

13 Bearing Failures analysis

In general, if rolling bearings are used correctly they will survive to their predicted fatigue life. However, they often fail prematurely due to avoidable mistakes. In contrast to fatigue life, this premature failure is caused by improper mounting. Handling, or lubrication, entry of foreign matter, or abnormal heat generation.

Bearing is a precise basic part of machinery. It is surely important that manufacturers supply high quality products that meet and satisfy the requirement of machinery in which the bearings. Yet it is even more important to use the bearing correctly. The bearing is inspected for quality, but premature failures may occur after mounting such as seizure. During rotating, flaking on the rolling surfaces and cage wear. The result indicates that the premature failure is mostly caused by mounting error.

13.1 Failures detecting

1) Contact fatigue failure

Contact fatigue failure refers to the failure of bearing caused by the repeat contacts of alternate stress on its rolling surface. Contact fatigue flaking happened on the rolling surface, and often accompanied with fatigue cracks, which occurs at the point of maximum alternate stress beneath the contact surface, and then reaches up to the surface with different forms, such as dotted flaking and sliced flaking. Along with the expanse of flaking, the flaking spread to the deeper of rolling surface and form deep flaking. Deep flaking is the fatigue source of contact fatigue failure.

2) Wear failure

Wear failure is related to the continuous abrasion of rolling surface caused by the relatively sliding friction between contact surfaces. Continuous abrasion would cause gradual failure of bearing component, and ultimately result in the loose of dimensional precision, biggest noise, and other related problems. Abrasion is likely to cause the shape change, fit clearance

increase and change of rolling surface. Besides, abrasion may also influence lubricant and make its contamination reach a certain level. Consequently, the bearing is deprived of its lubricating function

completely or even the running accuracy, which makes the normal running impossible. Wear failure is the most frequent failure in all type of bearings, which include particle abrasion and friction abrasion.

Particle abrasion is induced by the foreign matter like metal powder entered into the rolling surface. The abrasion often bring about furrow-like scratches on the bearing working surface. The foreign matter may come from the internal of machine in which bearings are mounted and other accessory component in the machine system via lubricating medium.

Friction abrasion refers to the asymmetric force on the friction surface caused by micro crown or impurity on the friction surface. When lubricating function severely fails, frictional heating on part of the surface will bring about deformation of friction surface and friction welding phenomenon on the friction surface. In severe cases, the surface metal may melt partly and force on the contact surface would make friction welding point cause plastic deformation. This phenomenon slightly caused friction abrasion. Generally speaking, abrasion is referred to as scratch, while severe friction is called seizure.

3) Fracture failure



The fracture failure of bearing is mostly caused by defect of materials and the over heavy load. The fracture that occurs when imposed load exceeds the limit of strength of materials is called overload fracture. The causes of overload is primarily related to the sudden failure of machine or improper installation. In case of impact load or strenuous vibration, defects such as tiny crack of bearing, shrinkage, bubble, big foreign matter, overheated structure as well as partial burnt etc. would cause fracture defective points. Therefore the review of imported raw material and quality control of forging and heat treatment must be reinforced in the course of manufacture. C&U group always hold a strict control for this.

4) Clearance change failure




Internal clearance change refers to the "seizure" caused by change of original fit clearance and loss of accuracy under the influence of external or internal factor. The main cause of internal clearance change failure include external factors such as over-sized shrink range, improper installation, temperature raise, instantaneous overload etc. as well as internal factors such as unstable state of retained austenite and residual stress.

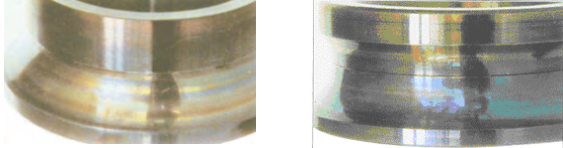
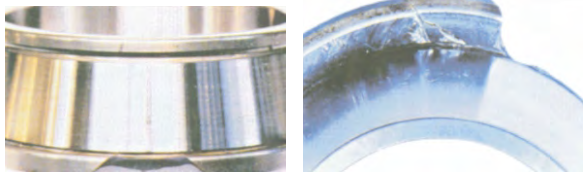

Learning from the common failure mechanism and failure mode of bearing, premature failure mostly related to such factors as manufacturing precision of machine fitting position region, installation quality, working conditions, lubricating effect, exterior impurity penetration, heating effect as well as sudden failure of machine etc. Therefore, the correct and reasonable use of bearing is systemic engineering. The service life of bearing and machine could be effectively advanced if we adopt relevant steps targeting the cause of failure in the process of structure design, manufacture and installation of bearing. C&U group can work out reasonable system solutions according to needs of different customers. Please contact the technical center of C&U group for details. Table 13.1 illustrates some representative examples of bearing failures.




Table 13.1 Forms and graphics of rolling bearing failure*

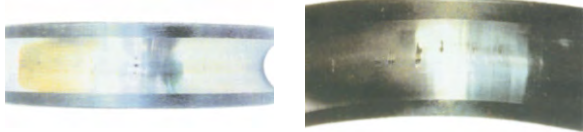
Phenomena	
<p>Premature failure</p> <p>When bearing rotates under load, the materials of inner & outer raceway groove or the surface of rolling element occurs scaled phenomenon due to reiterative stress cycle.</p>  	<p>Causes</p> <ul style="list-style-type: none"> ● Unsatisfactory precision of shaft and bearing housing, insufficient rigidity of bearing housing ● Overloading of bearing ● Large deflection of shaft ● Impurity invasion, water penetration ● Insufficient lubrication, improper lubricant ● Inadequate bearing internal clearance ● Scratched and brinelling <p>Countermeasures</p> <ul style="list-style-type: none"> ● Inspect the size of load and reexamine the bearing that is used ● Improve method of mounting ● Improve sealing device, rust preventive during shutdown ● Change viscosity of lubricant and adopt relevant lubricating method ● Inspect precision of shaft and bearing housing ● Inspect internal clearance

*Pictures collection for failures reference

Phenomenon	
Wear Wear mostly occurs to sliding friction surfaces such as roller end surface, rib surface, cage pocket surface as well as guide surface of bearing ring etc. The occurrence of these phenomena is not directly related to fatigue of materials.	<div>Causes</div> <ul style="list-style-type: none"> ● Impurity penetration, rustiness electric pitting ● Unsuitable or insufficient lubricating ● Creep caused by irregular movement of rolling element <div>Countermeasures</div> <ul style="list-style-type: none"> ● Improve sealing device ● Reconsider choice of lubricant and lubricating method ● Clean bearings
	
Burn Bearing rings, rolling elements as well as cages heat up quickly until occurrence of discoloration, softening, fusion and abrasion.	<div>Causes</div> <ul style="list-style-type: none"> ● Overload of bearing (too much preload) ● Rotation speed is too high ● Clearance is too small ● Water and impurity penetration ● Inaccuracy of shaft bearing housing, large deflection of shaft <div>Countermeasures</div> <ul style="list-style-type: none"> ● Study lubricant and lubricating method ● Precise model selection ● Study combination, bearing clearance and preload ● Improve sealing device ● Inspect precision of axle and bearing housing ● Improve method of installation
	
Electric pitting Electric pitting refer to the phenomenon that electric current flows in the contacting section of bearing ring and rolling element and sparks via thin lubricating oil film when the bearing is running, the flaming pit will occur on the surface of raceway and when the pit magnified, it appears as a hole like a crater.	<div>Causes</div> <ul style="list-style-type: none"> ● Bearing generate electricity, potential difference formed between inner ring and outer ring. <div>Countermeasures</div> <ul style="list-style-type: none"> ● Provide a bypass which prevents current from passing through bearings ● Take insulating measures, avoid electric current get through the bearing
	

Phenomena	
Discoloration Bearing ring, rolling element and cage will discolor because of temperature rise and their interactions with lubricant.	<div>Causes</div> <ul style="list-style-type: none"> ● Lubricant not good ● The interaction with lubricant brings about color change and temperature rise. <div>Countermeasures</div> <ul style="list-style-type: none"> ● Improve lubricating method
	
Fracture Fracture refers to the situation that small part of the bearing fracture breaks because impact or too much load is imposed upon rib of bearing ring or part of roller chamfer.	<div>Causes</div> <ul style="list-style-type: none"> ● Impact affect during installation ● Use error such as falling ● Quality of heat treatment ● Over load <div>Countermeasures</div> <ul style="list-style-type: none"> ● Improve method of mounting (adopt neat mounting, use proper tools) ● Rectify load-up condition ● Bearing is mounted properly so that the rib can take load
	
Rust corrosion The rust corrosion of bearing is demonstrated in many ways such as crater or flecked rust on the surface of rolling element and bearing rings.	<div>Causes</div> <ul style="list-style-type: none"> ● Penetration of water and corrosive medium ● lubricant improper ● Stop running under high temperature and humidity. ● Poor rust prevention in transportation process ● Poor storage condition <div>Countermeasures</div> <ul style="list-style-type: none"> ● Improve sealing device ● Study lubricating method ● Rust prevention after shutdown ● Improve storage method ● Use carefully
	

Phenomena	
Cage abrasion The damage of cage could be deformation, broken, abrasion etc. For example, broken of beam, deformation of end face, pocket broken and abrasion of guide surface.	<div>Causes</div> <ul style="list-style-type: none"> Poor installation (non-linearity of bearing) Improper use Large torque load Large impact and vibration Abrupt change of rotation speed Poor lubricant Over-high temperature <div>Countermeasures</div> <ul style="list-style-type: none"> Inspect the method of installation Inspect conditions such as load, temperature etc. Reduce vibration Change lubricant or lubricating method
	
Indentations The indentations generated on the surface of raceway groove or roller after tiny metal powder entered.	<div>Causes</div> <ul style="list-style-type: none"> The penetration of impurity like metal powder etc. Impacted in assembling or transportation process Overload <div>Countermeasures</div> <ul style="list-style-type: none"> Impacted shaft sleeve Improve sealing device Filtration of lubricating oil Improve assembly and method of application
	
Fretting Refer to the phenomena that bearing is worn by vibration or micro vibration when it is stable. Which often occurs in the contacting section of raceway groove and rolling element. Due to the abrasion powder is rufous or black, the abrasion is also named fretting corrosion.	<div>Causes</div> <ul style="list-style-type: none"> Poor lubricant Small swing Interference allowance not enough <div>Countermeasures</div> <ul style="list-style-type: none"> Use proper lubricant Add preload Inspect interference allowance Lubricant on the fitting surface
	

Phenomena	
Brinelling In micro-vibration period, nicks that is similar to the Brinell dent occurs in the contacting section of rolling element and bearing ring caused by vibration and swing.	<div>Causes</div> <ul style="list-style-type: none"> Vibration and swing generated in the transportation process or after shutdown of bearings rotation Small swing Lubricant poor <div>Countermeasures</div> <ul style="list-style-type: none"> Shaft and bearing housing must be re-fixed in the transportation process. The inner and outer ring of separate bearings should be packed separately in transportation. Add preload to alleviate vibration Use proper lubricant
	
Creep Creep refers to the phenomenon that space exists in the fitting surface and slip occurs, in which bearing rings move to the shaft or housing. Brightness or darkness can be found on the fitting surface, sometimes accompanied by discoloration or scratch.	<div>Causes</div> <ul style="list-style-type: none"> Inference allowance not enough Insufficient fastening of adapter sleeve for clearance fit Abnormal heating up or overload <div>Countermeasures</div> <ul style="list-style-type: none"> Inspect interference allowance Fix adapter sleeve adequately Study precision of shaft and bearing housing Preload in axial direction Fastening of bearing ring in axial direction Fill lubricant on the fitting surface
