

A Precise Solution to Motion Control Challenges

Randy Burchell, OEM Account Manager
Dave Roth, Marketing Manager
Thomson Industries, Inc.
Wood Dale, IL
540-633-3549
www.thomsonlinear.com

Today's motion control equipment faces tougher challenges than ever before. Conveyors, and packing, sorting, and other positioning equipment often operate 24 hours a day, seven days a week. As demand for faster product shipments increase, manufacturers have also turned up the speed of their equipment. Making these operational changes means hardware wears faster, loses positional accuracies, and increases the noise levels in most factories, warehouses, and distribution centers, conflicting with OSHA requirements for quieter environments.

In most industries, managers face a shortage of qualified engineers and maintenance staff to properly support and maintain equipment. Consequently, their engineers face multiple challenges when designing rugged, reliable, and quiet machines that meet these new motion control demands.

One way design engineers are meeting these challenges is with components that the motion control industry refers to as precision bearings. Although no one type of bearing is specifically labeled "precision," some bearings require little maintenance and offer features that deliver low noise and long life at high operational speeds. These features may add about ten percent to the cost of such a bearing, but the return on that investment is longer life. Depending on the precision-bearing type, its life could be eight times longer than non-precision type bearings.

For example, material-handling equipment, such as conveyors, usually use rolling-element bearings, although, some applications use taper or cylindrically shaped bearing elements. Whether precision or standard, a rolling element bearing consists of an inner ring, an outer ring, balls, and a retainer or separator, along with various housings and sealing mechanisms. One factor that categorizes bearings as "precision" is the tolerances held throughout the manufacturing process. Close tolerances result in a higher quality product, one that can withstand greater speeds and stresses, and other operational requirements.

Nearly silent running

A factory, warehouse, or distribution center is inherently a noisy environment. Over the last few years, though, noise has become a big issue. Simply increasing the speed of a few motion systems pushes the noise levels over OSHA limits, currently set at 80 decibels. According to several equipment manufacturers, OSHA may lower that requirement to 70 decibels in the next

few years. Thus, dampening noise is a priority of most new equipment.

The proper bearing can greatly reduce the noise problem. Ordinarily, bearings aren't thought of as silent components, but newer designs incorporate features that help lessen noise. Bearings that would fall in the precision category are also able to run at high speed, usually between five to ten feet per second, and they tend to eliminate bearing binding or chatter.

Bearings manufactured more precisely usually have a coefficient of friction of 0.001 to 0.002. A low coefficient of friction also reduces stick-slip, which is another factor to consider when selecting precision-type bearings.

To help dampen noise, precision-type bearings generally have smaller ball elements. The smaller the balls, the less contact area is available among the balls and the less space there is between them, all of which helps reduce chatter and thus reduce noise levels. Plus, much of the steel that's not used for transfer of load is replaced with a plastic, such as Delrin. The ball return portion of the bearing is one such area where plastic is used instead of steel because the balls aren't under load. The main steel components of such bearings are usually the shaft, each ball, and the bearing plate.

In conveying equipment, not every roller needs to have a precision-type bearing to reduce noise or lengthen life. Conveyor manufacturers will often put rollers with precision bearings in about one-quarter to one-third of the conveyor rollers. This strategy can also be used on existing equipment, replacing old, worn rollers with ones using higher quality bearings.

For those applications where acceleration is important, precision-type bearings can handle higher acceleration requirements than standard bearings. Some precision bearings handle acceleration rates to 450 ft/sec/sec.

Continuous running

Some bearings come with dual plates. This reduces the total number of plates compared to single-track products. Two plates bear the load concurrently, which reduces the effect of minor variations in housing bore on load carrying capacity. In addition, this design also helps increase bearing life. Dual plates in the Super Smart bearing, for example, lengthen the bearing's travel life by eight times over standard bearings.

Proper alignment of all the elements, both in the bearing case and in the equipment, are crucial to bearing life, noise, and capacity. Precision-type bearings have inner tolerances that eliminate misalignment and reduce play among their components. Hardened steel bearing components react like elastic bodies under load. This means that the bearing components flex as the load-bearing balls move through them. Over time, material fatigue can set in, and they eventually fail. The tolerances in more precision-type bearings should be much higher than in other bearings because it aids in tolerance stack up.

Bearings installed *on* equipment face tougher alignment challenges. Bearings often have to

accommodate either dynamic or static misalignment, such as a warped roller shaft or a deflected head shaft on a loaded belt conveyor. Chatter is often an initial sign that there's misalignment in the system. Bearings such as spherical roller bearings can accommodate some "wobble" while carrying full system load. There are a lot of torsional alignment inaccuracies in the base carriage of many machines.

However, some bearing features handle such challenges well. Precision hardened rings enable a bearing to find its own proper position under load, which evens wear and thus, lengthens life.

Self-alignment enables a bearing to compensate for misalignment that results from imperfections in housing-bore roundness and parallelism, deviations in flatness of mounting surfaces, imperfect system assembly, or deflection at load. Three particular types of misalignment are:

- Pitch, or shaft angular deflection or misaligned housing bore
- Roll, or distributed load on the ball tracks
- Yaw, or skewing between ball tracks and shaft.

Manufacturers can predict, with high accuracy, how long a bearing will last in a given application, which is a real aid for equipment manufacturers who offer extended life and warranties on their equipment.

One customer, R.A. Pearson, manufactures packaging equipment. One of their machines assembles boxes that slide into refrigerators to dispense bottled drinks. The equipment props up the sides and tapes everything together so that a box is ready to receive product. R.A. Pearson designed the machine so it would not fail, especially within the first two or three years, and they offered a warranty to back it up. The machine experienced numerous failures at one of R.A. Pearson's customer sites, and the field support group was frequently going out to fix the machine. They found the bearings failing repeatedly. They replaced the bearings two years ago with Thomson Super Smart bearings coupled with the 60C shafting, and there have not been any failures since.

Maintenance

Maintenance is a huge issue with motion equipment. Usually, it's just not done. In factories, warehouses, and distribution centers, equipment is rarely shut down. Once installed and turned on, the equipment tends to run until it fails. And most bearing failures are due to improper installation, lack of lubrication, and contamination. Lack of lubrication is probably the most common issue, with some users even refusing to lube bearings. For example, this situation is common in medical applications. Medical facilities do not want lubrication to be a factor in equipment design for sanitary reasons. Bearings can run without lubrication, but it's not recommended. Under such rigorous demands, the smart design choice is to use precision type bearings.

While precision type bearings offer the advantage of longer wear, lubricating and reducing contamination are still parts of the equation. Most precision bearings have a lubrication port or pillow block for oil.

And proper lubrication will reduce contamination. Many precision type bearings offer a well thought-out seal design. The Super Smart has a double-lipped wiper that's integral to the bearing. It retains lubrication with one lip while the other lip acts as a scraper to eliminate contaminants. Thomson also uses a Buna-N seal with every pillow block shipped out.

However, when an application can't be lubricated according to a schedule, grease should be used because it allows a longer time between lubrications than oil.

Also, grease tends to dampen noise a bit better. In high-speed applications, oil is recommended. In high load, low speed-applications, from three to five feet per second, grease is generally used.

Proper installation can keep maintenance needs low. Do-it-yourself customers should pay attention to maintaining tight mountings and alignment, and eliminating vibration. All bearing manufacturers have written procedures and recommendations that should be followed to ensure correct shaft seating, mounting tightness, and unit alignment.

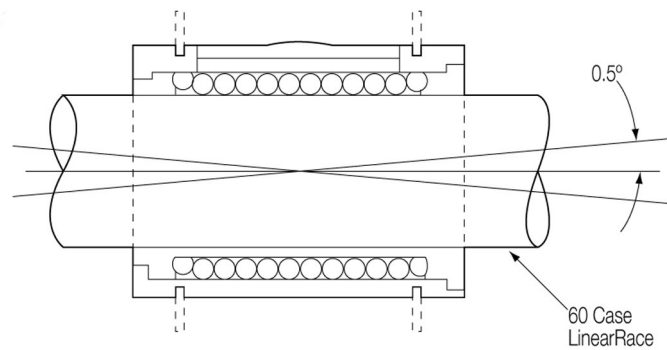
Alternatively, the bearing manufacturer can be brought in at the beginning of equipment design. Bearing manufacturers typically look at load, speed, and life, along with other critical factors in the design of the system. Also they often can help with drive system selection as well as other system components. Some have experience with all motion control components that would factor into equipment design, and that can be a real advantage. But, by bringing in the manufacturer, tolerances can be better, there will be less play among components, and therefore more system accuracy and reliability.

In general, any application can benefit from precision-type bearings. Precision bearings are increasingly coming into medical and semiconductor applications, especially in pick and place equipment. As semiconductor chips get smaller, positional accuracy becomes more critical. And even in standard applications, OEMs are turning to precision bearings because they offer more extensive warranties or a way to differentiate themselves from the competition.

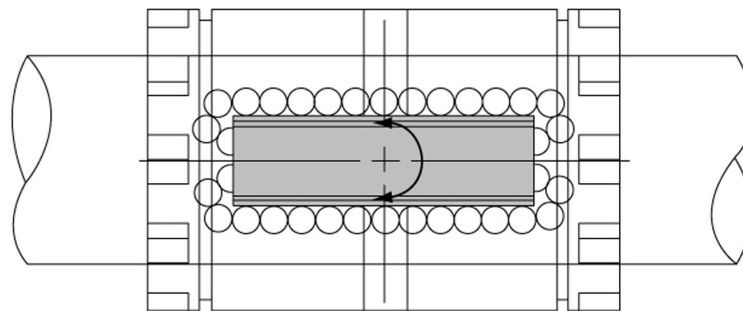
]

3 Types of Alignment

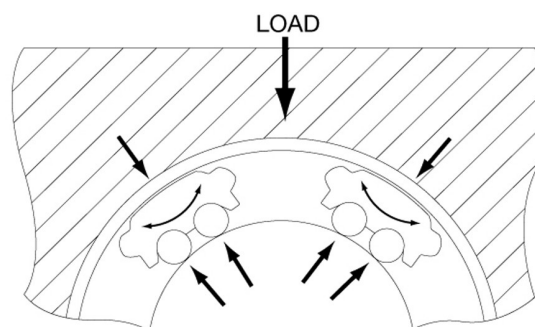
With self-alignment, bearings can handle three common types of alignment challenges. When the bearing's outer race can yaw in the direction of the shaft, it can stay in contact with the entire length of the shaft. This produces maximum load capacity and smoothness. Pitch self-alignment prevents binding due to misalignments from shaft deflection, housing bore alignment, and machine deflection. Reducing wear due to uneven load is the function of roll self-alignment.



Yaw Self-Alignment



Pitch Self-Alignment



Roll Self-Alignment