Super Precision Bearings for Machine Tools

Factors for a Successful Spindle Bearing Set Up

Did You Know?

What makes these bearings special?

Why Angular Contact Bearings? Angular Contact bearings are suited for high speed applications where both axial and radial loads exist and rigidity is required thru preloading. They are typically used in pairs.

Optimal bearing selection must be determined thru considerations about the properties required by the main spindle being used, in terms of: maximum speed, radial and axial rigidities, main spindle size, required accuracies, and lubrication systems. An understanding of the following is necessary to choose the optimum bearing for the application.

**Rigidity of Spindle**.

System rigidity in machine tool applications is extremely important because the magnitude of deflection under load determines machining accuracy. Bearing rigidity is only one factor that influences system rigidity; others include shaft diameter, tool overhang, housing rigidity and type of bearings used.

For axial loading applications angular contact ball bearings are normally used as their larger contact angle provides higher axial rigidity. If high radial rigidity is needed cylindrical roller bearings are preferred as they provide more surface contact although they are not suitable for very high-speed applications

**Preloading.** This is the removal of internal clearance by placing a thrust load on the bearings. Giving preload to a bearing results in the rolling element and raceway surfaces to be under constant elastic compressive force at their contact points. This has the effect of making the bearing extremely rigid so that even under load, radial or axial displacement does not occur. There are typically three increasing Preloads available Light, Medium or Heavy. It is important to choose the correct preload for your needs. Preloading is used to satisfy one of the following requirements:

1. Elimination of all radial and end play
2. Increased system rigidity
3. Limiting change in the contact angle between the inner and outer ring at high speed
4. Prevention of ball skidding under high acceleration (courtesy Barden)

**Bearing Arrangement Options**. Duplexed (paired) bearings control preload by having a preload offset which is a function of relieving of the faces of the inner and outer rings. When the bearings are clamped into position the offset faces are brought together introducing a preload. Based on a users’ specifications angular contact bearings can be arranged in various combinations.

1. Back to Back duplex (DB). The wider distance between the effective load centers of the DB arrangement allows for larger moment loads to be handled with rigidity. They can sustain radial and axial load in both directions.
2. Face to Face duplex (DF). This has a shorter distance between the effective load centers which reduces capacity for handling moment loads however it is preferred in slower speed applications where shaft binding due to misalignment may occur. They can sustain radial and axial loads in both directions.
3. Tandem duplex (DT). In tandem duplex arrangements the preload offsets of both the inner and outer rings create parallel lines of contact resulting in capacity to handle both large radial and large axial loads, but only in one direction. Many main spindles of machining centers use four row (DBBT) arrangements offering high rigidity and high speed.

**Contact Angle Options**. The combination of radial play and thrust loading creates a line of contact between the balls and the raceways. This is the Contact Angle.

1. The standard contact angle is 15-degrees as it provides optimum combination of axial and radial capacity and rigidity.
2. The 25-degree contact angle is used where greater axial rigidity is required. For higher rigidity requirements Ball Screw Support bearings may be used.

**Ball Screw Support Bearings**. For applications where extreme rigidity is required these are the solution with the same envelope dimensions as standard precision bearings. Contact angles can be as high as 60 degrees. Advantages:

1. Provide high rigidity with low drag torque.
2. Greater control of axial runout.
3. Higher running speeds and longer life.

**Bearing Life**. When bearings rotate the inner and outer rings and the rolling elements are constantly loaded. This produces material fatigue and eventual failure. The total number of revolutions before failure occurs is referred to as Basic Rating Life. XXXXXXXXXXXXXX

**Basic Dynamic Load Rating.** The basic dynamic load rating of a bearing with rotating inner ring and stationary outer ring is that load of constant magnitude and size which a large group of identical bearings can endure for a basic rating life of one million revolutions.

**Internal Clearance. XXXXXXXXXXX**

**ABEC / ISO Levels of Precision**

**Bearing Handling.**

Proper handling of precision bearings is essential to achieving maximum speed and limited temperature rise. This involves cleaning, drying, filling with grease, and the running in operation.

1. The cleaning process involves removing the rust preventative oil that precision bearings are delivered in.
2. After drying the bearing apply grease aiming for the inner ring surface between balls in equal amounts. For roller bearings, apply grease to the outer or inside of rollers while turning the rollers to spread the grease.
3. Running In. For oil lubrication the running-in operation is relatively simple because no peak temperature occurs and the bearing temperature stabilizes within a relatively short time. For grease lubricated bearings the running in process is more challenging. During the initial running in a large temperature rise occurs while the bearing speed is increased. It is important to increase the speed incrementally and allow for temperature stabilization between speed increases.