Checking Bearing Alignment

Written by MT Staff
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Premature bearing failure is often caused by misalignment. Here is how to check bearing position.

An anti-friction bearing is considered aligned when the faces of the outer race and inner race are parallel (Fig. 1).

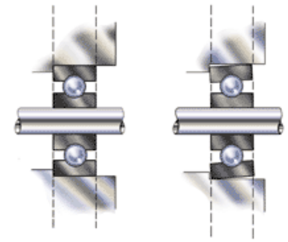

Figure 1. Faces of inner and outer races of aligned bearings are parallel.

Alternately, the races of aligned bearings are coaxial. It is surprisingly easy to misalign pressed-in bearings into aluminum housings. Plain bearings also can be misaligned when the bearing axis is not coaxial with the shaft. Thrust bearings are aligned when the thrust face is perpendicular to the shaft's rotating axis.

Why does misalignment matter? The symptoms of bearing misalignment are shock pulses and noise with anti-friction bearings, and rubs and higher temperature on plain bearings. These symptoms are identical to shaft-to-shaft misalignment. Therefore, it is not possible to positively diagnose misaligned bearings from vibration readings alone. A shaft alignment check must be done to eliminate shaft misalignment as a possible defect, and then move on to the bearings.

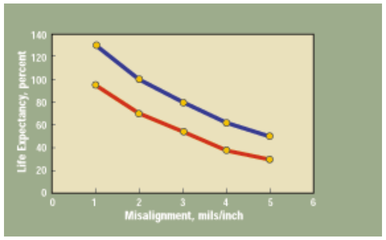

Figure 2. Bearing life varies inversely with misalignment.

It matters because when bearings are misaligned beyond their internal clearance, their life is dramatically shortened. All bearings have some internal clearance which can accommodate some thermal expansion and misalignment. When this clearance is fully consumed, then metal-to-metal impacting occurs with high dynamic stresses and the bearings quickly fail (Fig. 2).

How is alignment measured? A simple measurement of outer race runout detects the non-perpendicularity of the outer race to the shaft rotating axis as the shaft is rotated (Fig. 3).

The indicator setup on the shaft measures both static and dynamic misalignment of the outer race to the shaft. A similar test can be done to measure the inner race being square on the shaft by fixing an indicator to the housing and reading on the inner race as the shaft is rotated (Fig. 4).

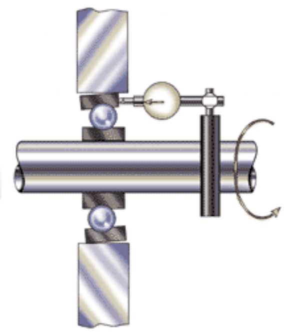

Figure 3. Indicator setup for measuring outer race runout.

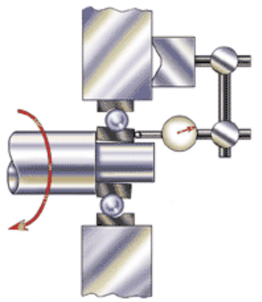

Figure 4. Indicator setup for measuring squareness of inner race with shaft.

Both of these measurements are described in the Machinery's Handbook, and appears to be a lost art in the mechanical trades.
The allowable runout is 1.0 mil/inch (1.0 milliradian) for ABEC-1 commercial ball bearings. That is, a bearing 4 inches in diameter will be allowed to have a total indicator runout of 4.0 mils on the outer race face. This is reduced to 0.5 mil/inch for roller bearings, and even further reduced for precision bearings, like machine-tool spindles. This measurement requires access to the outer race with a dial indicator when the bearing is installed (Fig. 5).

Other ways to deal with alignment issues The outer race is not always as easily accessible as shown in Fig. 5. There are other ways to handle it. One way is to carefully monitor the mounting of bearings onto shafts and into their housing, for the proper feel. This is described as no binding, about the right amount of force, or assembled easily. These all rely heavily on the experience of the mechanic. The use of excessive force is a warning flag that something is not right.

Another way to detect bearing misalignment is to slowly rotate the shaft by hand while feeling for binding and listening with a stethoscope. This is a good practice to do whenever repairing a machine prior to energizing.

Precision machine manufacturers control bearing alignment by one or more of the following methods:

- Shrink-fit assemblies
- Close tolerances on diameters
- Defining assembly tools and force
- Shaft shoulders (for squareness)
- End-bell concentric diameters on motors
- Precision machining practices on integral cast-iron housings, like gearboxes--defining position, perpendicularity, and orientation to datums
- In-line machining of bearing bores on integral housings, like pumps.

Precision machine manufacturers are well aware of the need for bearing alignment because their precision bearings have little, or no, clearance remaining to accommodate misalignment after the machine thermally stabilizes at operating temperature. However, in the process industries and facility equipment, not enough attention is given to this simple but critical parameter. We check bearing alignment on every repair job and since doing that, have never had a call-back on that machine. **MT**

Information supplied by Victor Wowk, P.E., president of Machine Dynamics, Inc., Albuquerque, NM; (505) 898-2094 . The company manufactures and sells bearing alignment tools.