NTN

ELECTRIC MOTORS

The most common causes of bearing failures

Summary

THE MOST COMMON CAUSES OF BEARING FAILURES IN INDUSTRIAL ELECTRIC MOTORS

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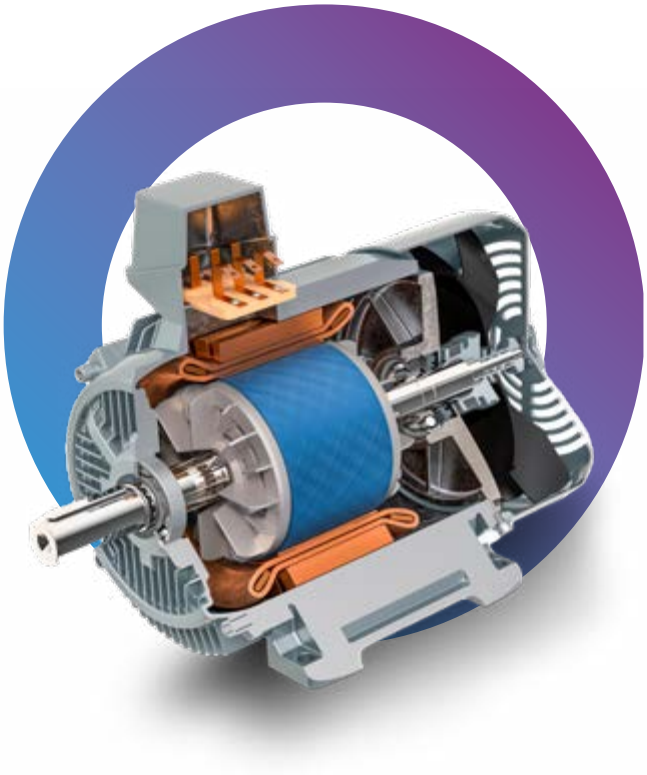
This NTN manual is intended for designers and end customers of industrial electric motors and servo motors. With the objective of providing recommendations based on our years of expertise and partnership with the leading manufacturers and end users in the segment.

Electric motors are crucial elements of the industrial landscape because their performance is decisive for the smooth operation of factories, production lines,... in the most diverse sectors.

With approximately 8 billion electric motors in use in the EU, consuming nearly 50% of the electricity produced by the EU, the performance of electric motors is subject to evolving regulations in order to contribute to energy conservation efforts.

From motor design to motor handling, the bearing is one of the critical components to ensure both performance and maximum availability. More than 50% of electric motor failures are related to defective bearings.

This manual will provide you with tips and tricks on three of the most common bearing failures.



LUBRICATION

Three main purposes of the lubricant

- To separate the surface of the rolling elements by a protective film and thus, avoid metal-to-metal contact, reduce friction and wear
- To protect the bearing and related components from corrosion
- To protect the bearing from contaminants

Proper lubrication is an absolute “MUST” to ensure maximum reliability and availability of engine operation.

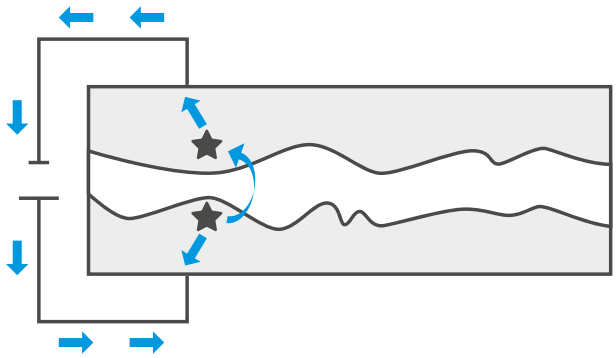
3 points of attention that have a particular impact on electric motors:

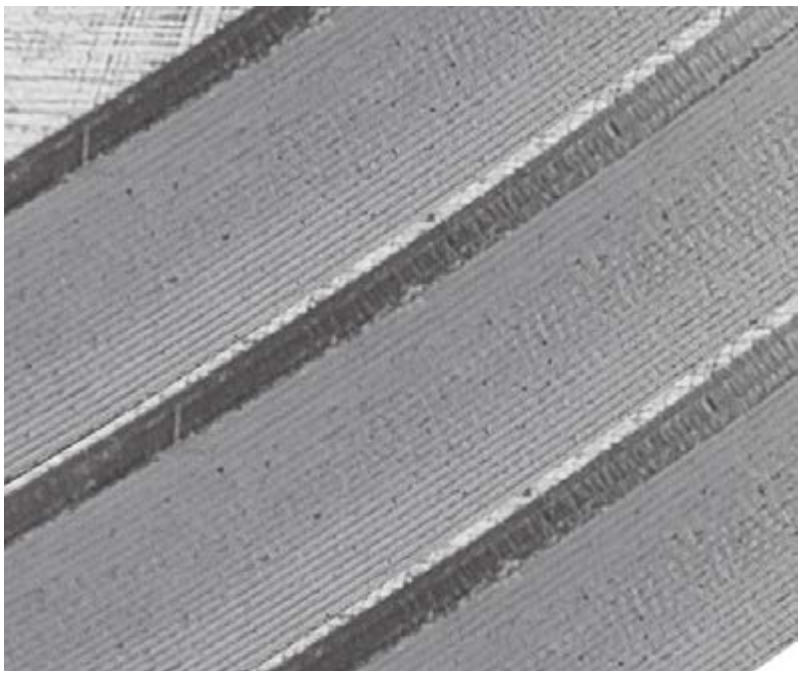
- Insufficient lubrication
- Excessive lubrication
- Cross mixing or wrong lubricant

> **55%** of premature bearing failures can be prevented with proper lubrication.

Insufficient lubrication

Insufficient lubrication does not allow the oil film to be established permanently and metal-to-metal contact occurs between the rolling elements and the raceways, resulting in increased in frictional heat in the bearing. This has a direct impact on the bearing, causing seizure and shortening its service life.





Excessive lubrication

Excessive lubrication can cause an increase in operating temperature, which will lead to overheating of the bearings, failure of the bearings and an increased risk of grease leakage and pollution of surrounding parts.

In addition, excess grease can cause the rolling elements to slip on the raceways, resulting in overheating, intermittent noise and premature bearing wear.

Cross mixing or wrong lubricant

Grease compatibility is a key consideration when selecting a lubricating grease for electric motor.

Grease is a complex blend of chemicals - base oil, additives and thickener. Motor bearings require the right combination of lubrication performance characteristics for the application. Failure to provide these properties is certain to compromise motor reliability.

Mixing greases can cause many problems, as the components of greases are not compatible with each other. The chemicals can react negatively with each other, which affects their functionality. For example, incompatibility can cause the base oil and thickener to separate and compromised lubrication performance.

It is generally not advisable to mix two lubricating greases. If two greases are mixed (e.g. when changing the grease in a lubrication system), check the compatibility of the two greases beforehand.

Oil	Mineral	PAO Poly Alpha-Olefin	Ester	P. Poly glycol	Polyphenyl ether	Silicone (Methyl)	Silicone (Phenyl)	Fluorinated
Mineral	C							
PAO Poly Alpha-Olefin	C	C						
Ester	C	C	C					
P. Poly glycol	NC	NC	C	C				
Polyphenyl ether	C	C	C	NC	C			
Silicone (Methyl)	NC	NC	NC	NC	NC	C		
Silicone (Phenyl)	C	C	C	NC	C	C	C	
Fluorinated	NC	NC	NC	NC	NC	NC	NC	C

Legend C : Compatible - NC : Not Compatible.

Thickener	Anhydrous calcium soap	Calcium complex soap	Lithium soap	Lithium complex soap	Lithium / calcium soap	Aluminium complex soap	Bentone silica gel	Polyurea	Fluorinated
Anhydrous calcium soap	C								
Calcium complex soap	NC	C							
Lithium soap	C	NC	C						
Lithium complex soap	C	C	C	C					
Lithium / calcium soap	C	NC	C	C	C				
Aluminium complex soap	C	NC	NC	NC	NC	C			
Bentone silica gel	C	NC	NC	NC	NC	NC	C		
Polyurea	C	C	C	C	NC	C	NC	C	
Fluorinated	NC	NC	NC	NC	NC	NC	NC	NC	C

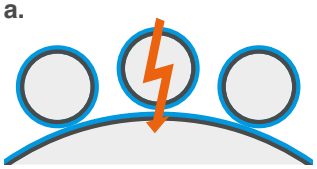
Legend C : Compatible - NC : Not Compatible.

Finally, the wrong choice of lubricant is another cause of problems. For electric motors, speed and temperature are two critical operating conditions. Grease viscosity should be chosen with these two parameters in mind, with low viscosity grease generally preferred for high speeds and higher viscosity recommended for high operating temperatures.

ELECTRICAL EROSION

Electrical erosion often occurs in bearings used in electrical equipment due to current leakage. An electric current in the vicinity of a bearing can flow through the bearing, causing an arc between the rolling elements and the rolling surface. The arc created will raise the temperature of the steel at the point of arcing and change the structure of the steel material, ultimately causing the bearing to fail. It will also affect the grease and cause increased noise and vibration levels.

a.

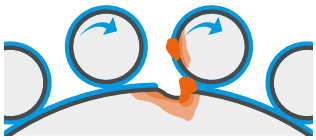


Current chooses the lowest resistance path to the ground, which sometimes runs through the bearing

b.

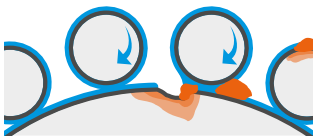
Current leakage then causes arcing between rolling elements and rings raceways, leading to weaknesses in the material

c.



Tiny metal particles break away from bearing components

d.



These particles will move inside the bearing and can cause pitting or fluting

The increasing use of Variable Frequency Drives (VFDs) has also amplified the number of occurrences. While VFDs offer obvious advantages in reducing energy costs and matching speed / torque / power to process requirements, they can also damage the motors they control. This is because they induce stresses on the motor shafts that can discharge through the bearings, causing pitting, splitting and ultimately failure.

Without bearing protection, the savings from using VFDs can be quickly offset by the cost of motor replacement and system downtime.

This electrical pitting can be avoided by using insulated bearing at the non-drive ends. There are 2 types of insulated bearings: coated bearings or ceramic hybrid bearings.

VIBRATION

Electric motors can be subjected to vibrations of many different origins. In all cases, they can cause serious damage and significant downtime. Bearings can both be the source of vibration and be subjected to it if it has another origin.

Causes of electric motor vibration

- Misaligned gears
- Imbalances
- Loose foundation
- Wear and tear
- Foundation misalignement
- Vibration caused by the bearing

Vibration caused by a factor other than the bearings

They will cause premature bearing failure:

MISALIGNED GEARS

Motor gears frequently produce vibration because they mesh with each other, but not in a negative direction, until they are misaligned. When gear teeth begin to lose contact or are broken and worn, they can rub against each other, causing a dangerous vibration.

IMBALANCES:

Imbalance can be caused by mechanical defects or maintenance problems. As the motor speed increases, the imbalance increases and begins to reduce the life of the motor and bearings.

LOOSE FOUNDATION:

Mounting bolts must be securely fastened, as vibration can cause them to loosen during operation. When a motor is improperly attached to its mounts, vibration can further damage the bearings. Improper mounting can cause wear and fatigue on the mounts and other motor components.

WEAR AND TEAR:

General wear and tear on a motor, whether it's roller or ball bearings, gears or drive belts, causes vibrations. When a roller bearing raceway is rutted, the bearings can create movement every time they pass over the pitted area. A chipped gear tooth or the worn drive belt can also create vibration.

FOUNDATION MISALIGNMENT:

There are two types of misalignment :

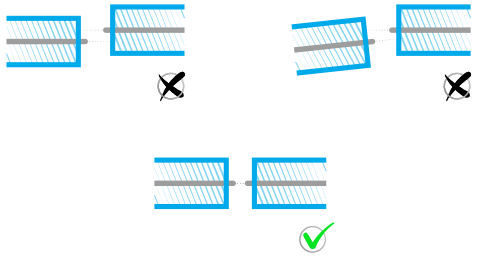
1. Angular misalignment occurs when the axes of a motor are not parallel.

2. Parallel misalignment is when the axes are parallel but not aligned.

Either can develop over time or be the result of poor assembly. If misalignment occurs over time, it may be due to component displacement, faulty reassembly or thermal expansion, causing radial or axial vibration.

Proper alignment between the axes of the motor and the driven equipment shafts is essential to ensure smooth and efficient power transmission between the two parts.

Misalignment can occur during both the manufacturing and repair processes. In addition to deteriorating performance, misalignment produces excessive vibration, noise, coupling and increased bearing temperature. It also causes excessive forces in the bearings, resulting in premature bearing failures with all the consequences that entails.



Vibration caused by the bearing

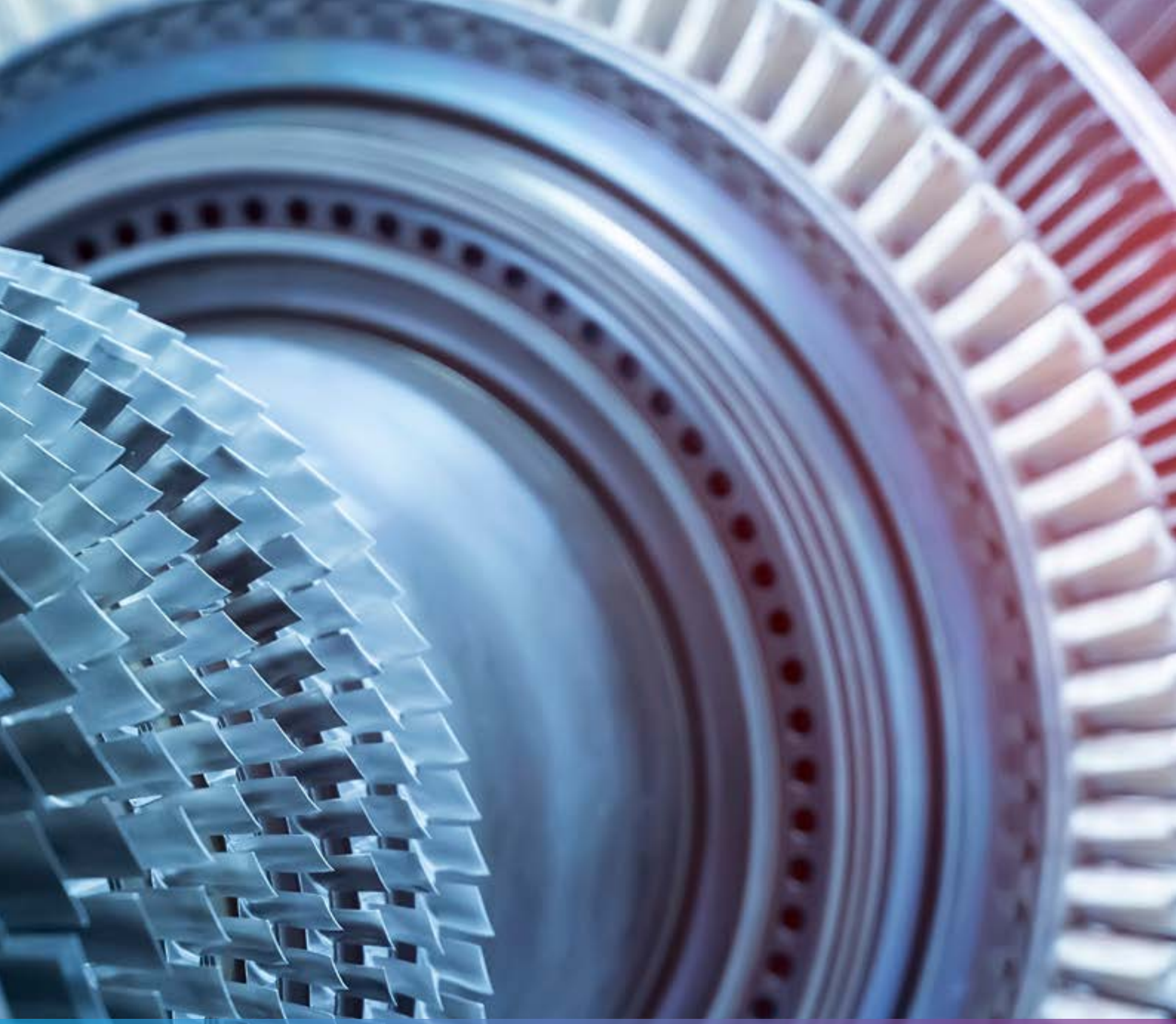
Loose bearings are the beginning of other motor malfunctions. Particular attention should be paid to the choice of shaft and housing connections as well as the choice of bearing internal clearance. Excessive clearance or loose connections will cause vibrations that will be transmitted to other components.

If the outer ring is poorly fitted (light alloy housing and thermal expansion, need for a floating bearing, etc.), this can lead to creep. In this case, a special design with an anti-creeping «feature» should be considered.

Alignment tolerances

Motor speed	Parallel offset (mils) short flex couplings		Angular misalignment (mils per inch) spacer couplings	
	Excellent	Acceptable	Excellent	Acceptable
900	3,0	6,0	1,2	2,0
1,200	2,5	4,0	0,9	1,5
1,800	2,0	3,0	0,6	1,0
3,600	1,0	1,5	0,3	0,5

Source: Alan Luedeking, Ludeca, Inc. «Shaft versus Foot Alignment Tolerances: A Critique of the Various Approaches.» 2008.



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