Trends In Power Transmission: The Synchronous Belt

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Synchronous belts do not slip, need retensioning or require lubrication. Offering 98% constant efficiency, these belts are now being used on all types of plant equipment and machinery. This report tells how they stack up against chains, gears and traditional V-belts.

A manufacturer of stainless steel products is saving $50,000 annually. How? By a simple conversion to synchronous belts in the plant's grinding and polishing operation.

Until the switch to synchronous belts the maintenance staff was replacing an entire set of six standard V-belts two or three times a week. Each set cost $250. Now, one synchronous belt does the work of six and lasts more than a year.

In the first full year the new belt was used savings in excess of $50,000 were calculated, based on reduced belt replacement costs, and avoided downtime and maintenance labor charges.

Examples of savings such as this from industries across the country are becoming common as synchronous (toothed) belts are used to replace chains, gears, and even some V-belts.

Synchronous belts are versatile and dependable. Forecasters at The Gates Rubber Company, the world's largest maker of belts and hoses, expect the synchronous belt market share to grow by 5% per year for the next five years--a 25% jump. Why? Synchronous belts provide positive, non-slip power transmission. They operate by making positive smooth engagement with mating grooves on the pulleys, much like chain and gear drives.

Because the belts operate with exacting speed and precision, engineers are using them on conveyors, positioners, actuators, and metering devices to provide constant angular velocity, minimum backlash, freedom from chatter and a wider speed range. Since they require minimum maintenance they are often used to replace V-belt and chain drives in inaccessible or hard-to-reach areas.

No creep or slippage

Synchronous belts require no lubrication. Clean operation makes them ideal for contamination-sensitive applications. They do not stretch over time like V-belts and roller chains, so there is no change in speed due to stretch, creep or slippage. They rarely need retensioning, which can be an important consideration on drives with limited center distance adjustment.

Because of their construction, the belts are highly resistant to abrasion and many corrosive substances. There is little wear to the teeth in most applications.

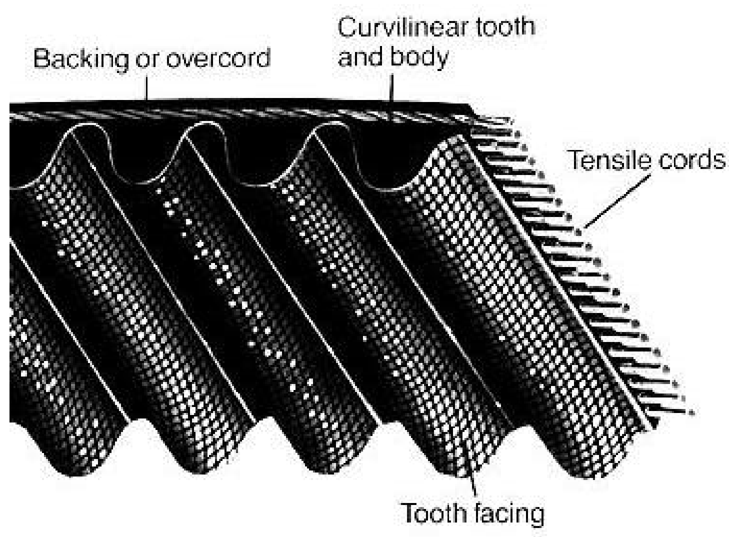
Studies by Gates power transmission engineers reveal that synchronous belts may be the most efficient form of power transmission short of a direct drive. The average V-belt drive is about 97% efficient when installed, but can drop to 93% or less as the belts stretch and slip. Synchronous belts, however, offer a near constant 98% efficiency over the life of the belt. This is due to their non-slip characteristic and lower bending stresses (thinner section) which results in minimum heat buildup. This means that the user can increase the efficiency of the drive by 5 to 10% and save significantly on energy costs.

The primary drawbacks of synchronous belts are the higher initial cost of belts and sprockets, and the need for accurate initial alignment of drive components. In most cases the higher initial cost will be offset by savings from reduced maintenance and energy savings from higher drive efficiency.

Sync belt anatomy

There are four parts that make up the standard synchronous belt:

1. *Tensile Cords:* The muscle of the belt, usually a high tensile strength fiberglass cord that has great resistance to elongation.
2. *Backing:* Protects the tensile member from oil, grease, moisture and other adverse environmental conditions.
3. *Teeth:* Perform the function of engaging the grooves on the pulley or sprocket. They are precisely formed, spaced and compounded of a high modulus material.
4. *Facing:* A wear-resistant nylon fabric that acts as a wear surface, protecting the teeth. The facing also helps keep frictional loss to a minimum.



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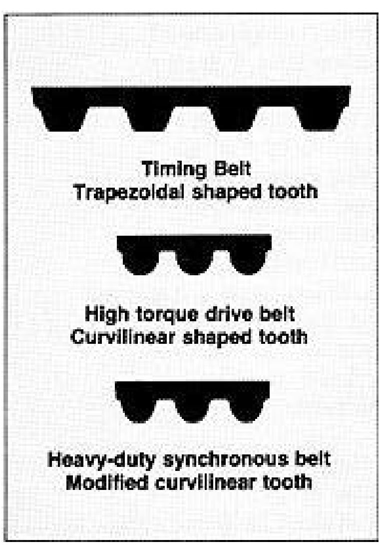
Specifying the belts



When ordering a conventional timing belt with a trapezoidal-toothed profile, the engineer must know three dimensions: belt pitch length, tooth pitch and width.

The pitch is the distance from the center of one tooth to the center of the next tooth. The industry accepted pitches are: MXL (2/25-in), XL (1/5-in), L (3/8-in), H (1/2-in.), XH (7/8-in.), and XXH (1-1/4-in.).

For example, a 30-inch long timing belt with a 3/8-in. pitch and a 3/4 in. width would have a nomenclature of 300L075.

Timing belts are primarily used when synchronization of input and output shafts is required. A curvilinear-toothed belt also has belt pitch length, tooth pitch and width dimensions. Pitch sizes are 3, 5, 8, 14 and 20 mm.

Identified in millimeters, a 720mm long belt with a 14mm pitch and a 55mm top width would be designated a 720-14M-55 belt.

The curvilinear tooth design belts carry 20 to 100% more power per inch of width than conventional timing belts.

Synchronous belts are a growing factor in power transmission. They can solve tough drive problems. And when properly installed, they provide space and weight savings, low maintenance and maximum energy efficiency.

Troubleshooting Tips

Most of us have no difficulty recognizing a problem drive. The real difficulty lies in knowing the cause and cure. The following problems have many possible causes. A few of the most common ones are discussed here.

Noise: Noise problems are commonly caused by drive misalignment, worn belts and sprockets, or improper tensioning. Noise can also be created by drives on high speed applications. If proper tensioning and alignment do not reduce the noise level, verify that all pulley dimensions are sized according to manufacturer's specifications. Another possible cause is improper mixing of belt and sprocket tooth profiles. Replace any worn sprockets.

Ratcheting: Ratcheting is the synchronous belt equivalent to V-belt slip and occurs when the belt teeth slide completely out of the pulley or sprocket grooves. Although there may be no visible evidence of damage, the capabilities of the belt are most likely destroyed after it has ratcheted. Ratcheting is caused by improper tensioning, excessive loads, or inadequate bracketry that allows the center distance to close when a load is applied to the drive. This tendency is increased in wet or lubricated environments. When a belt ratchets, the tension requirements should be re-evaluated and a new belt installed with the correct static tension.

Unusual Wear: The smallest amount of pulley wear is greatly magnified in its effect on belt wear. If unusual belt wear occurs, the obvious first step is to inspect pulleys or sprockets. Small amounts of wear may be hard to detect, but excessive wear usually is obvious by visual inspection. All dimensions should be within manufacturers specifications The most common commercial power transmission sprocket material is gray or ductile cast iron. When a softer material is used, wear may be accelerated. Abrasive environment, drive misalignment and improper tensioning all will lead to rapid synchronous belt and pulley or sprocket wear.

Belt Breakage: Belt breakage can be caused by excessive shock loading or severe misalignment. The fiberglass tensile member used in standard timing and high torque drive belts may not be the best choic e for drives subjected to severe shock loads. An alternative tensile cord, such as DuPont Kevlar7, would be recommended under these conditions. When a drive is severely misaligned, the belt
tension ana ioao are concentrated on one side of the belt. Tensile failure at the point will initiate breakage. Occasionally, a belt can be destroyed by one extreme, momentary peak load that exceeds the ultimate strength of the cord or tensile member material. Remedies for this problem are to change to a larger pitch and/or wider belt to increase the ultimate strength of the belt, or to modify the drive system to minimize the shock loads.
In the troubleshooting process, the engineer should be aware of the normal mode of synchronous belt failure. The end of the useful life of a synchronous belt is characterized by even tooth facing fabric wear and eventually tooth separation. Any other type of belt failure will most often indicate an underlying drive problem.

TECH DATA

Developed and patented in the mid-1940s, the first synchronous belt was flat with metal teeth clamped at intervals around the body. It was used to synchronize the needle and bobbin of an industrial sewing machine.

The tooth profile, a design still recognized as standard, had a trapezoidal shape. As manufacturers gained experience with these "timing belts," emphasis shifted from mere synchronization to the efficient transmission of power.

Today, with the benefits of non stretch tensile cords, the development of more efficient tooth profiles, and polyurethane body constructions, synchronous belts are making inroads in high-power drives once restricted to V-belts, chains and gears.

In addition to the original timing and high torque drive configurations, many other special belts, some made-to-order, are available. The selection includes belts with teeth on both sides, high and low temperature belts, non-marking belts, and belts designed for extreme resistance to oil, static and noise.