Advanced Materials Research
ISSN: 1662-8985, Vol. 744, pp 95-99
doi:10.4028/www.scientific.net/AMR.744.95

Online: 2013-08-30

The Research of Lubricating and Colling System of the Low-speed and Heavy-load Sliding Bearing

SUN Pei-ming [1, a] WEI Xie-ben [1, b] CHEN Shu-qin [2, a]

[1]Department of Mechanical and Electrical Engineering, Jieyang Vocational and Technical College, Jieyang, Guangdong, China

[2]Jieyang DALI mould CO.,LTD, Jieyang, Guangdong, China

[a]sunyulixj@163.com, [b]weixieben@qq.com

Keywords: Plain bearings, Low speed and heavy, Lubricating, Cooling, System Research

Abstract. This paper analyzes the influence of lubricating oil film of the low-speed and heavy-load sliding bearing on a variety of factors. It introduces the operation of Bearing for lubricating oil film in monitoring method, common fault causes and treatment measures. Finally, the bearing cooling system structure is discussed, providing reference for practical engineering application. There are many reasons to cause the failure of the bearing lubrication such as bearing assembly defects, the error of size and cooling system problems. By detecting and contrast parameters, this study analyze the determine data and correct the fault. Through the use of reasonable structure of the oil tank and cooling water channel, we can improve the lubrication performance, and extend the bearing life. This paper analyzes the factors restricting the low speed and high load sliding bearing lubricant film, and solves the actual bearing lubrication problem.

Introduction

The slow heavy equipment widely used in metallurgy and food industry, such as hot rolling mill, press, etc.. Plain bearings of these devices have the following characteristics: low speed, loads, and withstand shock and vibration. The lubricating oil film between the bearing pads and the journal must be formed, and it makes the stable rotation of the journal and the bush in the case of non-contact [1]. Plain bearings for low speed and high load conditions, prone to uneven distribution of the lubricant film, the journal and the bearing dry friction bearing heating problems in the actual production, which will cause the device to not work correctly. This paper analyzes the factors restricting the low speed and high load sliding bearing lubricant film, and solves the actual bearing lubrication problem.

Lubricant film formation and monitoring

Hydrodynamic sliding bearings, lube oil wedge is formed between the journal and the bearing when the shaft reaches a certain speed, the shrinking of the hydraulic oil wedge cross section gradually increased, the formation of oil high pressure zone to make the journal lift, thusto form a film lubrication.

Under the conditions of low speed and heavy, to make the lubricating oil is formed to satisfy the conditions required of the film more difficult. The bearing lubricant film formation is related to many factors, including the journal speed, to withstand the load, the bearing clearance, the pad material and its surface roughness, the shape and size of the lubricating oil grooves, lubricants category and bearing temperature, etc..

Oil film thickness and bearing clearance. Lubricant film formation and its thickness size, have a decisive impact on the carrying capacity of the sliding bearings, bearing wrap angle and aspect ratio of the journal is constant, the smaller the minimum film thickness, the greater the bearing capacity. Determine the circumstances of the load, lubricant viscosity and the bearing geometry, the important factors affecting the thickness of the oil film of the bearing gap, the smaller the gap, the smaller the minimum film thickness [2].

In equipment operation due to bearing wear, bearing clearance is changing; bearing the design gap is the initial gap, work with the bearing wear, the gap gradually increasing the bearings carrying capacity decreased the F and clearance of the bearings carrying capacityψ curve, over the time t is shown in Fig.1.

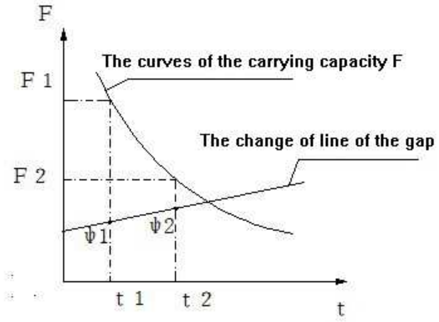

Fig.1 Bearing load amount F and the gap ψ curve versus time

We can see from Figure 1, when the bearing clearance increases from $\Psi 1$ to $\Psi 2$, its carrying capacity dropped from F1 to F2, can not meet the requirements of equipment load, from t1 to t2 the bearing repair machine intervals, when the bearing clearance increases to $\Psi 2$, unable to form a carrying capacity of the required minimum film thickness, it must be repaired. $\Psi 2$ is an empirical data, different devices have different equipment regulations, the decision mainly based in the factory equipment procedures and equipment operating parameters monitoring, equipment monitoring parameters bearing temperature, the main motor current, bearing vibration parameters, lube oil quality status. Yang Hong Kong, Guangdong $\Phi 550$ two aluminum hot rolling mill roll bearings (split bearings), bearing copper alloy, the journal of the diameter of 286mm, bearing design gap to 0.24mm to 0.34mm detection bearing normal running clearance 0.31 mm ~ 0. 62mm, the maximum gap $\Psi 2$ 0.95mm.

The bearing clearance generally refers to the tip clearance, split bearings, in repairing machine records requirements to measure and record the the tip clearance ψ with two side gap a, b; split bearing by two arcs, using addition and subtraction padsheet to adjust the side of the bearing clearance and the tip clearance, as shown in Fig.2. The split bearing, the radius of curvature of the next two pad should be greater than the radius of the journal, is formed nearly in the radius of curvature of the oval bearing, so the pre-load value is greater than zero, and to improve the stability of the bearing [3]. Held oil capacity adjustments by both sides of the gasket, an appropriate increase in the eccentricity of the bearing, increase the oil wedge and wedge convergence, improve the lubrication conditions and to improve the bearing capacity. The improper bearing clearance will cause bearing fever, can be adjusted by adding or subtracting spacers bearing clearance, such as the $\Phi 550$ aluminum hot rolling mill bearings in a repair machines, its working temperature is 20 ^{0}C above normal through the pads and shims increase or decrease, adjust the side of the gap and the tip clearance, the temperature returns to the normal range, the adjustment records are shown in Table 1.

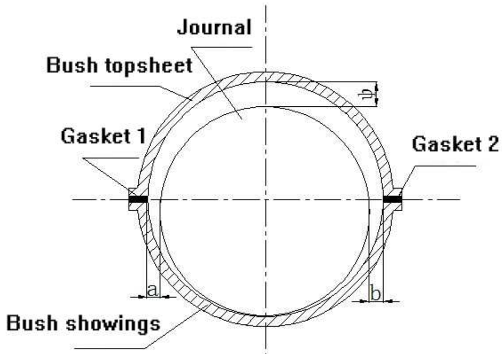

Fig.2 Bearing clearance and gasket schematic diagram

Table 1 Φ550 aluminum hot rolling mill bearing clearance adjustment record

Project	Tip clearanceψ/mm	Left gap a/mm	Right gap b/mm	Bearing average temperature /^{0}C
The repair machines installed gap	0.41	0.16	0.18	115
Adjusted gap	0.45	0.21	0.18	82

The film's monitoring. Oil monitoring technology can be used in the practical application of engineering, bearing lubrication system monitoring. The domestic oil analysis diagnostic techniques are mainly oil sample wear particle analysis and the degree of deterioration of oil analysis techniques, to monitor bearing oil film lubrication good or bad [3]. Main monitoring of the lubricating oil film bearing oil film thickness distribution of the film hydraulic distribution and oil composition; monitoring methods resistance method, the capacitance method, laser method, etc., on the oil film thickness of the optical fiber sensor can be used for high-precision measurements [4].

The actual production of the factory, the film's monitoring equipment is easy to operate, easy to install and move, the price is not high, intuitive readings. While monitoring the oil film in the use of equipment, combined with the empirical data to determine the condition of the bearing lubrication of bearings. Usually by monitoring operating parameters, real-time monitoring of the bearing clearance, the visual inspection lubricants distribution measuring vibration to determine the low speed and heavy bearing lubrication conditions.monitoring the the bearing temperature changes, run-in period, the temperature should reach a normal and stable value. Such as the Φ550 aluminum hot rolling mill bearing temperature is 65 ^{0}C ~ 85 ^{0}C.The periodic maintenance of equipment, the check pad wear, the contact area of the journal and the bush, the distribution of the oil film, the lack of oil area of the size and distribution. Such as the hot mill Φ550 aluminum sliding bearing for the upper and lower of the two halves of the split bearing, if reached 70 ° ~ 85 °, the contact angle of the bush and the journal the bush friction surface film evenly distributed, it can be judged that the bearing lubricants forming good; if into a piece of dry friction, the film uneven distribution of the film area is too small, the poor condition of the oil film lubrication, generally use the pad scraping, adjust the upper and lower bearing clearance, change the the sump structure size and oil viscosity methods to solve them.The key factors that affect the thickness of the oil film journal and the bearing clearance. Abnormal operation of the bearing, the bearing clearance using real-time monitoring of the eddy current sensor, combined with empirical data for fault diagnosis.The vibrometer monitor bearing vibration, based on empirical parameters of amplitude, frequency, combined with the normal operation of equipment can quickly determine the condition of the bearing oil film lubrication [5]. If abnormal vibration, should check local dry friction bearings, lubricants dirty and other faults.

The common lubrication failure and the failure processing

The common lubrication failure and reason.(1) Bearing abnormal wear and scratches.The reason is mainly the following aspects.1)Side of the gap and the tip clearance is not appropriate, bearing dislocation, the same bearing concentricity of the shaft at both ends do not meet the requirements, bearing and bearing too loose or too tight.2)Shaft and bearing improper assembly, includingbush does not comply with the dimensional accuracy requirements, including shaft deflection the roundness of tolerance, bearing deformation and uneven thickness.3)Oil supply system problems, including improper sump location, the size is too small, poor oil cooling. (2) bearing abnormal temperature rise. Mainly including the bearing size accuracy is poor, the gap is too small, assembly defects, oil cooling, poor poor cooling effect of the cooling water. (3) bearing corrosion. The main reason is the lubricant selection the inappropriate and oil unclean. (4) the lining of babbitt bearings (babbitt) backing (bearing) combination of bad to cause bearing lubrication failure, serious cause bearing failure [6]. The main reason for the alloy pouring temperature is too low, bush Preheat tinned improper.

Case study of lubrication failure. Bearing lubrication failure occurs, the operating parameters will be abnormal, must pass the detection parameters compared to determine the fault lies and timely processing, and otherwise cause damage to the bearings and related equipment, scrap. Several Φ550 two roll-aluminum hot rolling mill bearing lubrication failure analysis and judgment and processing are as follows.Damage caused by lubricating oil network failure. Aluminum hot rolling mill bearings in the detection of the operating parameters, the main motor current fluctuation abnormal increase, bearing temperature, vibration increase. Vibrometer detection found that the amplitude of the two bearing 320 ~ 400μm (normal less than 90μm) on the same side. Remove bearing checking found bearing more serious belt wear surfaces, the analysis is the lubricant entrained metal particles caused by impurities, and check the oil filter found oil network has been broken, replace the oil network, spraying patch bearing, re-scraping normal, bearing installed.

Shaft at both ends of the bearing wear due to lubrication failure. Aluminum hot rolling mill in use, the inspection found that the main motor current, bearing abnormal temperature rise, is still unable to reduce lighten the load, and excretion of lubricant oil residue are deteriorating situation, take multiple measures does not improve, and finally install the eddy current sensors, real-time monitoring and recording of a gap in the bearing running found bearings run on both sides of the roll gap difference between the larger and the maximum gap position is different, so that by adjusting the bearing clearance on both sides of consistent, make normal bearing lubrication, hot rolling mill eventually run properly.

Sump lubrication structure caused by the irrational failure. The inner surface of aluminum hot rolling mill bearing original opened a "×" shape the sump, depth and width smaller cross point after the the bearing central equipment has been run-in period, the bearing temperature is always higher than the normal 16 ^{0}C, the main motor current. the inspection found a larger area of the pad surface dry grinding axial middle of lack of oil more serious. Analysis bearing lubricant viscosity up to 100mm²/s, and the unreasonable structure from the sump, the oil supply shortage caused; the bearing sump transformation, from the bearing axial center of the 1/5 L(L bearing length) at to open a deep 3mm wide 40mm ring tank, as shown in Fig.3. Ring tank is not open in the middle, in order to avoid a weakening of the load carrying capacity is too large, the examination revealed after the transformation, the bearing surface to form a good film, film area covering the entire friction surface bearing temperature is stable and normal, the main motor current down to normal.

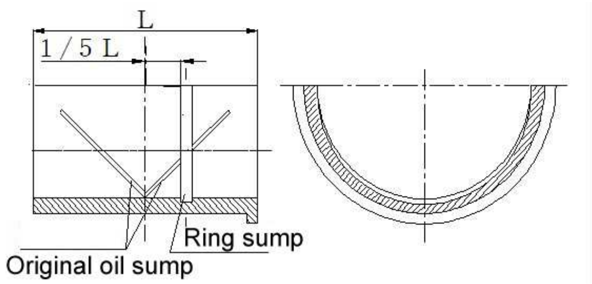

Fig.3 Sump sketch

The transformation of the bearing of the cooling system

Addition to lubricants away bearing part of the heat, low speed and high load bearing usually needed cooling water for cooling. Cooling water passages are generally arranged in the bearing housing, as close as possible to the bush on the back. Same size bearings, increasing the area of the cooling water passage, can effectively improve the cooling rate. The cooling water passage structure of the design of the cooling effect to play a key role. Increase the amount of sugarcane juice, a sugar refinery back seat press load increases, the bearing temperature exceeds normal above 16 ^{0}C (normal temperature is 45 to 60 ^{0}C) taken to increase the cooling water flow lubricating oil pressure oil only eased temperature rise. Repairing machine of the the presser chock cooling water passage to transform from the original single serpentine arrangement replaced by the dual serpentine arrangement, as shown in Fig.4

(cooling water passage sectional area of constant size). After transformation, the area of the cooling water passage has increased more than 50% per unit length of the heat transfer area of the cooling water passage burden is substantially reduced, to accelerate the cooling rate. Transformation of the former, the latter bearing a water cooling parameters are shown in Table 2 (average of 10 measurements).

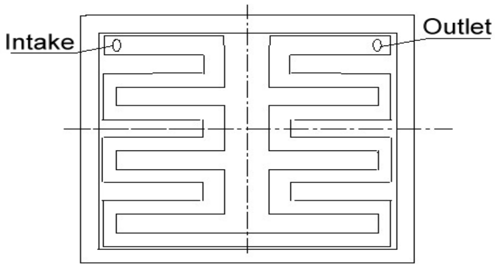

Fig.4 Transformation bearing dual serpentine cooling water channel

Table 2 Bearing water cooling parameters

Project	Before the transformation	After the transformation
Water pressure MPa	0.28	0.37
The area of the cooling water passage m²	0.105	0.161
Channel inlet water temperature ^{0}C	26	26
Channel outlet water temperature ^{0}C	39	48
Bearing temperature ^{0}C	73	58

Conclusion

Under conditions of low speed and heavy, lubricating oil film is formed is more difficult, the formation of the lubricant film and the bearing clearance, the temperature, the assembly and oil viscosity, the bearing clearance changes a great influence on the formation of the oil film lubrication and load carrying capacity; in factoriesproduction monitoring of operating parameters, bearing clearance real-time monitoring, oil lubrication distribution of visual inspection, and bearing vibration measurement methods for monitoring film lubrication conditions. Bearing assembly defects, size error and cooling systems, etc. will lead to bearing lubrication failure, the judgment must be analyzed by detecting parameters contrast, correctly handle the failure. Through the use of reasonable structure of the oil tank and cooling water channel, we can improve the lubrication performance, and extend the bearing life.

References:

[1] D.X. Cheng: Mechanical Design Handbook (Chemical Industry Press, China 2010)

[2] L.G. Pu: Mechanical Design (Higher Education Press, China 2001)

[3] Z.G. Li: Machinery Lubrication and Diagnosis Techniques (Chemical Industry Press, China 2010)

[4] R.Q. Zhang and G.W. Zhou: Machine Tool and Hydraulics, Vol. 37 (2009) No.04, p.106.

[5] Q.G. Shen and S.Y. Zheng: Equipment fault diagnosis (Chemical industry press, China 2005)

[6] H.L. Yu and G.H. Li: Process of rolling bearing sliding bearing preparation device (Machinery Industry Press, China 2009)