Review of Different Types of Bearing Failure

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ABSTRACT

Bearing is moving object, so friction force of comes into play, and must be surpassed to move the Bearing. Various types of bearings are used to reduce this friction force for moving mechanism. The bearing named from the fact that it bears a turning axle or shaft. Rolling bearings use balls, or rollers so it's called "rolling elements. If the operating loads and speeds are known then you can calculate bearing life expectancy based on material fatigue. These calculations must assume that the bearing is correctly mounted, lubricated and otherwise properly handled. It cannot take into consideration the effect of adverse operating conditions. Bearing failures have great impact on industry and economy. The aim of the present work is to study and spot the major causes that limit bearing efficiency, thus l eading to bearing failure.

Keywords: *Bearing failure, Rolling element, Ball bearings, Roller Bearing, Failure analysis.*

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1. INTRODUCTION

Bearings are one of the important machine elements used in many applications, which include rotating component .Rolling element bearings generally consist of two rings, an inner and an outer, between which a set of balls or rollers rotate in raceways.Bearings are among the most critical mechanical components that have wide applications in many industries and have proven to be reliab le and long-lived when properly applied. Design specification, the loads on the bearing are angular, axial, or radial. Ball and roller bearing are relatively simple mechanisms but their internal operations are complex. At extreme condition of heavy loading, very high speed, and very high or low operating temperature leads to early bearing failure and reducing bearing life [13-14]. When design requirements not met that leads to excessive deflection, vibration, high frictional torque and temperature. Bearing temperature are many critical parameters, such as the lubricant viscosity, load-carrying capacity, load distribution and power loss. Many researchers are working on thermal analysis of journal bearings [1-12]. Ball and roller bearing failures are caused by interference of the lubricant supply to the bearing or inadequate delivery of the lubricating oil to the raceway contact.

Radial-contact ball bearings are designed to support radial loads. Angular contact bearing for combination of radial and axial loads. Thrust bearings for axial loads. Roller bearings are designed for higher load capacities than ball bearings for a given size and used in moderate speed heavy-duty applications. The preliminary bearings are cylindrical, needle, tapered, and spherical roller bearing. Fig. 1 shows the component of ball bearings and roller bearings [15-16].

The service life of bearings [17] is expressed either as a period of time or as the total number of rotations before the occurrence of failures in the inner ring, outer ring or in rolling element (ball or roller) because of rolling fatigue, due to repeated stress. Bearing failure increase maintenance cost.

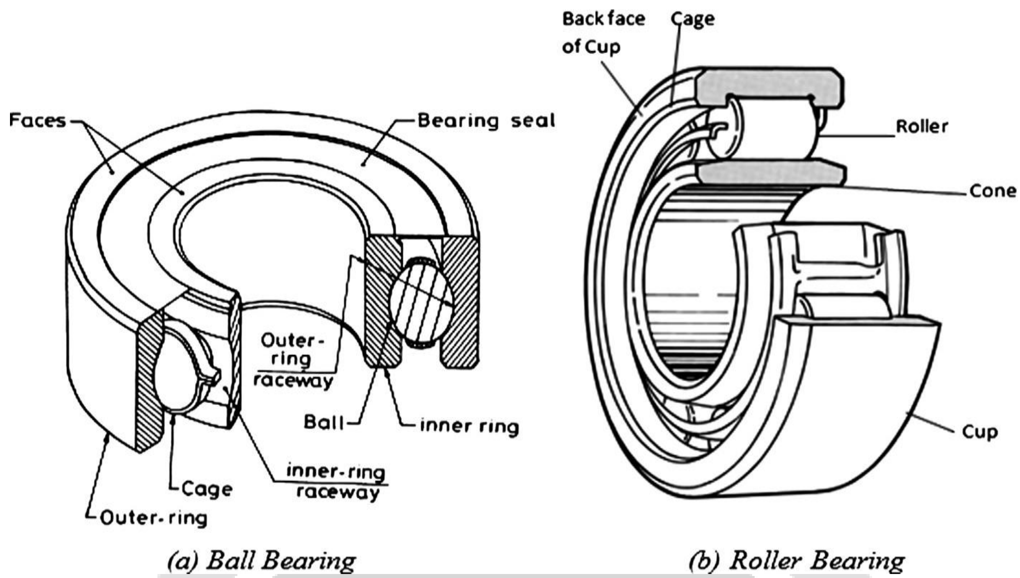

Figure.1 Component of (a) Ball and (b) Roller Bearing.

2. LITERATURE REVIEW

Eschmann et al (1958) stated that one of the reason fatigue failure begins with smaller scissure between raceway and rolling elements and it's propagate gradually with continues operation .it's also generate vibration and increasing noise levels [18].

Riddle (1995) stated that bearing failure is occurred due to contamination, improper lubrication and dirt particles. Improperly installed bearing are also reason of failure due to forcing bearing on shaft and housing and its causes physical damage as brinelling [19].

R.K Upadhyay stated that due to cyclic stress rolling contact fatigue occurs.to reduce this kind of problem we have to increase angle of oscillation to secure roller overlap to drag fresh lubricant in to area so surface of raceway and balls are separated by lubricant and reduce friction [23].

Jafar Takabi et al (2015) stated that first type is thermal failure of rolling bearings that can occur at high rotational speeds and large radial loads, and the second type deals with spindle bearings of high–speed machine tools. The results of dynamic simulations for the first type of thermal failure show that the unstable motion of the cage can lead to an ultimate bearing seizure because of the cage failure due to the large rollers/cage contact forces and high wear rate of the cage. Second type of thermal failure of rolling element bearings, the simulation results reveal that the minimum film thickness at the raceways. Severe surface damage and wear occur at the raceways contact surfaces and eventually the bearing fails. The cause of this failure is the thermal seizure of the spindle bearing due to the rapid rise of the thermally–induced preload inside the bearing assembly with no sign of cage instability [21-22].

Aditya et al (2014) tested cylindrical roller bearing in order to investigate its tribological properties. Initially, wear rates are very small and constant over a period of time. This wear is further responsible for fatigue failure of the bearing. Due to increase in wear, lubricant film is not capable to form a hydrodynamic film between roller and inner race. scanning electron microscope of the inner race and rollers have revealed the presence of pits, cracks at the contact surface and wear debris due to surface contact fatigue. An increase in bearing temperature reduces the lubricant film thickness. The lubricant film between the roller and inner race could not be effectively formed due to increase in bearing temperature, which results in direct contact between two metal surfaces and thus wear takes place [20].

First linear model of vibration in shaft bearing system was proposed by Yhland in 1992[24] due to bearing imperfection like radial and axial waviness [24].

3. CAUSES OF FAILURE

Causes	Failure rate in %
Dirt	45.4
Misassembly	12.8
Misalignment	12.6
Insufficient Lubrication	11.4
Overloading	8.1
Corrosion	3.7
Other	3.2

The table Above lists the major causes of premature bearing failure, along with percentage figures which indicate prime contributor to a bearing's destruction. In many cases a premature bearing failure is due to a combination of several of these causes [26, 28]

3.1 Contamination

Contamination symptoms are denting of the bearing raceways and balls resulting in high vibration and wear [32-37]. Contaminants include airborne dust, dirt or any abrasive sub-stance that finds its way into the bearing. Principal sources are dirty tools, contaminated work areas, dirty hands and foreign matter in lubricants or cleaning solutions.

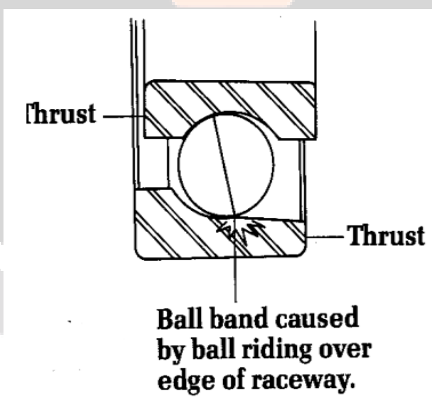

Figure 2 Contamination

Clear working areas and distance from grinding operation can reduce this type of failure and keep bearing in their original packaging until not ready for install.

3.2 Misalignment

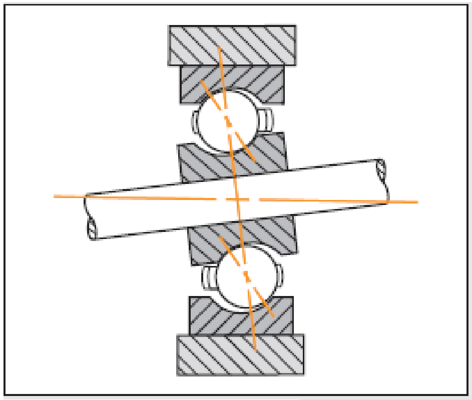

Figure 3 Shaft misalignment.

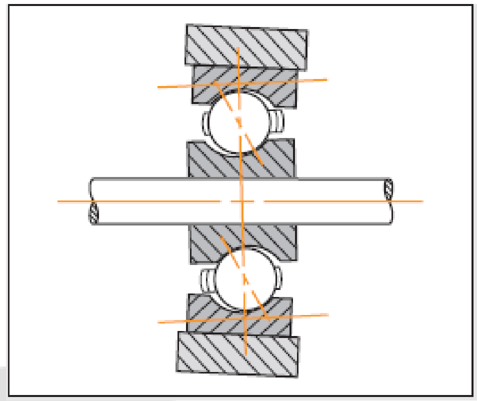

Figure 4 Housing misalignment.

Misalignment can be detected on the raceway of the nonrotating ring by a ball wear path that is not parallel to the raceway edges, if Misalignment exceeds 0.001 in. you can expect an abnormal temperature rise in the bearing and housing and heavy wear in the cage ball pockets. The most prevalent causes of misalignment are: bent shaft, burrs or dirt on shaft or housing shoulders. Fig. 3 and fig. 4 shows the shaft misalignment and housing misalignment.to cure this we have to take corrective action. use of single point turned on non-hardened shafts and ground threads on hardened shafts and with use of precision grade locknuts.

3.4 Corrosion

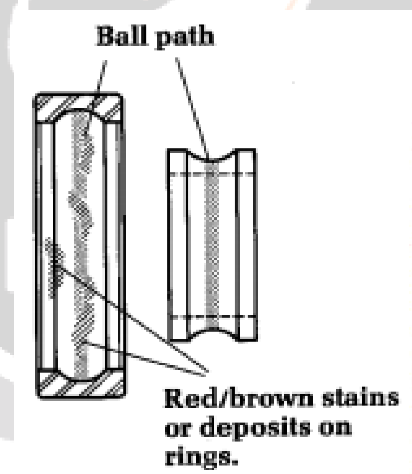

Figure 5 Corrosion

Red/brown areas on balls, race- ways, cages, or bands of ball bearings are symptoms of corrosion [fig. 5][25]. This condition results from exposing bearings to corrosive fluids or a corrosive atmosphere. The usual result is increased vibration followed by wear, with subsequent increase in radial clearance or loss of preload. In extreme cases. Corrosion can initiate early fatigue failures. Correct by diverting corrosive fluids away from bearing areas and use integrally sealed bearings when- ever possible. If the environment is particularly hostile, the use of external seals in addition to integral seals should be considered. He use of stainless steel bearings is also helpful.

3.5 **Insufficient lubrication**

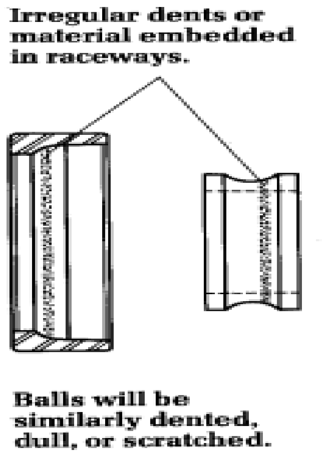

Figure 6 Lubrication Failure

Discolored (blue/brown) ball tracks and balls are symptoms of lubricant failure [fig. 6][25]. Excessive wear of balls, ring and cages will follow, resulting in overheating and subsequent catastrophic failure. Ball bearings depend on the continuous presence-of a very thin-millionths of an inch-film of lubricant between balls and races, and between the cage, bearing rings, and balls. Failures are typically are caused by restricted lubricant flow or excessive temperatures that degrade the lubricant's properties.[30,31]

3.6 fatigue failure

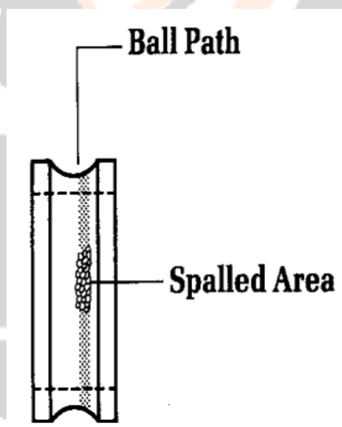

Figure 7 Fatigue failure

Spalling is used in terms of fatigue failure for fracture of running surface and removal of small particles. Spalling usually occur on raceway fig. 7 [25] this type of failure will spread after once initiated and its increase vibration and remedy is to replace bearing or redesigning to use of bearing.

3.7 Brinelling

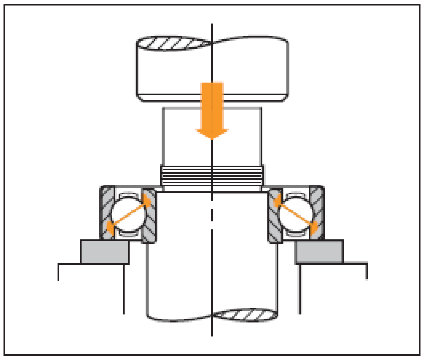

Figure 8 Incorrect.

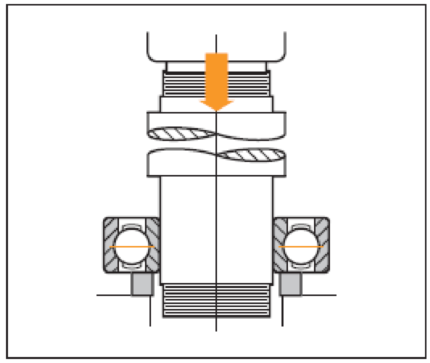

Figure 9 Correct

Brinelling usually occurred due to improper mounting, incorrect disassembly and extremely high impact load. Brinelling increase vibration noise and causes a premature failure. As shown in fig.8 and fig. 9 incorrect removal of bearing and correct mount or dismount of bearing by applying force on tight fitted raceway.

3.8 Overheating

Discoloration of the rings, balls, and cages from gold to blue [fig. 10][25]. When bearing temperature excess of 150°C can deform bearing raceway and rolling element. Increase in temperature can also destroy lubricant and it's also increase with speed. So, overload controls and supply of cooling are effective cure.

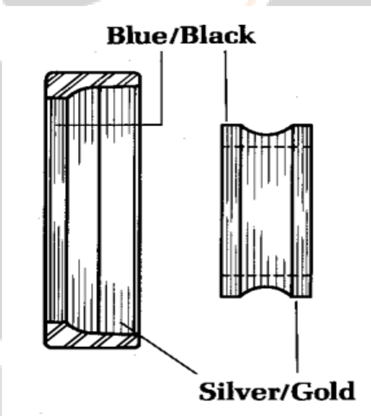

Figure 10 Overheating

3.9 Excessive Loads

Figure 11 Plastic deformation on an inner ring raceway produced by overloading

Excessive loads usually cause premature fatigue [fig. 11][26]. Tight fits brinelling and improper preloading can also bring a bout early fatigue failure.This type of failure looks the same as normal fatigue, although heavy ball wear paths, evidence or overheating and a more widespread evident with shortened life. Solution is to reduce the load or redesign using a bearing with greater ca pacity.

4. CONCLUSION

After review all type of bearing failure and its causes and cures we have to take some corrective action to resolve above failure and most of them due to lubrication, misalignment and contamination .Other Indirect failures, such as unacceptable operating conditions, transport, storage and handling represent 4% of premature bearing failures. Among other indirect causes, the worst operating conditions are overloading, over-speeding, excessive vibrations, high temperature and electrical discharge.

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