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Denver, Colorado USA

SYNCHRONOUS BELT DRIVES SAVE ENERGY

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April 1988

Use of synchronous belt drives can translate into significant dollar savings from increased system efficiency

Eliminating energy losses in power transmission systems has a high priority. With current high energy costs -- more than 250% higher than those of 10 years ago -- cutting down on drive system efficiency losses may translate into large savings. Otherwise, an average 35% premium paid for energy-efficient motors may be wasted through inefficient drives. Power transmission drive system designers are tending toward specifying synchronous belt drives to obtain an energy-saving edge over alternative systems.

Synchronous or toothed belts are suited for a large range of applications. They require no lubrication, resist corrosion, withstand attack by abrasive particles, and operate in wet conditions.

The newer curvilinear tooth configuration provides greatly increased power ratings for these belts. Through improved stress distribution, this design allows the teeth to withstand the shearing action of high-torque loads without separating from the belt.

Helically wouldn't tensile cord members impart belt strength and provide exceptional flex and elongation. A wear-resistant nylon fabric covering the tooth provides extra protection. The neoprene backing ensures that the tensile cords are protected from oil, grime, and moisture. Basic construction features of a synchronous belt are shown in Fig. 1.

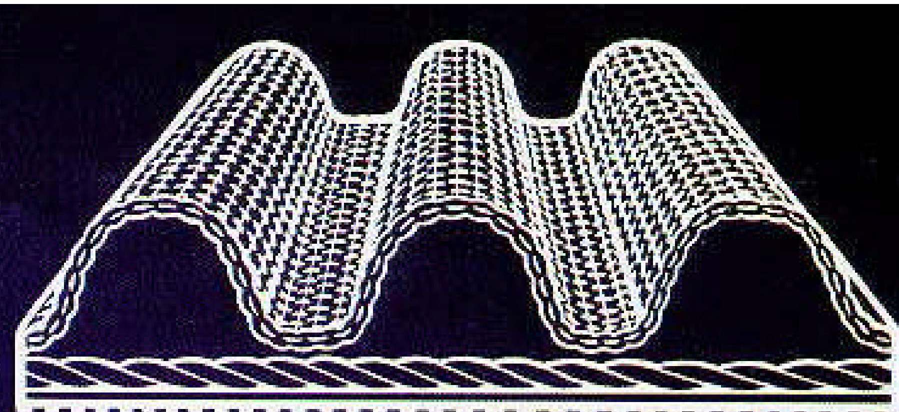

Fig. 1. Synchronous belt tensile cords provide strength and flex. Backing or overcord protects the tensile members from the environment. Curvilinear teeth positively engage sprocket grooves. Tooth facing provides a wearing surface.

Laboratory tests support the conclusion that synchronous belts use less power than some other drive systems. A drive with three V belts was tested next to an 8mm synchronous belt drive under identical conditions. Efficiencies were measured at shaft speeds ranging from 1160 to 3500 rpm. Various pulley diameters and variable loads from 2 to 25hp were used. The tests measured the relationship of efficiency, torque, speed, pulley diameter, and single and multiple V belts.

The major findings were the following:

- Efficiency increases with increasing torque for synchronous belts. It declines for V belts as slippage increases, because torque overcomes preset static tension.
- Larger pulleys produce higher efficiency.
- Narrow or fewer belts tend to produce higher efficiencies at low torque.
- Wide or numerous belts tend to produce higher efficiency at high torque.
- Underbelted or overbelted V-belt drives become inefficient, but synchronous belts maintain relatively constant efficiency.
- There are large variations between V-belt drive efficiencies, but the efficiency of synchronous belt drives is predictable

Proper maintenance of belt drives can alleviate plant engineers concerns over energy losses.

Synchronous belts start operation with no slip and do not change. Low bending stresses result in minimal heat buildup, allowing synchronous drives to achieve up to 98% efficiency.

V-belt efficiency is as high as 95 to 98% at the time of installation. In operation, this efficiency may deteriorate as much as 5% because of belt slippage. V-belts typically operate at 40 to 80 deg F above ambient temperature, a sign of slippage.

V-belts tend to stretch during their life, causing initial tension to drop. If maintenance and proper tensioning are neglected, slippage can increase dramatically. It can result in energy losses as high as 10% in poorly maintained drives, Fig. 2.

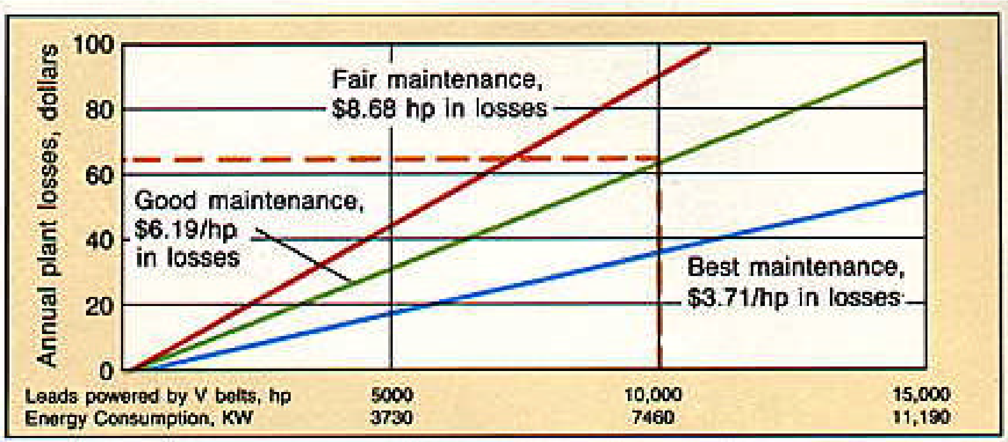

Fig. 2. Graph shows wasted-energy costs resulting from belt slip, based on a 40-hr week and an $0.08/kWh energy charge. For example, if the total of V-belt-powered loads is 10,000 hp, with good maintenance the annual loss would be about $62,000.

The switch to synchronous belts offers favorable financial benefits. A plant whose belt systems carry 5000 to 10,000 hp annually can waste tens of thousands of dollars in slippage.

Comparison of Belt Drive Costs

The payback for converting to a synchronous system from a V-belt system is usually short. Assume a 75-hp fan drive is converted to synchronous belts for continuous operation.

Approximate Cost of System with V Belts

One four-groove B13.6 in. sheave	$102
One four-groove B18.4 in. sheave	130
Four B 136 V-belts	108
Total Cost	$340

Approximate Cost of System with Synchronous Belts

One P52-14M-85 sprocket	$ 220
One P72-14M-85 sprocket	320
One 3150-14M-85 belt	478
Total Cost	$1018

The synchronous belt system initially cost $678 more than the V-belt system. If slip is 5%, energy costs $0.08/kWh, and the fan operates 168 hr/week, the synchronous belt yields predicted savings of $2152/year (see accompanying table). This saving does not include savings in reduced maintenance or downtime.

The complete drive conversion can be paid for in about 6 months. The payback time is determined by dividing the additional synchronous drive cost by the annual energy savings.

Annual Savings

Connected Horsepower	Annual savings, dollars, when weekly operating time, hr, is 40	80	168
10	72	152	312
15	112	224	464
20	144	288	608
25	176	352	744
30	208	416	880
40	280	560	1168
50	344	688	1448
60	416	824	1736
75	512	1024	2152
100	680	1368	2864
125	840	1688	3544
150	1008	2024	4248

These figures represent estimated annual energy savings per motor when a synchronous belt drive system is used instead of a conventional V-belt drive system. Calculation is based on $0.08/kWh standard industry motor efficiencies, and 5% slip. (Cost for electricity may range from $0.03/kWh to as high as $0.12/kWh.)