A Case Study on Nicks Formation in a Bearing Manufacturing Industry

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Abstract: **Bearings have been playing a pivotal role in the operation of efficient industrial machinery right from the industrial revolution. However, their may be premature bearing damages before installation which can be attributed due to many assignable causes. If a bearing has any kind of nick or damage, it may lead to rejection by the potential customers.**

The purpose of this study is to determine quantitatively the various reasons of nick formation in a bearing industry. To accomplish this, a leading ball and taper roller bearing manufacturing industry in northern India has been selected and study was performed with the above mentioned objective. The data was collected using data collection sheets along with personal observation and visual inspection. The study revealed that nearly 6% to 12 % bearing components were encountered with the problem of nick formation which is substantially high as regards industrial quality standards are concerned. It was found that three prominent nicks occur in the bearings namely face nick (back or front), rib nick and race nick. The study proposes corrective actions and necessary handling techniques which may lead to lower rejection rate by potential customers. This in turn will help the select industry (and other similar bearing industries) to increase their overall productivity and business performance as well.

Keywords: bearing, nicks, productivity

1. INTRODUCTION

Bearings are among the most important components in the vast majority of machines and there exist a huge demand based upon their functionality and reliability. Proper functioning of bearings is most important in nuclear power stations, chemical plants, aviation industries as well as in process industries [1].

There are primarily three broad categories of ball bearings namely radial contact, thrust and angular contact bearing. The applications where radial loads are there radial-contact bearings find their use but angular contact bearings can sustain the combination of radial and axial loads. When axial loads are there, thrust bearings are conveniently used [2].

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The rolling element bearings are mostly used in rotating machineries and considered as a most vital component. It has been seen that for a specified size and dimensions, the roller bearings offers higher load capacities and hence preferred for medium and heavy-duty applications. The schematic view of ball and roller bearings has been depicted in Fig. 1[3].

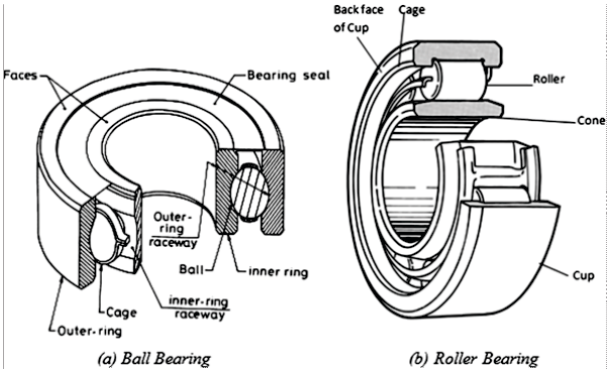


Fig. 1: Schematic of ball and roller bearings [3]

Bearing damage on a large scale due to improper handling and installation is likely to happen in most of the industries. One can reduce it by improvements in design, training and ensuring adequate lubrication and guarding against contamination and overloads [4].

The improper or careless handling can lead to burrs or high spots in the seats of outer race. In addition, during inspection of housing seat from tool, minor raised areas become pronounced around the gouge. It is recommended to scrap or ground down these high spots before the outer race is installed failing which they may pass through the outer race and can cause corresponding high spots on the inner diameter of the outer race. Due to this, the rolling contact stress increases thereby reducing the fatigue life causing spalling or in severe cases, the component is fractured [5]. The other undesirable side-effects of gouges and deep nicks include surface roughness, vibrations and noise in the bearings. Besides the above reason, a statistically misaligned bearing can also be detrimental to a bearing life and will have a shorter life which depends on the degree of misalignment. To reduce this, during installation one should ensure proper and accurate alignment. Another problem with misalignment is that in case of severe misalignment, the loads are concentrated on only limited rollers, balls and races and not properly distributed along the rolling elements which may potentially lead to fatigue. To further increase the service life of bearings, the seats and shoulders, abutting surfaces, necessary

fillets and undercuts should be sized within specified limits by manufacturer [6].

To ascertain the service life of a bearing, the time period or the total number of rotations are counted before any failure is observed in rolling element, inner ring or outer ring. The following literature discusses the various types of bearing defects[7, 8]:

1.Flaking of the surface: This defect primarily include stearing-off the material due to thermal overloading of the bearing which is unacceptable in service life. It occurs due to the cyclical loading of bearing components and normal fatigue of the material.

2.Depressions and pressure damage: By depression, we mean the defects introduced due to improper and indelicate installation, inclusion of solid impurities during operation and shallow depressions in the bearing raceway. The pressure damage is mainly influenced by equipment vibrations or stationary overloading during logistic shipments of bearings over long distances.

3.Abrasion: This defect is seen in terms of glazing of ball due to overloading and improper lubrication and abrasion of the race due to spinning within the seat. The condition in both cases is unacceptable.

4.Grooves and craters: Due the passage of electric current, a sparking occurs over a thin layer of lubricant which in turn damages the ball and the raceway of the bearing. In motor housing and roller-contact seats in rail vehicles, this defect is commonly seen and to prevent this insulation layer is embedded on one of the rings.

5.Corrosion: The traces of acceptable contact corrosion on the raceway are shown in Fig. 2. Corrosion mainly occurs due to inadequate protection against moisture or the use of an unsuitable lubricant which has detrimental effects in the service life of bearings.

6.Cage damage: Due to inadequate lubrication the surfaces in contact with rolling elements and guiding surfaces of bearing rings are subjected to cage wear. However, under normal operating conditions, the roller bearing cage is stressed little and cage wear is not so pronounced.

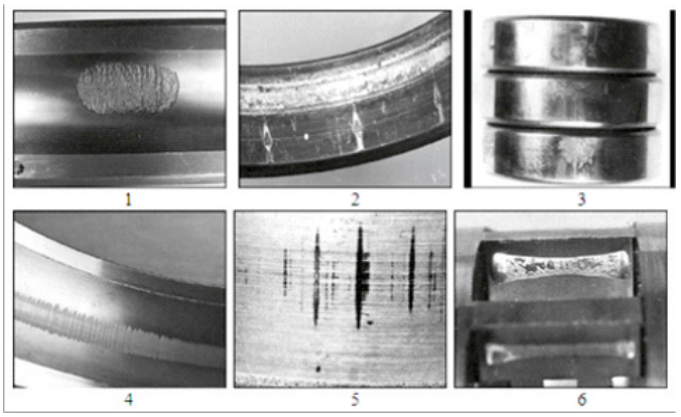


Fig.2 various types of bearing defects [6]

2. PROBLEM STATEMENT

This study is carried out at a leading manufacturing company of taper roller bearings in India. On the basis of personal observations and discussions with the management of the organization, there is a vital problem of nick-marks on double-cups and cones bearing components (Fig. 3). The aim of this research is to find out reasons for occurrence of nicks and also proposing suggestions to rectify the same. Nicks on non-functional area are permissible but they should not extend to the functional area. More specifically, nicks with raised surface are not allowed.

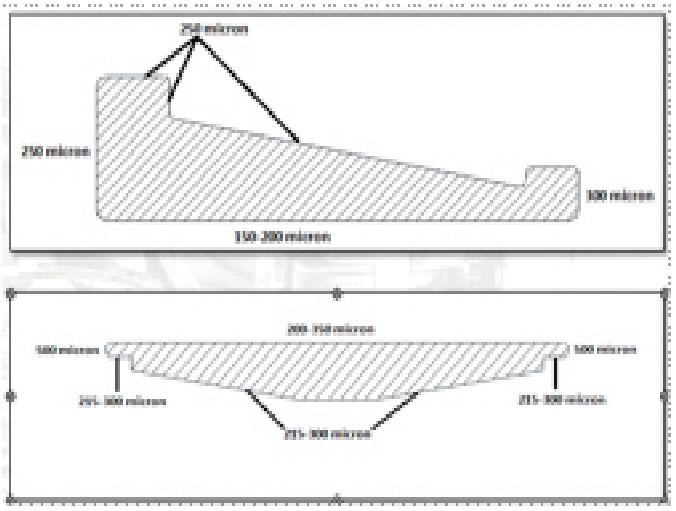
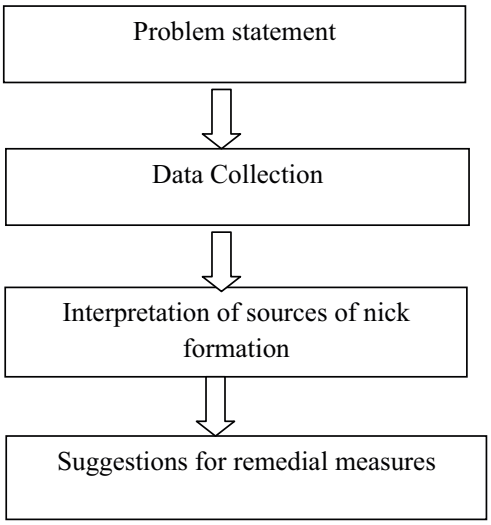


Fig. 3:Cross-sectional view of double cup and cone showing the tolerance level for different surfaces.

3. FRAMEWORK OF STUDY



3. OBSERVATIONS AND INTERPRETATIONS:

The first step of the study is visual inspection of purchased raw material. During the inspection the following types of nicks were identified.

- Face nicks (back or front)
- Rib nicks
- Race nicks

Fig. 4 : Identification of various nicks

Figure 4 shows the nicks found during visual inspection. Some of them are small but many of them are large enough to reject the component. Some nicks are identified due to improper handling (Fig. 5). It was also noticed that some nicks are coming through supplier side. Figure 6 shows some of nicks available in the packaged cartoon.

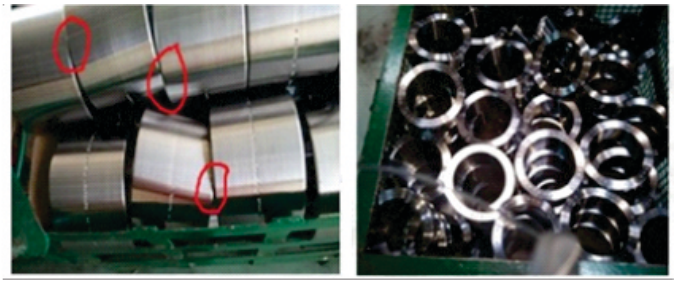


Fig. 5 : Nicks due to mishandling of components

Fig. 6 : Nicks that were found to come out of carton

After inspection, there are some reasons for nicks and recommendations:

Table: 1 possible reasons and recommendations for nicks

Reasons for Nicks	Recommendations
Mishandling: Cups are opened in ring- yard and is arranged in basket like this. Uneven stacking of cones in basket after cleaning. Cones strike with each other when placed in the basket. Time constraint of the workers makes them work fast.	D-Cups: open boxes directly in the heat treatment plant. This will lead to elimination of this step of arranging cups in basket and then taking them to HT plant. **Cones:** After every layer of cones, used carton layer can be kept this will reduce direct strike between the cones and will not even slow down the entire process.
Due to transportation (supplier end): Some cartons gets damaged while transportation. Mishandling at supplier end: Proper inspection was done for both d-cups and cones, nicks were found to come from within the carton.	Filler material like wheat straw should be used on the floor of trucks and between boxes and wall of truck so that boxes don't strike to the wall of the truck. Allowable limit of nicks for the supplier end should be kept very low and components with nicks beyond that limit should be rejected. This way they will also improvise on their supply chain.

A trail was conducted to find out whether nicks are coming from supplier side below is its findings.100% checking of double cup has been done in Ring Yard. And cone has checked in HT plant.

Table.2 Number of nicks found during observation

Supplier Company	Product	No. of pieces checked	Nicks found	% Nicks
Company A	DC(EY)	972	120	12.3%
Company B	DC(EY)	993	75	5.53%
Company B	Cone(KX)	182	12	6.59%
Company A	Cone (UX1)	336	28	10.7%

Table 2 gives information that nicks were coming from supplier end. No. of nicks found in the components of Company B was found to be very less as compared to Company A. Difference was found in their packaging, Company B packing was better than Company A in both physical parameters and visual parameters.

Multiple handling in the plant:

The material goes the following work places for processing:
- Supplier to Godown
- Godown to Ring Yard
- Storage and unpacking (Ring Yard)
- Brought to Heat Treatment plant according to plan
- Cleaning
- Heat Treatement

A trail was carried out by sending boxes of double cups directly to the heat -treatment plant and then opening it there just before making charge for a period of one week.

Table.3 Number of nicks found at heat treatment plant

	No. of Components	Nicks found	Percentage of nicks
Part X	487	1	0.20
Part Y	2389	2	0.083
Part Z	700	1	0.14

Table 3 shows the percentage of nicks found at heat treatment plant. All nicks found were minor and were passed after inspection.

4. CONCLUSION

Bearing components should be free from any defects, especially cages as they are damaged by improper handling or installation. One should take utmost care to adequately lubricate and avoid overloading. It can be concluded that mostly nicks were coming from supplier end. Difference was found in their packaging, Company B packing was better than Company A in both physical parameters and visual parameters.

4. SUGGESTIONS

- D-Cups: Boxes should be directly opened in the heat treatment plant. This will lead to elimination of step of arranging cups in basket and then taking them to HT plant. This will also reduce manual handling at two places saving labor hours which can be utilized at some other place.
- Cones: After every layer of cones, used carton layer can be kept this will reduce direct strike between the cones and will not even slow down the entire process
- CCTV Cameras can be installed in cleaning area.
- Filler material like wheat straw should be used on the floor of trucks and between boxes and wall of truck so that boxes don't strike to the wall of the truck.
- Allowable limit of nicks for the supplier end should be kept very low and components with nicks beyond that limit should be rejected.
- Difference was found in their packaging, Company B's packing was better than Company A in both physical parameters and visual parameters so Company B packing should be set as a standard.
- For local suppliers the standard should be low as compared to distant suppliers.
- Products with high value should be directly brought to ring yard.

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