Kingsbury, Inc.®

Thrust Bearing End Play Basics (Axial Clearance)

Thrust Bearing End Play Basics

Axial Clearance

Scope:

- **Purpose of End Play (EP)**
- **Typical Values and Tolerance**
- **Setting End Play**
- **Changes in End Play**

The purpose of thrust bearing end play is to provide axial clearance between the thrust collar and the thrust bearing assemblies. The end play allows room for the formation of an oil film, misalignment, and thermal expansion of the bearing components. End play is the total distance the shaft can move between the two thrust bearings and is sometimes called float, thrust bearing clearance or axial clearance.

if the gap, speed, and oil viscosity are at precisely the right values to excite it. On many machines, pad flutter never occurs regardless of the end play. At very large gaps, the oil film is not formed at all and so there are no dynamic effects on the slack side. Some gear applications use up to 0.50" of end play. In cases such as these, the shoes should be retained so they do not fall towards the collar. The end play must not be so large to allow rotating elements to contact stationary components.

Another problem that can occur with lightly loaded thrust bearings is shaft shuttling. In this case, the whole shaft

end play enough to solve the problem without getting it too tight which can raise oil film temperatures due to increased forces. In these cases, the tolerance should be reduced. Values less than 25% the typical end play should be avoided.

Setting End Play

The setting and checking of end play is a critical step in the setup of a

Typical values of end play can be calculated by the following formula:

Inches - EP (nominal) inches = [0.0005 x Bearing OD size(in inches)] + 0.003"

Millimeters - EP (nominal) millimeters = [0.0005 x Bearing OD size(in millimeters)] + 0.08 mm

Tolerance range:

For Bearing OD up to 15", use ±.002" (± 0.05mm) from the nominal

For Bearing OD larger than 15" up to 30", use ±.003" (± 0.08mm) from the nominal

For Bearing OD larger than 30", use ±004" (± 0.10mm) from the nominal

Bearing OD size is the babbitt Outside Diameter dimension of the bearing assembly.

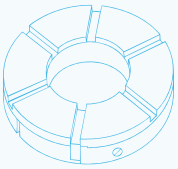

Figure 1

Typical Values and Tolerance

Typical values of end play can be calculated by formula in the blue box (Figure 1). While these values are typical, larger or smaller values are often used. In general, higher shaft speeds require more end play then lower speed applications. As end play becomes larger, the unloaded (slack) bearing will see a larger gap. In some cases, slack side pad flutter can occur

bounces back and forth between the loaded and slack thrust bearing. With smaller end play values, a strong oil film will develop on both side of the bearing which increases the stiffness and damping of the bearing. Values of half the typical amount of end play have been used with great success to reduce shuttling and pad flutter. The challenge with reduced end play is the tolerance. The idea is to reduce the

machine. There are several methods utilized in the process of setting end play. One method is to machine the thrust bearing and cavity to a very accurate value so that the end play is designed in. The most common method however, is to use shims or filler plates behind the thrust bearing that can be used to adjust the bearings overall height (stacked height.) This method also allows for the positioning

of the rotor within the machine by shimming one bearing more or less than the other.

Initially setting end play requires measuring the available space between the bearing housing and the thrust collar and the bearing's overall height. For equalizing bearings, the height must be checked using a flat plate, placed on the bearing shoes or placed babbitt face down on a flat surface. With this information, the thickness of the shim or filler plates required behind the bearings can be determined.

Once the shims or filler plate thicknesses have been determined the bearing components can be assembled into the bearing housings with the cover assembled. The end play should be verified by checking the axial movement of the shaft. The shaft should be moved in each direction and loaded with a force equal to between 50 to 150 psi bearing unit load. This is important to make sure the bearing shoes and leveling plates are set in their correct positions and that shims and filler plates are flat.

If using a dial indicator to measure shaft movement, it should be located as close as possible to the bearing. Ideally, axial proximity probes should be used to measure the gap along with dial indicators to confirm the probes setup.

Changes in End Play

Changes in end play can sometime occur. Hydrodynamic thrust bearings are designed to operate on an oil film without metal to metal contact. Under this condition the bearing babbitt surface will not wear, however there are conditions that can cause a reduction in babbitt thickness. The rate of reduction would vary depending on the cause and severity. Several factors that can contribute to such a situation include erosion, cavitations, chemical attack, electrostatic discharge, and stray electric currents. These conditions will eventually lead to a bearing wipe and failure if not addressed. Babbitt wear can also occur in machines that start and stop under load; however even with many start/stop cycles, the wear will be very minimal with clean oil.

Babbitt loss can be determined by measurement of the shoe height and surface profile. Another method to determine babbitt loss is by routine oil analysis. An analysis can identify trace elements of babbitt (tin) in the lubricating oil however it does not indicate the amount or location of loss.

Changes in monitored shaft position or end play may also occur as a result of elastic and plastic deformation of the bearing components. Line and point contacts in the bearing components create high contact stresses which can cause small permanent indentations. Most of this deformation occurs early in the operation of the system and then levels off. The end play and position can be adjusted at the next maintenance cycle back to the specified end play. If the bearing is disassembled, it is important to put the components back in their original locations. After this first adjustment, the end play should change very little.

Another reason for increasing end play is axial shaft vibration. The common source is collar wobble where the leveling plates are constantly working to equalize the rotating high point of the collar. Equalizing thrust bearings are not designed to take high dynamic loads or swashplate loads. These loads cause the contact points of the leveling plates to wear, reducing the bearing's height and leading to increased end play. It is important to check the runout of the assembled collar and shaft prior to installation.

Practical Insights

The following is a quote from a 1966 Kingsbury catalog: ***"Much time may be saved if it is realized that, for most installations, the amount of end play is not an exacting matter. Usually the nominal amount, plus or minus a few thousandths, is quite satisfactory."*** While this may still hold true today, we would suggest keeping the end play on the smaller side rather than on the larger side.

Contact Kingsbury

At Kingsbury, we are dedicated to providing top-quality products and services for your thrust bearing requirements.

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