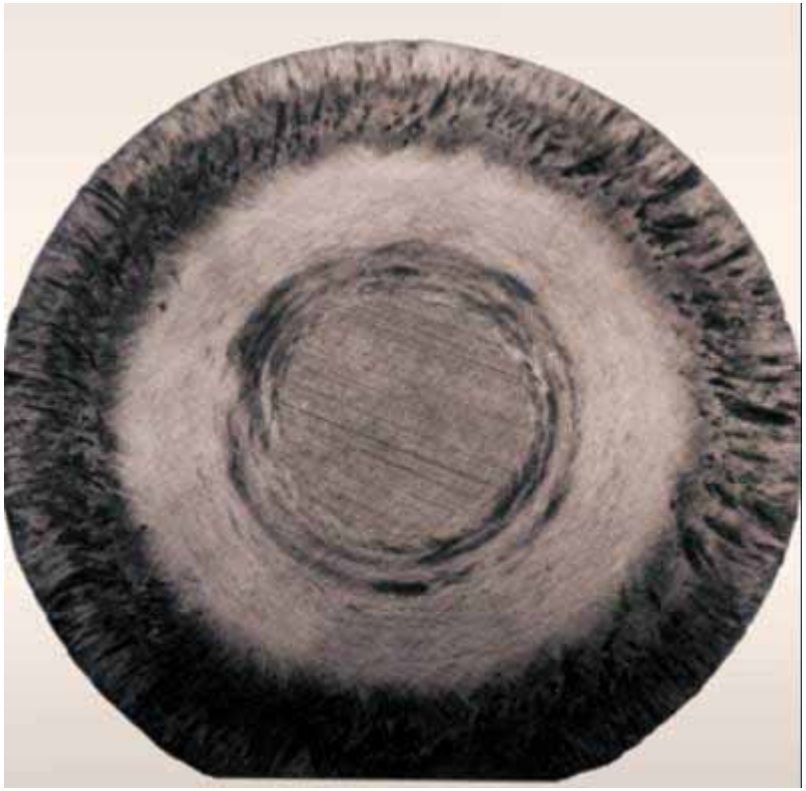
- Micro motion between fitted parts where the fits are too loose in relation to the acting forces

Fretting

Remedies

- Follow mounting instructions for appropriate fit recommendations

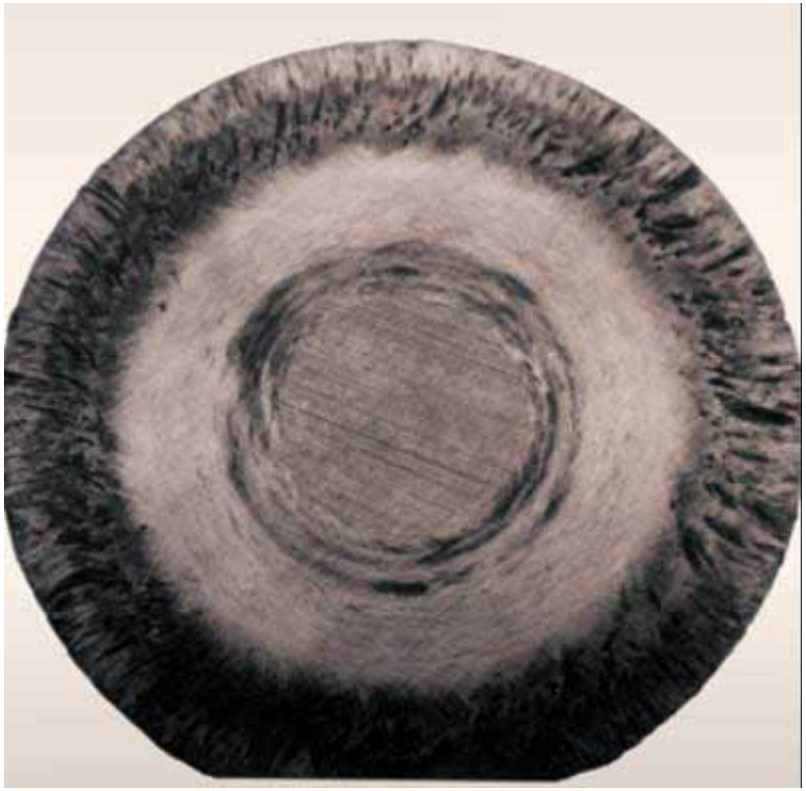
Seizure



Symptoms

- Partial or large-area welding and deep scratches in the lip and roller face areas
- Also lubricant coking in this area

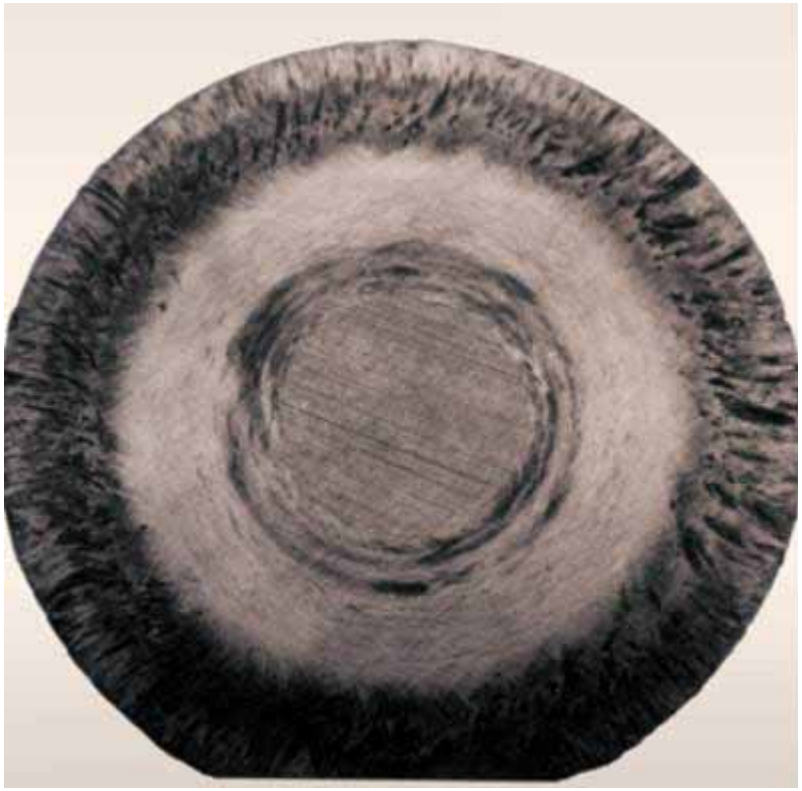
Seizure



Causes

- Inadequate lubrication with high loads and high speeds (quantity or operating viscosity of lubricant too low)
- Inadequate lubrication with high loads and low speeds (when there is no hydrodynamic lubricating film between the roller face and lip)

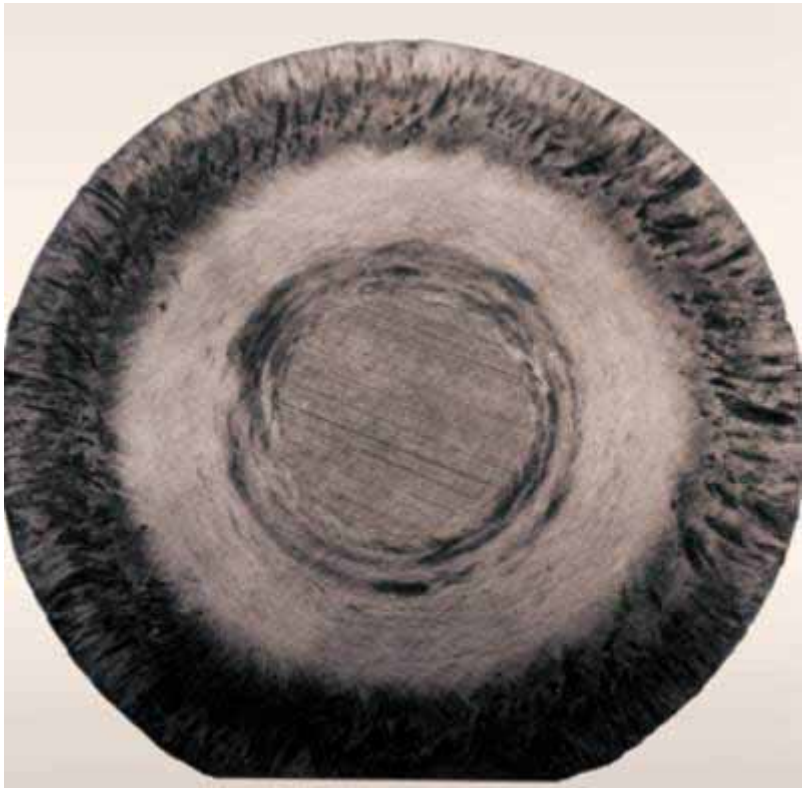
Seizure



Causes

- Detrimental preload due to heat expansion
- Skewing of rollers due to raceway wear or ring tilting
- Axial load too high on cylindrical roller bearings
- Axial preload too high for out-of-square mating surfaces

Seizure



Remedies

- Improve lubrication (increase viscosity, EP additives, increase quantity)
- Ensure correct adjustment of bearings

Reverse Loading

Symptoms

- Balls will show a grooved wear band caused by the ball riding over the outer edge of the raceway
- Failure mode is very similar to that of heavy interface (tight) fits.

Reverse Loading

Causes

- Angular contact ball bearings are designed to accept an axial load in one direction only
- When loaded in the opposite direction, the elliptical contact area on the outer ring is truncated by the low shoulder on that side of the outer ring

Reverse Loading

Causes

- Result is excessive stress and an increase in temperature, followed by increased vibration and early failure
- A thrust load applied to the wrong bearing face results in a wear band on the balls.

Reverse Loading

Remedies

- Ensure proper installation of angular contact bearings