

Slashing Operating Costs Of Low-Profile Conveyors

Charles Mitchell, President, Conveyor Technologies LTD.

(Editor's Note: Follow-up questions put to Tony Mitchell, Conveyor Technologies vice president of sales, immediately follow.)

Introduction

Low-profile conveyors are ubiquitous in industry, serving key roles in the production and assembly of everything from cosmetics to snacks; beverages to electronics; and land transportation. Broadly speaking, we're talking about compact belt conveyors with one- to two-inch pulley diameters and maximum belt widths of 24 inches. Typically used in 24/7 applications in packaging, assembly, labeling, inspection and sorting, low-profile conveyors form critical production links where unplanned

downtime or time-consuming maintenance is intolerable. Upstream equipment, such as ovens, bottlers, extruders and pasteurizers continue to churn out product, so line stoppages—planned or unplanned—must be minimized.

Certainly the most critical areas of low-profile conveyors that draw maintenance attention are the belt itself and the pulley/bearing system. Speed, load, accumulation and inclined operation increase forces on these components, as well as the drive system, highlighting problem areas such as belt tension. Belt manufacturers universally cite correct belt tension and crowned pulleys as keys to long belt life and consistent, slip-free performance with positive self-tracking. Incorrect belt tension is responsible for a high percentage of component-related failures and maintenance cost. Whether over- or under-tensioned, incorrect belt tension can cause a variety of problems, including bearing overload, mistracking, belt slippage and accelerated component deterioration.

What do Belting Manufacturers Recommend?

Correct tension varies, but typically it will be one mm of belt stretch per foot of conveyor length. However, with allowable manufacturing tolerances on belts, a belt will normally be a little longer or shorter than its stated size. To ensure correct tensioning, a simple system has been developed to allow maintenance people—and even novice operators—to set correct tension in seconds. The system uses the tail pulley to set tension; once all belt slack is taken up, tension is set via a scale on each side of the conveyor where each increment represents the tension-setting-per-foot of conveyor length. It seems counterintuitive, but a belt that is under-tensioned can actually elongate in use, which leads to many belts in good condition being discarded, due to a conveyor's limited tensioning capacity.

Again, following the recommendations of the world's major belt manufacturers, a crowned pulley with a correctly tensioned belt is the preferred way to

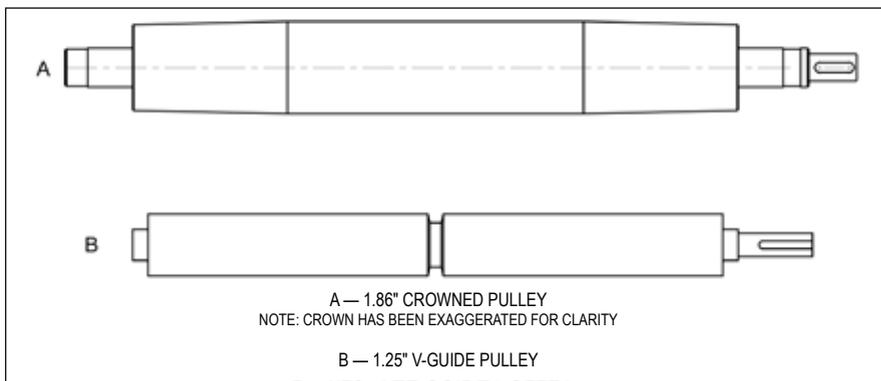


Figure 1—As pulley width increases, a 1.25"-diameter pulley will deflect nearly five times more than a 1.86"-diameter pulley; this effect is compounded when the pulley is weakened with a V-groove.



Figure 2—A tool-less, swing-up tail pulley provides one-minute belt exchange while retaining the tension setting. Calibrations on both sides permit rapid, precise balanced tension by which each increment represents the tension-setting-per-foot of conveyor length.

achieve automatic belt centering. A crowned pulley produces dual, lateral opposing belt forces that balance each other when the belt is centered over the crown. If the belt moves off center, these lateral opposing forces become unbalanced, resulting in the “higher-force” side directing the belt back to its centered position. This action provides virtually wear-free centering. Crowned pulley systems also allow higher accelerations and speeds with much less belt and component wear.

Properly tensioned belts on crowned pulleys easily withstand moderate short-term lateral forces without major displacement from center. When side loads increase, a V-retainer on the underside of the belt can be added to limit off-center drift. The V-shaped profile rides in a groove cut into the pulleys (that reduces pulley rigidity), and a groove running the length of the conveyor bed. This approach allows the crowned pulley to quickly center the belt when the external force is removed, thus minimizing wear on the V-retainer. Belting manufacturers recommend that V-retainers should not be the primary belt tracking system, due to the high wear the V-profile incurs. If the lateral force is sufficient, the V-retainer will climb out of its groove and may damage the belt. An alternative is to use the V-retainer on the top edge-surface of the belt and have it guided and constrained from the top down by a rolling Delrin V-guide, located opposite the point where the belt experiences side forces. These guides keep the V-profile fully constrained and with reduced wear. A normal V-retainer alone offers no true “non-contact guiding” so it tends to drag against the sides of the groove and constantly wear. Another point to consider on a bottom-mounted V-retainer is that the weld used to attach it results in a slight high spot in the middle of the belt, which can be troublesome if the belt carries small products that are tip-over prone. Because of material incompatibilities, the V-profile cannot be used with certain types of belts, such

as silicon-based, Teflon and polypropylene.

Pulley Diameter: Size Matters

Low-profile conveyor pulleys normally range from 1- to 2-inches in diameter, but this small range can produce a surprising difference in conveyor capacity and performance, as well as

in belt, cleat and bearing life. Smaller-diameter pulleys may be needed for applications requiring a minimum height profile where speeds and loads are moderate. However, logic dictates that a smaller-diameter drive pulley will have a much greater tendency to

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deflect as the conveyor width increases (a 1.25" pulley without a V-groove will deflect nearly five times more than a 1.86" pulley with the same load). This creates an inherent "traction" disadvantage for load-carrying purposes and can negate the crowning effect (belt-centering capability) of the pulley. This is highly problematic in applications that involve reversing, wider conveyors and accumulating or inclined operation. Flexing a belt over a smaller diameter also accelerates the breakdown of the belt structure, leading to erratic operation and shorter life.

When scaled up in width, conveyors with small-diameter pulleys often cannot carry proportionally greater loads. For example, a conveyor with a pulley diameter of approximately 2 inches, with a correctly tensioned belt, will carry twice the load at a 24-inch width than it does at a 12-inch width. But this rule of thumb does not hold, as pulley diameters approach the 1.25-inch range (see chart).

Smaller pulley diameters—with their greater tendency to deflect—have limited ability to produce the proper belt tension needed to achieve automatic centering with a crowned pulley. The resulting loss of "traction" and self-centering are sometimes compensated for by lagging or knurling the pulley and substituting a longitudinal V-retainer—rather than a crowned pulley—for belt centering. Because the pulley must now have a V-groove in its center—as well as being knurled—its rigidity is further compromised. Indeed, belt manufacturers discourage knurled pulleys because they invariably abrade the belt underside and resist tracking—leading to a substantial reduction in belt life. Impacted debris in the pulley knurl, or worn knurling, can lead to belt slippage and mistracking, as well as accelerated belt, V-retainer and pulley knurl wear. Abrasion can occur without any load on the conveyor or increases of belt speed. Debris from this abrasion may be unacceptable in food, pharmaceutical or clean-room applications. And routine

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cleaning of the knurling is impractical because it requires stopping production and removing the belt.

Bearing life is also greatly affected by pulley diameter. A one-inch pulley must run at twice the rpm of a two-inch-diameter pulley to produce an identical belt speed. Small pulley diameters can result in smaller bearings with lower load capacity running at higher speeds, thus reducing service life. Ensuring that the bearing outer race cannot rotate in the bearing plate housing can improve bearing performance and avoid the need to replace worn bearing housings.

Drives are available in a wide variety of styles. One style that is gaining popularity is the external shaft-mounted design. This unit is compact, provides “perfect alignment” and eliminates all couplings, drive belts, chain, sprockets, guards and tensioning. These drives can be radially positioned in 30-degree increments. Mounting of this drive allows an exchange in less than five minutes when equipped with an optional plug connector.

If a conveyor is used for multiple applications that can be run at lower speeds, a variable speed drive may be desirable. This reduces wear and power consumption and provides optimum speed for each application.

The service manual for a conveyor can provide clues to potential failure issues; sections on preventive maintenance and troubleshooting can be enlightening. For example, does the manual recommend stocking spare pulleys, bearings and bearing plates, or disassembling and checking bearings during a belt change or cleaning knurled pulleys? Belt change time should be based on the conveyor in its operating position, not resting on a bench.

Manufacturers offer a broad range of options, such as cantilever stands, tool-less guide rail removal, belt support removal and belt release that can permit a tool-less, “one minute” belt change on a stand-mounted conveyor. These options should be reviewed with the

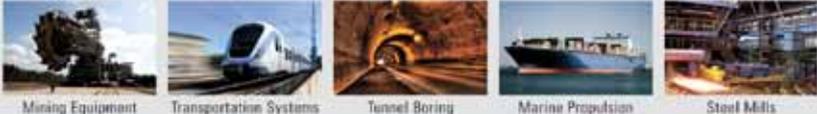
manufacturer—especially if downtime is a critical factor.

Follow-Up Questions for Tony Mitchell, Conveyor Tech Vice President of Sales PTE. Are there any advancements on the horizon in the material composition of drive belts that would enhance their

durability?

TM. I am not aware of any new advancements in belting composition that would drastically impact the low-profile conveyor. Pulley diameter has a major influence on belt life since a larger pulley decreases belt fatigue and

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permits a heavier, broader belt selection. Conveyor Technologies Ltd. has customers running daily production without having replaced belts, pulleys, bearings and bearing housings in 10 years.

PTE. Why—unless it is simply continual human error—do conveyor system users have so much trouble in maintaining the proper tension for running their lines? Wouldn't on-the-job experience come into play?

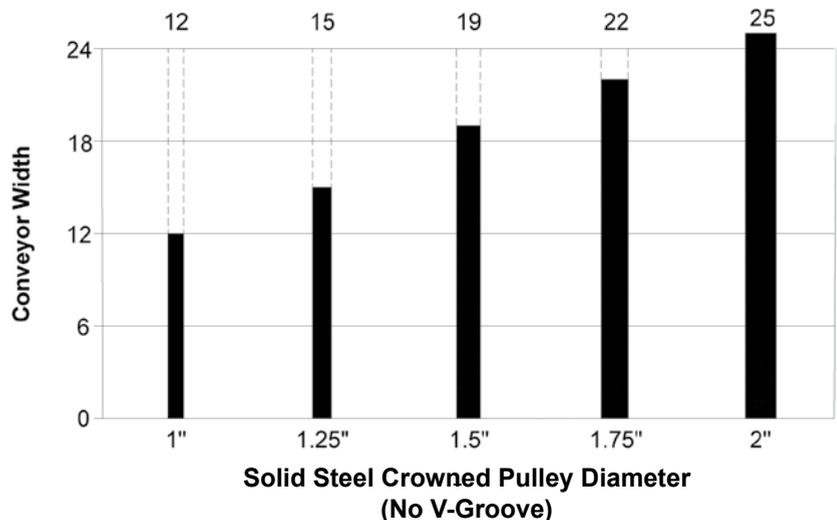
TM. The primary reason that proper belt tension is such a major problem area is that until Conveyor Technologies Ltd. appeared, no one offered a precise method for tensioning that considered belt manufacturers' recommended tension value, conveyor length, manufacturing tolerance, or if stretching has occurred. (For example), a well-known low-profile conveyor manufacturer's service manual dealing with tensioning does not address these issues. Because the service manual does not define

"proper tensioning," it is difficult to know if it has been achieved when their procedure is complete. Another major producer also assumes the belt length is correct and ignores the same issues. This system also does not provide assurance that the correct tension has been achieved. There is little wonder that conveyor users are often compelled to increase belt tension to achieve a functioning conveyor—and live with a higher maintenance cost.

PTE. If one-inch pulleys are so problematic vs. 2-inch pulleys, why do companies use them?

TM. With the advent of the Vee guide for belt tracking, most one-inch pulley designs converted to 1.25"–1.375" diameter. While this provided a slight reduction in pulley rpm, it does little to improve tensioning because of the Vee groove. This 1.25" diameter still retains a reduced belt and bearing life, along with a low-tension capability on wider

Table 1—Pulley Diameter vs. Recommended Maximum Conveyor Width Using 8-Class 8 N/mm Belting.



This chart—based on data from a leading belt manufacturer—illustrates how conveyor width can be limited by pulley diameter. This represents belting commonly utilized on low-profile conveyors. The belt rating is 8 N/mm, using a minimum recommended tension of 0.3 percent to ensure automatic belt tracking. The data provide a technical approach to pulley selection that will assist in achieving optimal performance of conveyor and belting—and lower operating cost. (Caution: The belting manufacturer notes that use of a V-groove for restraining the belt will have a negative effect on chart values, thus voiding the chart data for this type of pulley.)

units. Why these manufacturers hesitate to convert to 1.875"–2.00" diameters—which could have a positive effect on performance and component durability—is debatable. It would certainly have a negative effect on production costs and replacement part income. The benefit to the customer, however, in terms of maintenance costs and production down time, can be tremendous. **PTE.** Is bearing *material quality* a contributing issue regarding their lifespan in these systems, or is it simply a size vs. outer race and plate housing issue? **TM.** Because most low-profile conveyors require the belt top to be the highest surface, the pulley diameter controls the maximum bearing size. Consequently, the smaller the pulley diameter, the smaller the bearing.

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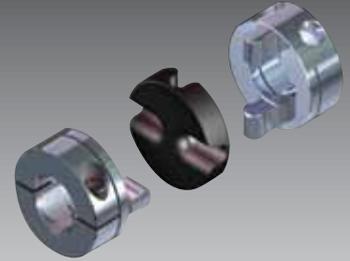
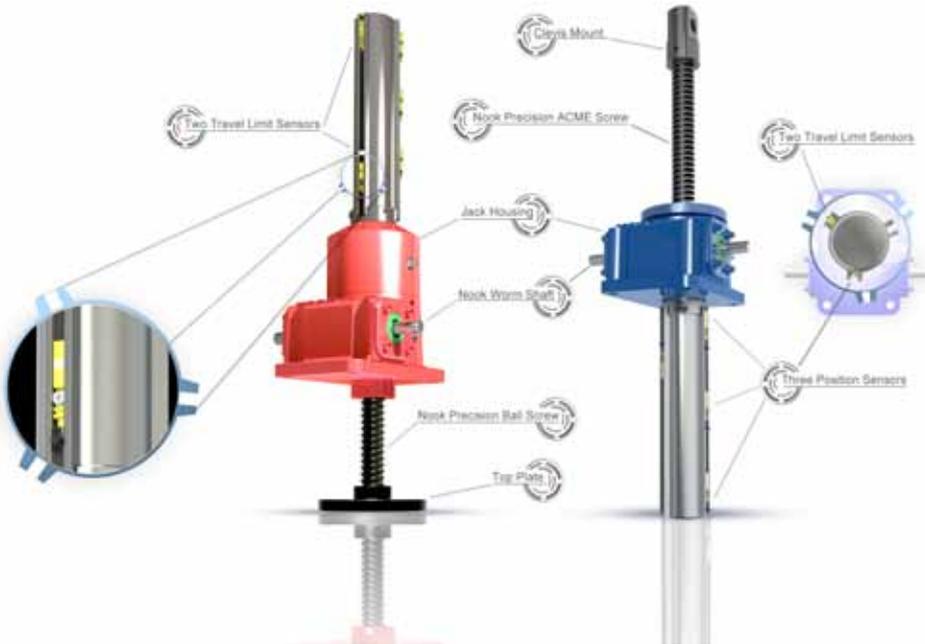
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Gates product application engineer Dan Parsons reviewed the designs and made key recommendations—eliminate

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