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A Case Study - Failure of Roller Spherical Bearing of Shakeout Used In Foundry Industry

[1,]Mr. Nilesh D. Dhote , [2,]Prof. S.N. Aloni , [3,] Dr. S.P. Untawale, [4]Mr. Vishal Ramteke
[1,]M-Tech Student, Dmietr Wardha,
[2,]Asst. Prof., Dmietr Wardha
[3],Principal, Dmietr Wardha,
[4]Asst. Manager, Jayaswal Neco Ind. Ltd. Butibori,

ABSTRACT: *Bearings are amongst the frequently encountered components to be found in rotating and vibratory machinery used in many applications. Though inexpensive, their failure can interrupt the production in a plant causing unscheduled downtime and production losses.This paper deals with study of different bearings failures of shakeout used in foundry and remedies improve the performance of shakeout. It discussed factors affecting bearing life and recommendation towards enhancement of bearing life is also suggested.*

KEY WORDS : *Bearing Failure, Radial Load, Bearing life, Shakeout*

I. INTRODUCTION

The Bearings are one of the important machine elements used in many applications, which include rotating and vibrating component. This supports another moving machine element permitting the relative motion between the rolling-element. Bearings consist of balls or rollers positioned between raceways [1]. This paper consists of application of bearings in foundry shakeout. In foundry, shakeout is important process [5], which starts after solidification of metal poured into the mould. It separate sand and casting from mould box placed over the vibrating deck of shakeout. Separated sand is fall down on belt conveyor placed below the vibrating tray and send to reutilization. The shakeout uses principle of two-mass natural frequency spring system between the drive and the shakeout body, two-masses are mounted on shaft each on one side as shown in figure1and supported by bearings fixed in shakeout frame. The motor of 30 Hp is coupled to a shaft with universal joint and rotate the shaft with masses. It creates the centrifugal force results in vertical vibration of shakeout. Machine stroke is easily adjustable on two-mass shakeouts, which makes them adaptable to any shakeout situation [2]. Figure1 shows cad model of component of shakeout used in Jayaswals NECO Industries Ltd. ,Foundry, 1-Couter mass of two numbers having mass of 63 kg, 2-Shakeout tray, 3-Bottom frame, 4-Longer shaft subjected to rotation of 960 rpm, 5-Double row spherical roller bearing of two numbers of 22322 type, 6-Springs.

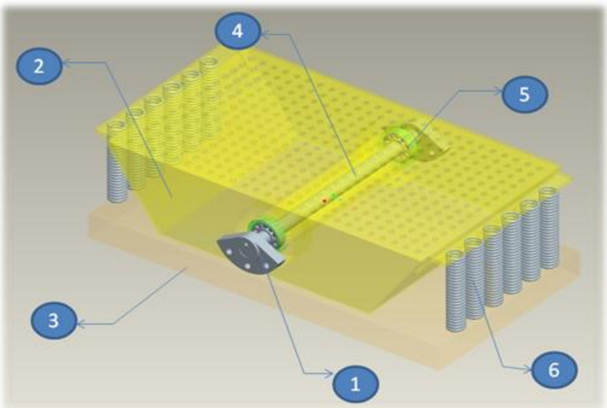

Figure1. Shakeout used in foundry

II. FAILURE, CAUSES AND POSSIBLE REMEDIES

The bearings used in foundry industries are rolling element bearings having inner races, outer races, rolling element roller or ball, cage. Failure of these causes failure of bearings.

Flaking, Pitting

In Flaking the bearing surface turns scaly and peels off due to contact load repeatedly received on the raceway and rolling surface during rotation. Occurrence of flaking indicates that the end of a bearing's service life is near. In Pitting small holes 0.1 mm in depth are generated on the raceway surface by rolling fatigue [7].

Causes

Flaking and pitting occur early in a bearing's service life under the following conditions:

[1] During operation, bearing internal clearance becomes narrower than specified.
[2] Bearing ring is mounted at an inclination by mistake.
[3] Flaw is created during mounting, or brinelling, nicks, rust, etc. occur on the raceway surface or rolling surface.
[4] Inaccurate shape of shaft or housing

Remedies

Flaking

[1] Use a bearing with heavier rated load.
[2] Check if abnormal load is being generated.
[3] Improve lubrication method to ensure better formation of lubricant film, by increasing the viscosity.

a. Pitting

[4] Increase viscosity of lubricant to ensure better formation of lubricant film.

Figure2. Flaking

Figure 3. Wear on roller face

Wear and fretting

Wear is caused mainly by sliding abrasion on parts including the roller end face and rib, cage pocket surface, cage, and the guide surface of the bearing ring. Wear due to contamination by foreign matter and corrosion occurs not only to the sliding surface but also to the rolling surface. Fretting occurs when slight sliding is repeatedly caused on the contact surface. On the fitting surface, fretting corrosion occurs, generating rust like powder [7].

Causes

[1] Improper lubricant or shortage of lubricant.
[2] Contamination by foreign matter.
[3] Vibration load.
[4] Slight vibration on fitting surface caused by load.

Remedies

Wear

[1] Review and improvement of lubricant and lubrication method.
[2] Filtering of oil.
[3] Improvement of sealing.
[4]

Fretting

[1] Investigation and countermeasures for the source of vibration.
[2] Investigation and increase of interference.

Cracks

Cracks include slight cracks, splitting and fracture.

Causes

[1] Heavy load.
[2] Excessively heavy internal load caused by improper installation.
[3] Abnormal heat is generated due to shortage of lubricant.

Remedies

[1] Investigation followed for excessively heavy load.
[2] Removal of thermal impact.

Figure4. Cracks in rollers

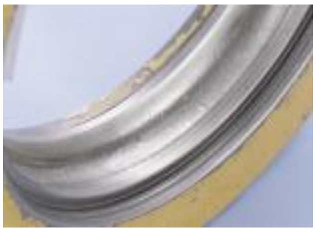

Figure5. Brinelling on races

Brinelling

Brinelling is depressions created on the part of the raceway Surface which comes into contact with the rolling element and is due to plastic deformation. Brinelling is also small depressions on the rolling surface caused by contamination by solid foreign matters [7].

Causes

[1] Extremely heavy load (static load, impact load) applied to bearing.
[2] Solid foreign matter caught in bearing parts.

Remedies

[1] Investigation followed by countermeasures for excessively heavy load or impact.
[2] Enhancement of sealing capability.
[3] Careful washing of shaft and housing to remove foreign matter.
[4] Filtering of oil.
[5] Investigation of flaking in target bearing together with other bearings.

Creep

Creep is the displacement during operation of a bearing ring, relative to the shaft or housing.

Causes

Creep occurs when interference is too small in relation to the heat or load generated during operation [7].

Remedies

Review of interference between inner ring and shaft and between outer ring and housing.(Increase of interference.)

Figure6. Creep on races

Figure7. Failure of cage

Failure of Cage
If rust or corrosion is found on cages, it can be assumed that it is also occurring on the bearing ring and rolling element.

Causes
[1] Careless handling.
[2] Abnormal load, Vibration impact.

Remedies
[1] Improvement of sealing capability. Periodic inspection of lubricant.
[2] Provision of adequate rust prevention during storage of bearings.

III. BEARING LIFE

A Bearing is fail due to lubrication related problem, wrong mounting and vibration, fatigue. The life of individual bearing cannot be predicted. Therefore the term life refers to group of bearings. According to standard given by Anti-Friction Bearing Manufacturers Association (AFBMA),USA. For single bearing L_{10} also refers to life associated with 90% reliability. It is found that life which 50% of the group will complete or exceed is approximately five times of the above rating life and is sometimes referred as average life [8].

$$L_{10} = (C/P)^\wedge n * k\_ret$$

Where, L_{10} = Life in million cycles
C = Dynamic load capacity (kN)
P = Equivalent Bearing Load (kN)
n = 3.33 for roller bearing
k_ret = Reliability factor select from table

Life of Bearing (in hours)

$$L(in\ hour) = 10^6 L_{10}/60\ N$$

Where, N= Rotational speed in rpm

Equivalent bearing load P (kN) is calculated as:

$$P = (x\,F_r + y\,F_a)k_s k_o k_p k_r$$

Where, *Fr* = Radial Load (kN)
Fa = Axial Load (kN)
x,y = Constant for bearing from table
Ks = Service Factor
Ko = Oscillation Factor
Kp = Preloading Factor
Kr = Rotational Factor
(All values of factors selected from table)

Radial Load F_r (kN)

$$F_r = (f G_1 G R \omega^2)/S(G_1 + G)$$

Where, *f* = Application factor
G = mass of body (kg)
G_1 = Mass of counter weight (kg)
S = Number of bearings
R = Distance of C.G. of counter Weight from axis of Bearing

Recommendation

In this paper all possible failure which occurs in bearings during performance of shakeout are studied and suggested possible remedies. Also it discussed bearing life and factors affecting bearing life, life can be improved by using bearing of higher dynamic load capacity in shakeout.

IV. CONCLUSION

From the above case study regarding bearing failure of shakeout, it is revealed that failure of bearing mainly occurs due to brinelling. This type of shakeout bearing failure is avoided by using bearing of higher dynamic load capacity

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