BY CHRIS STEWART, TURBOCARE

CORRECT INSTALLATION AND MAINTENANCE WILL AVOID COSTLY BEARING FAILURES

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Fluid film thrust and journal bearings should provide plant operators with years of worry-free operation. Unfortunately, this is not always the case. Too often, premature bearing failure results in plant shutdowns to repair or replace the faulty part. Poor quality manufacturing, overloaded equipment, contaminated oil, misaligned parts and other issues can lead to premature bearing failure.

The challenge is to correctly identify the underlying root cause so that the proper corrective action is taken and the reliability of the unit is improved. Almost all problems in rotating equipment are transmitted to the bearings in one way or another. If you know what to look for, bearings can serve as a diagnostic tool pointing to other problems in the system.

STRONG BOND

The first step in identifying the cause of bearing failure is to examine the condition of the babbitt. By design babbitt is a soft alloy and has been used extensively over the years as the liner material for high speed fluid film bearings. Many types and grades of babbitt have been developed, but the most popular in the U.S. is ASTM B-23 Grade 2. This is a high tin (89%) babbitt with copper (3.5%) and antimony (7.5%) added for increased strength.

Babbitt has an excellent blend of conformity, compatibility and embeddability characteristics that result in a very rugged material for bearing applications. It has good wetting qualities for development of the lubrication film on the bearing surface. Babbitt can be bonded chemically or mechanically to a variety of backing materials. The quality of the bond depends on many factors that must be precisely controlled during the babbitting process.

The chemical or metallurgical bond is dependent on a thin layer of alloy that forms during the tinning process. Complete adhesion is important since high mechanical and thermal stresses can develop within a bearing while in service. If the bond does not have sufficient strength and ductility, it is possible to fracture the bond and separate the babbitt from the backing material. This is of particular concern with backing materials that contain copper.

If the babbitt process is not properly controlled it is possible for the babbitt material to delaminate from the backing material in a complete section. Ultrasonic testing should be done to verify that there is adhesion between the two metals. However, this test does not indicate the mechanical characteristics of the bond. These characteristics can only be verified through destructive tests that validate the process used to cast the babbitt

In normal operation, all fluid film bearings are subjected to a cyclic load as the shaft rotates. The intensity of the cyclic load is a function of the level of system imbalance. If the bond fails in a load area, the babbitt will flex with each cycle. This results in fatigue cracking of the material and loss of babbitt. In this type of bearing failure a series of cracks running along the surface of the babbitt and down towards the backing material is generally visible.

If the failure is due to poor bonding, there will be no indication of a tinned backing surface under the areas where the babbitt has been removed. If the backing area shows indications of tin, then the failure is babbitt fatigue due to high cyclic loadings and not due to a loss of bond.

COMMON TYPES OF BEARING DAMAGE

Since damage can be caused by either a poor babbitt or by other aspects in the system, an inspection of the bearing surface can identify a problem. Figure 1 is a sample of babbitt failure through fatigue. Cyclic loading results in the propagation of cracks within the babbitt and when the cracks merge the babbitt material comes loose. The damage shown in Figure 1 is due to poor bonding of the babbitt and the steel backing. This is evident by the lack of tin on the steel surface. Correcting this type of problem will require replacing the bearing with one that

Figure 1: Babbitt failure due to poor bonding of the babbitt and the steel backing and fatigue. Source: TurboCare

Figure 2: Fatigue from misalignment and high vibrations. Source: TurboCare

Once you have identified and corrected the source of the problem, it is necessary to repair or replace the bearing. To avoid future shutdowns, it is imperative that the company doing the work have the necessary expertise and equipment to provide a long lasting, trouble-free part.

Choosing a reliable repair facility

An experienced bearing manufacturer can modify or redesign the bearing to compensate for many conditions, even if the source is unknown. It is also helpful to visit the facility to review the babbitting process. The essential process variables that influence the quality of the babbitted part are surface preparation, tinning process, temperature, casting method and the materials used.

Surfaces to be babbitted must be completely free from oils and other contaminates. The vendor should have a process that ensures the surfaces are properly cleaned, etched and fluxed prior to the tinning process. Likewise their process should ensure that the part flows through the operation in a timely manner without extended delays between steps.

The tinning process controls the quality of the bond between the babbitt and the backing material.

The plant personnel should also verify that the tin used by the vendor meets ASTM B339 or QQ-T-371 Grade A specifications. A reputable vendor should have documentation on site from a certified third part test lab that shows that the bond developed with their process meets DOD-STD-2183(SH) for strength and ductility.

To ensure the proper consistency of the babbitt in the finished part of cylindrical parts, it should be centrifugally cast with babbitt. The vendor should have the capability to spin the part at a speed suitable for proper segregation of the molten babbitt during the casting process. Improper speed can result in poor bond or reduced mechanical properties of the babbitt.

Likewise, there should be a method of quenching the part to complete the casting process. Quenching is important as it freezes the segregated molten babbitt and locks the impurities in an area for ease of machining, thus leaving a babbitt lining with the desired composition and properties. For best results, it is important that the vendor certify that their babbitt meets ASTM B-23 Grade 2. Although it takes time to inspect a vendor's facility it is minimal compared to an unscheduled outage of your plant due to premature bearing failures.

Figure 3: Triangular wear pattern from misalignment. Source: TurboCare

has been certified as bonded through ultrasonic testing from a qualified bearing supplier.

Another example of fatigue cracking is shown in Figure 2, but the nature of this failure is slightly different than that shown in Figure 1. Because tin is still evident on the backing material it indicates that the bond is still intact. The damage on one end of the bearing indicates that misalignment in conjunction with high vibration is the primary suspect. This type of problem can sometimes be resolved by correcting the source of the misalignment. However, it can also be resolved by replacing the bearing with one that is designed to compensate for the misalignment.

Misalignment is the most common source of premature bearing failure in high speed rotating equipment. It is also the most easily to identify. If the shaft and bearing are not square the load will be unevenly distributed along the bearing surface. A triangular wear pattern is the first clue. Figure 3 shows the wear pattern is noticeably wider at one end of the pad.

This particular design of bearing has the ability to tilt or rock in the circumferential plane, but not axially. As a result, the bearing is unable to align with the shaft misalignment. The dark patch to the left of the wear pattern is a sign of high temperature in the heavier loaded side of the pad. This is varnishing caused by overheating of the oil. Correcting the source of the misalignment, or replacing the bearing with one that is designed with alignment capabilities in the axial plane, are solutions for this problem.

Figures 4a and 4b are examples of misalignment at the thrust bearings. Figure 4a is the active side bearing which is a tapered land thrust plate with no alignment capability. Wear on the babbitt surface is highest on the top three pads and is progressively lighter in the circumferential direction. The inactive bearings shown in Figure 4b shows a similar pattern of wear, but the highest wear area is 180 degrees opposite the active bearing.

Figure 4 a (top): Active side bearing. Wear from misalignment of the thrust bearings. Source: TurboCare.

Figure 4 b (left): Inactive side bearing. Highest wear is 180 degrees from the active side bearing wear. Source: TurboCare.

These two bearings indicate a very high level of misalignment between the rotating shaft and stationary thrust bearings. Although correcting the source of the misalignment can rectify this problem, it can also be resolved by replacing the bearing with a self-equalizing tilt pad thrust bearing. PE

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