

TECHNICAL INSIGHT

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Identify Ball Screw Quality Before It's Too Late!

Identifying Quality When Choosing a Precision Ball Screw.

Selecting the appropriate precision ball screw for an application is by no means an easy process, but when a machine designer's reputation is on the line, it is an important one. Few, if any, external factors provide clues about a ball screw's performance, and poor quality is often left undiscovered until a component fails prematurely.

To avoid this scenario, designers and procurement must carefully select a ball screw after understanding some details of ball screw manufacturing and asking the right questions of ball screw suppliers. The tips and tools outlined below can help avoid premature ball screw failure and give insight into a supplier's attention to quality and detail.

Research the Manufacturing Process

Without a complete understanding of the ball screw manufacturing process, it is difficult for designers and purchasers to select the appropriate product for a design. Improper ball screw selection often results in premature wear, meaning unplanned downtime and costly rework. The mechanical demands placed on a ball screw can vary significantly among different applications, and understanding how various aspects of the manufacturing process impacts performance can help designers select

the appropriate product for their unique needs. By being aware of some key quality indicators, a company can help ensure that their image is not impacted by a component's poor performance in the future.

Manufacturing a high quality ball screw begins with the raw materials. During the processing of steel, microscopic inclusions can form in the material. These inclusions will eventually lead to the propagation of cracks that shorten the product's useful life. Steel production technology has evolved to the point where the number and size of inclusions can be significantly reduced, but such a material does demand a premium price. Typically, the best products start with material similar to an aircraft-quality, vacuum-degassed purified alloy steel.

Ball screw components will undergo heat treatment at some point in the manufacturing process. Stringent quality checks should be completed by the ball screw manufacturer to verify the depth and the amount of heat treatment along the shaft length. If the heat treatment is too shallow, the life of the product can be significantly reduced. In situations where the depth is insufficient, the compression of the balls in the ball groove during operation will result in microscopic indentations. Over time, these indentations will diminish the product's accuracy, performance, and life. The ball screw shaft heat treatment should be even and cover the entire threaded length. Should the heat treatment be short of the required threaded length, the untreated area will be soft in comparison to the rest of the ball groove and will



wear prematurely. To develop an understanding for how a ball screw supplier handles quality and consistency during the manufacturing process, it is important to ask about the quality checks during heat treatment.

Maintaining consistent accuracy between products requires strict process controls throughout the machining and grinding processes. This holds true particularly for the grinding of bearing journals where tolerances of a few microns must be held. Because extremely high precision is required to achieve reliable accuracy and long product life, ball screw components should be ground in an environment where temperature control is maintained. Even if two interacting components are manufactured to exact specifications, temperature variances can cause them to be out of tolerance when brought together. Ask the manufacturer about their facilities' climate control.

Strict process control during the grinding of the ball shaft and ball nut raceways ensures that the contact angles will meet design specifications. Good control of the grinding process should allow for a small range of ball sizes from the nominal. A large ball range from nominal allows the contact angle to shift and can result in decreased life.

Most, if not all, manufacturers of high quality ball screws document verification of the preload and torque and compile measurements taken during the heat treat, turning, grinding, lead accuracy, and assembly phases of production. When manufacturing a ball screw of high quality, systems must be in place to ensure tolerance checks are completed and out-of-tolerance parts are removed from the process. A ball screw supplier should be asked about their process control in manufacturing, the points at which manufacturing inspections occur, and what documentation is maintained and could be supplied upon request.

Additionally, a purchaser of ball screws should consider the packaging of the final product. This holds true particularly if the product could be held in stock for a significant period of time. The proper lubricant and packaging materials can significantly reduce the negative effects of long-term storage, including oxidation and rust.

Examining Design

Proven ball screw designs include models that use tubes or deflectors for recirculation and, most recently, systems of internal ball recirculation. This latest approach offers a compact nut design, high-speed operation, and lower noise levels than more conventional methods of recirculation.

When considering product specifications, including the ball screw accuracy class, selection of a proper precision ball screw requires consideration of both the application and the environment in which the product will operate. In machining centers, for example, a C5 accuracy class would typically be used. Applications such as image processing machines or inspection equipment, where greater resolution is required, may require the higher C3 or C1 accuracy class. It is important to take into account the differences between C grades and Ct grades of ball screws. A ball screw that is created by rolling, can generally achieve a transportation grade accuracy.

To achieve a positioning grade accuracy ball screw, the method of manufacture is usually grinding. However, for many applications, looser tolerances of Ct grades may result in reduced accuracy or product life, costing more in the long run and harming a company's reputation.

In design, the operating environment plays an important part in ball screw selection. Both temperature conditions and the materials being processed affect which type of ball screw will provide maximum performance. For example, in a woodworking application, wood particles can stick to the ball screw, necessitating special seals to prevent contaminants from entering the ball nut.

Another application might require placement of a ball screw in a difficult-to-reach position, making models with maintenance-free lubrication systems preferable. By providing details of the application and environment to a ball screw manufacturer, the best solution can be determined. When selecting a ball screw manufacturer, consider the experience of their engineering staff and how well your application is understood. Remember, the manufacturer's engineering staff should be the experts in selecting the right ball screw for your application. The correct recommendation will add value to your company's name and maintain the value in the future.

Making an Informed Choice

Understanding the key characteristics necessary to produce a quality ball screw can make the design and purchasing process easier and can help to ensure the product exceeds the expected performance levels. When the correct ball screw is applied to an application, it can provide many years of highly accurate, reliable, and consistent operation. On the other hand, selecting an inadequate ball screw could lead to poor performance or premature failure. In today's competitive global industry, making an informed decision is vitally important.