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Dodge® belt and chain drives: comparison in industrial applications
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Today, there are a number of means for mechanically changing speeds and transmitting power in industrial applications. Commonly, V-belts, synchronous belts, and chains are used. All three methods can transmit power between two shafts separated by a wide distance and are readily available over a wide range of speed ratios. Additionally, speeds on an existing drive can be modified easily by simply changing a single component in the system. Unless you are experienced in the selection and operation of these three types of drives, you might be confused about which type offers the greatest benefits in your application. To select the best design, the advantages and operating characteristics of each drive must first be understood.

V-belt Drives

V-belt drives are some of the most common means of transmitting horsepower and reducing speed. They are a quiet, low-cost product, requiring little maintenance. V-belt drives have been in existence since the early 1920s and have improved in functionality ever since.

These drives transmit power through friction created by a wedging action of the belt in the sheave groove. V-belts work optimally with speed ratios of up to 6:1, but they are available with drive ratios up to 10:1.

V-belts are applied in a variety of applications but work best in applications greater than 500 RPM. They offer a great benefit in that they will slip upon overload, thus protecting other, more expensive equipment from load surges. Some applications, where service factors of 2.0 or higher are applied, a chokable situation can exist where the V-belt will not slip but will stall out the motor instead. This application is more common in fire hazard areas.

The service life of a properly designed V-drive is approximately 20,000 – 25,000 hrs. This life can be dramatically less if the drive is not installed or applied properly. V-belt drives are limited to a maximum misalignment of ½°, and standard belts are limited to operating temperatures between –40°F and 130°F. However, published belt ratings are based upon an operating temperature of 85°F. For every 35°F above the baseline temperature the life will be cut in half. In addition to ambient temperatures, excessive slip, tight bends, and poor ventilation can lead to increased belt operating temperatures. Another cause for V-belt failure is worn sheave grooves, which can lead to excessive belt slip.

Synchronous Belt Drives

Synchronous belt drives offer positive engagement between mating teeth of a toothed belt and a toothed sprocket at a medium cost. As with V-belts, no lubrication is required and they can operate at higher speeds than other positive-engaging drives such as chain drives. Additionally, they offer less noise at slow speeds than chain drives.

The first generation of synchronous belts, the trapezoidal tooth profile, developed in the 1950s, has come to be referred to as timing belts. These belts are offered in inch pitches and can provide power transmission up to 50hp. The second generation, the curvilinear tooth profile, was developed in the 1970s and has a more rounded tooth. This generation came to be known as the high torque drive, or HTD. HTD sprockets have metric pitches and can transmit up to 300hp. In the 1990s, the third generation was developed, the modified curvilinear tooth profile, which has a higher

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tooth angle and slightly shallower tooth. These belts can transmit up to 500hp or around 150% - 200% more than the HTD belts.

Applications requiring positioning, indexing, constant speeds, and no-slip are ideal for synchronous drives due to their positive tooth engagement. Additionally, wet environments, where chains can rust and V-belts might slip, are other ideal applications. The greatest benefit of synchronous drives come from replacing chain drives, as the synchronous drive does not require routine maintenance. Additionally, the no-slip feature of synchronous belts leads to greater efficiency at 98%, which reduces power consumption.

Alignment, noise, and high shock loads are more critical with synchronous belt drives. Alignment should be held to within ¼°. Otherwise, the belts could wear rapidly. High horsepower and high-speed synchronous belt drives can experience noise problems due to rapid tooth interaction. Furthermore, synchronous belts are more susceptible to damage from high shock loads, and thus require a greater design service factor. However, properly applied and installed synchronous belt drives will last between 8,000 and 12,000 hrs.

Chain Drives

High torque, slow speed applications are ideal for chain drives. Chain drives are compact, economical, and easy to install. They are capable of operating in high temperature environments and provide no slip with no special tensioning. Additionally, they offer the same efficiency (98%) advantages as synchronous drives due to their no-slip feature.

Chains are also common in serpentine drive applications and specialty conveyors because a variety of chain attachments and types of chain are available. The versatility, availability, and compact nature of chain drives allow them to be used in all industries and in all countries. While synchronous belts and V-belts are offered only in fixed belt lengths, a chain can be set to any length, providing for unrestricted center distance.

Improper lubrication is the primary cause for premature chain failure. Sufficient lubrication is necessary for proper chain operation. The type of lubrication method varies dependent upon the speed and operating environment but is generally limited to one of three main types: manual, bath, or oil stream. Manual lubrication involves periodic application of oil from an oiler or brush and is acceptable for slow speed and intermittent operation. Oil bath lubrication is best for most applications and involves submerging the lower strand of chain in a chain casing oil sump. Finally, recirculating oil systems or forced lubrication can be used to provide continuous lubrication to the chain. This method is more common in high speed, high horsepower applications. Recommended oil viscosities range from SAE20 to SAE50, depending on operating temperatures. Extreme temperatures beyond 200°F may require synthetic lubricants.

Chain sprockets can operate in a variety of environments. Dust and dirt can easily be separated from oil through proper circulation and filtering, allowing chain drives to be operated in rather harsh environments. Furthermore, chain drives are often used in high temperature environments, provided sufficient lubrication is available that won't break down at elevated temperatures.

Knowing the advantages and disadvantages of each type of mechanical drive is a valuable tool and should help make future drive selections easier.

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Mechanical Drive Characteristics			
	V-Belt Drive	**Synchronous Belt Drive**	**Roller Chain Drive**
Optimal Speed Ranges (RPM)	500-3600	50-2000	Below 500
HP Capacity	Up to 1000	Up to 1200	Up to 1000
Noise < 500 RPM		Low	Low
500 – 1500 RPM	Low	Med	High
>1500 RPM	Low	High	
Misalignment	1/2°	1/4°	1/2°
Cleanliness	Good	Good	Good
Maintenance Requirement	Belt Retensioning	None	Lubrication
Temperature	-40° to 130°F	-30° to 185°F	0° to 350°F
Overhung Load	High	Moderate	Low
Vibration Isolation	Good	Good	Poor
Maximum Speed Ratios	Optimal under 6:1, 11:1 Max	Optimal under 5:1, 6:1 Max	Optimal under 6:1, 10:1 Max
Efficiency	95% Typ	98% Typ	98% Typ
Life	20,000 - 25,000 hrs	8,000 - 12,000 hrs	12,000 - 15,000 hrs

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