Finding Your Bearings

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Bearings permit movement between two surfaces with smooth, rotary or linear low friction. Bearings employ either a sliding or rolling action. In both cases, there is a strong attempt to provide enough lubrication to keep the bearing surfaces separated by a film of oil or grease. The absence of physical contact through proper maintenance gives most bearings a long service life.

What's in a name?

A bearing can carry loads along its axis of rotation or perpendicular to its axis of rotation. Those carrying loads along the axis of rotation are referred to as thrust bearings. Rolling-element bearings carrying loads perpendicular to the rotational axis are called radially-loaded bearings. Plain bearings carrying such loads are usually called journal bearings or sleeve bearings.

Carrying the load

Bearings are evaluated on the basis of how much load they can carry, at what speeds and how long they will last under the specified conditions. Friction, start-up torques or forces, ability to withstand impact or harsh environments, rigidity, size, cost and complexity are also important design considerations.

Torque required to put a bearing into motion from rest is usually higher than that required to keep the bearing running once it starts. Starting friction, therefore, has an important influence on the power required in a bearing drive system.

Self- or manual-lubrication

In terms of self-lubrication, a material is either inherently self-lubricating or a mechanism does the work of delivering lubricant to critical points. Examples of the latter are oil splash systems, oil slingers and oil baths.

Self-lubricated bearings vary widely. It is difficult to predict performance for a given bearing/lubricant system. Heat is generated either by shearing of the oil film or by rubbing contact. In a hydrostatic or hydrodynamic bearing, heat generation at running speeds is the result of oil shear, and bearing temperature can be regulated by controlling the oil flow through the bearing or by using external cooling.

Boundary-lubricated and self-lubricating bearings are more sensitive to sliding velocity than fluid-film types because the coefficient of friction is as much as 10 times greater in the first two bearing types. Frictional heating is a function of bearing pressure, sliding velocity and coefficient of friction. Rolling bearings usually provide more precise shaft positioning than journal bearings.

Preloaded angular-contact and tapered roller bearings are particularly rigid and are commonly used in turf equipment. Shaft position is more predictable under varying loads. Running and static positions are nearly the same.

Wear of plain bearings is influenced by the state of lubrication. Manual lubrication requires the use of a portable pump, which is not part of the machine, and an oil cup or grease fitting. Tubing or drilled passages carry the lubricant from the fittings

Photo courtesy Eddie Konrad.

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to the friction points. Lubricant is applied by connecting the pump outlet to the fitting and injecting a specified amount of lubricant.

Roller bearings

The principal types of roller bearings are cylindrical, spherical, tapered and needle. In general, they have higher load capacities than ball bearings of the same size and are widely used in heavy-duty moderate-speed applications. We use them in front and rear roller applications.

Tapered roller bearings

When a tapered roller bearing is subject to a load, a force develops between the roller and the cone back-face rib because the load tries to squeeze the rollers out of the bearing. Most of the load is carried by normal forces at the cup-roller and cone-roller contacts, but a small force is always present at the roller-cone back-face rib contact. This contact also provides roller guidance, so careful design and precise machining of this surface and roller ends are required. Techniques for lubricating this roller-rib contact area permit high-speed operation of tapered roller bearings. Tapered roller bearings are used to provide precise guidance for reels in reel mowers.

One of the most widely used types of tapered roller bearing is the single-row bearing. It has a high radial capacity, however, its thrust capacity is about 60 per cent of its radial capacity. The exact percentage depends on the size of the tapered roller bearing. Variations within the type include tapered bores for frequent removal, pin cages and hollow rollers for higher thrust capacity, and steep roller angles for higher thrust capacity.

Needle bearings

Needle bearings are roller bearings with rollers that have high length-to-diameter ratios. Needle bearings are used in hydraulic pumps and motors, transmissions, small gasoline engines, gear pumps, alternators and golf equipment generators.

Compared with other roller bearings, needle bearings have much smaller rollers for a given bore size. They have the highest load capacity for a given radial space of all rolling-element bearings, but their use is limited to bore diameters of less than 25.4 cm (10 in.).

Axial positioning

Accurate axial positioning of the shaft relative to the housing requires shoulders, snap rings or bearing flanges. Fit accuracy between shoulder and mounting diameter should be as good as bearing accuracy.

Axial adjustment

Removal of excess bearing end play, when required, may involve preloading of the bearings to OEM torque specs. However, depending on requirement, one has to establish an allowable range of end play under a given reversing thrust load. This can be achieved with Belleville or wave washers which exert a very light load on the bearing. The use of a spring washer usually involves a loose fit between the bearing ring and its mounting surface. Therefore, the washer should apply its force against the non-rotating ring.

Eddie Konrad is the head mechanic at the Ladies' Golf Club of Toronto in Thornhill, Ont. He can be reached via e-mail at eddie.konrad@ladiesgolfclub.com.