Dodge® mounted bearings for conveyors: choosing the right bearing to maximize uptime

Downtime is often blamed on poor maintenance or lack of maintenance. Undoubtedly proper maintenance is important in keeping your conveyor in uptime and not downtime. However, there are many operators with exceptional maintenance practices who struggle with downtime. A contributing and often overlooked cause of downtime is the conveyor's bearing selection.

Conveyors vary from a few feet to several miles long, and the design requirements and complexity increase with length. However, regardless of size or scale, all conveyors require bearings that are properly selected for the load and environment. Knowing the basics of bearing design will help operators determine if a conveyor's bearings are suitable for the application.

The Conveyor Equipment Manufacturer's Association (CEMA) has published a great deal of literature that details all aspects of conveyor design, including bearing selection. Unfortunately many operators will not have the time or resources to study and apply all of this information. However, even a basic understanding of bearing ratings and characteristics can allow operators to properly select bearings and reduce their costs and downtime.

When specifying bearings for conveyors, it's important to choose not only the brand but also the type of bearing to be used. For example, a ½-ton, ¾-ton and 1-ton truck may all be able to pull a 15,000-pound load. However, shorter life and earlier failure are to be expected in the ½-ton as compared to the 1-ton. In the same way, a pulley equipped with ball bearings may be capable of carrying the same load as a pulley with spherical roller bearings, but failures and downtime will generally be much more frequent and severe with the ball bearing as opposed to the spherical.

There are many different types of roller bearings. For conveyors, there are generally 3 basic bearing types to consider: ball, spherical roller, and tapered roller. Understanding the basic characteristics of each will help you identify problem areas in your operation and aid in specifying suitable bearings for future purchases.

Ball Bearing Characteristics

Think of a ball bearing as the ½-ton truck in our analogy. Ball bearings can carry both radial and axial loads. The load in a ball bearing is carried by a number of metallic balls, riding in a curved, tunnel-shaped raceway. Because the raceways have a slightly larger radius than the balls, the load is concentrated at a single point of contact. In other words, the bearing is "point loaded," and the load is not uniformly distributed over the width of the raceway. Because the load is only supported by such a small area, the load ratings and fatigue life are limited compared to tapered and spherical roller bearings. Ball bearings

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can usually handle misalignment, but typically do not have shaft expansion capabilities. Ball bearings are generally used for lighter applications, such as unit handling and package handling conveyors.

Spherical Roller Bearing Characteristics

A spherical roller bearing would be akin to the ¾-ton truck. Spherical roller bearings have two rows of barrel-shaped rollers which, when assembled, form a spherical profile. The outer raceway is also machined with a spherical shape, so the rollers contour to the outer ring and form a sort of ball joint. Because of this geometry, spherical roller bearings have a high radial capacity but are not well suited to high axial loads. This makes them ideal for heavily loaded, horizontal shafts, such as in mining, aggregate and construction applications. They are fully self-aligning, meaning that the rollers can adjust freely with misalignment. This is useful for applications where some degree of misalignment would be common, such as take-up pulleys. In addition, these bearings commonly have expansion capabilities for high-temperature or outdoor applications. Typically, heavier duty conveyors have a non-expansion bearing placed on the drive end of the pulley and an expansion bearing placed on the driven end.

Tapered Roller Bearing Characteristics

A tapered roller bearing would be considered the 1-ton truck. Tapered Roller Bearings use conical rollers that run on conical races. The rollers are wedged between the inner and outer rings and make contact along the full width of the raceway. Tapered roller bearings generally have a significantly higher load rating than ball bearings or spherical roller bearings, and they can handle purely radial, purely axial, or combined loading. Tapered roller bearings are not self-aligning, though some unitized, mounted bearings are designed to allow for misalignment and expansion. Therefore, tapered roller bearings are best used in the most heavily-loaded applications where the shaft can be properly aligned and fixed at installation, such as the drive or tail pulley.

The most critical selection criteria for a bearing is the load rating. The load rating for a bearing is typically described by two metrics: *static capacity* and *dynamic capacity*.

The static capacity (C_0) of a bearing is the maximum static load the bearing can support before the rollers begin to permanently deform the raceways. The static capacity is primarily used to rate bearings that remain stationary under load or run at very low speeds (< 10 RPM). Therefore, for most applications, the static capacity will not be a determining factor for bearing selection.

The dynamic capacity (given as C for ball and spherical, C_{90} for tapered) of a bearing is the more important characteristic but is often misunderstood. The dynamic capacity of a bearing is the load at which 90% of a given group of the bearings are expected to meet or exceed 1,000,000 revolutions (90,000,000 revolutions for tapered). The dynamic capacity is used to predict the fatigue life of a bearing and should not be considered the maximum load of the bearing in service.

So, rather than the static or dynamic capacity, bearings should be selected primarily by their predicted L_{10} *life*. L_{10} is a statistical estimate of fatigue life based on the dynamic capacity of a bearing. The L_{10} life

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of a bearing is the length of time which 90% of a given group of bearings can be expected to meet or exceed at a given load and speed and assumes ideal, identical running conditions for each bearing. Increasing either the load on the bearing or the speed will increase the rate of fatigue and thus decrease the L_{10} life. The L_{10} life does not account for lubrication, contamination, vibration, temperature changes, etc.; all of which will reduce the actual life that a given bearing can reach.

For many applications, an L_{10} life of 30,000 hours is considered the minimum. However, conveyor designers often require an L_{10} of over 100,000 hours to ensure the value and performance of the selected bearings and reduce the risk of unexpected failure. Though a longer L_{10} life may require a more expensive bearing, the initial cost must be weighed against the potential cost of multiple replacements and repeated downtime.

Though often overlooked, the bearing's environment is also a crucial factor for bearing selection. For example, two sets of conveyor bearings with identical loads and identical maintenance service can have dramatically different life. Why? One conveyor may be used in a clean, climate-controlled, indoor environment, while the other conveyor may be used outdoors with exposure to temperature changes, contamination, and moisture. Although load ratings may justify the same bearing for both applications, the second conveyor requires a bearing with a more rugged sealing system due to the application's environment. The type of seal is independent of the type of bearing, meaning that the seal will need to be considered based on the environment after the type of bearing has been selected based on the loads.

Of course, the initial cost will increase between "Good," "Better," and "Best," in mechanical design. However, you may find the difference is a very small percentage of the overall conveyor cost and insignificant when downtime and maintenance costs are considered. Proper selection of your conveyor's bearings should be the first priority in your operation's preventive maintenance program. The cost to maintain a conveyor equipped with the correct bearings is far less than one that isn't. Understanding the basics in bearing design will ensure uptime and savings for your operation.