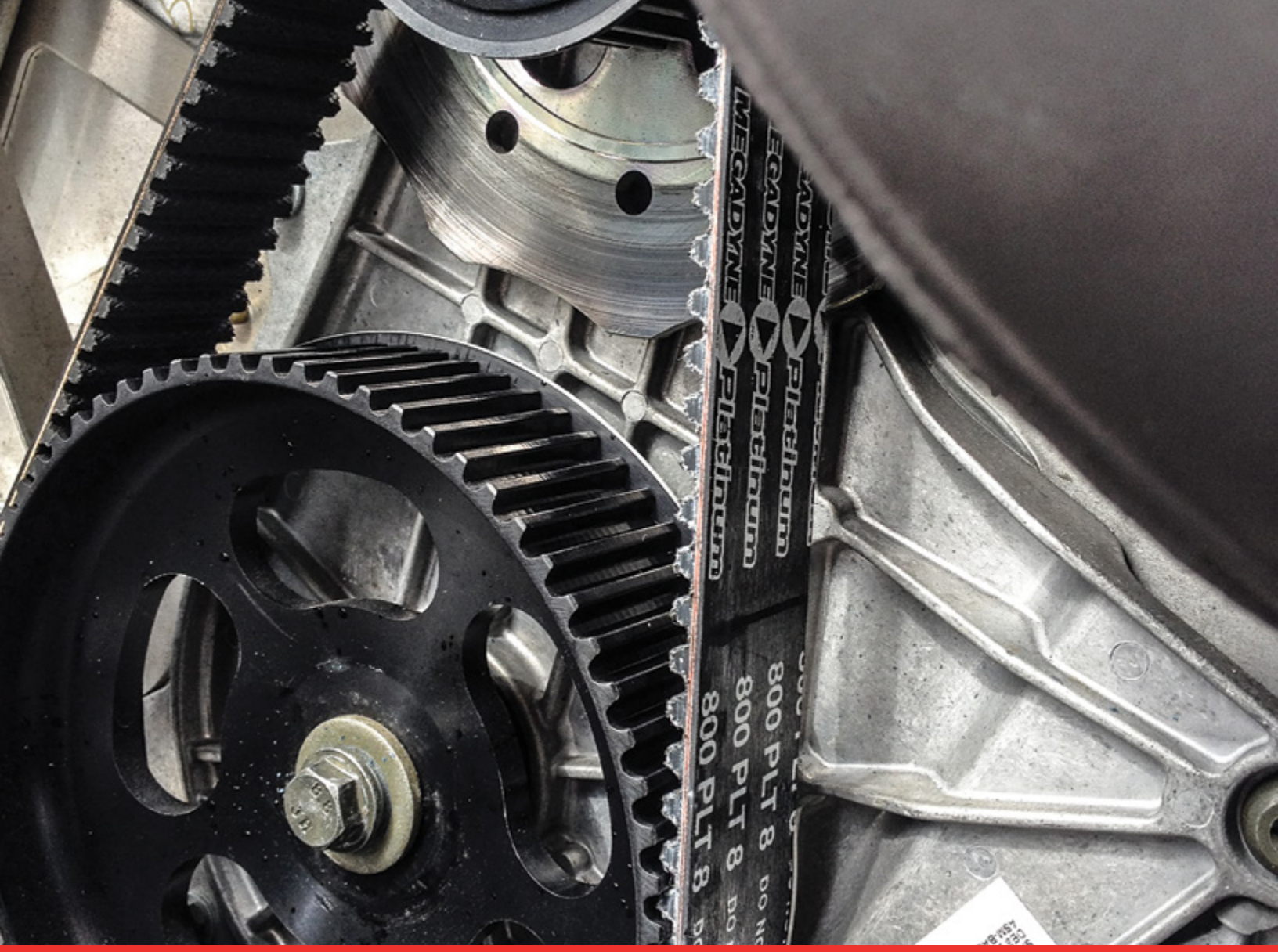

SAVING ENERGY WITH EFFICIENT BELT DRIVES

MEGADYNE

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Introduction

The cost of energy in manufacturing operations has a major effect on the overall cost of a product. In fact, energy cost is currently one of the main drivers in reshoring, the growing movement of bringing manufacturing operations back to the United States from offshore locations. In addition, rising energy costs mean that, over time, inefficient drives will waste profits that could be otherwise invested.

By introducing energy efficient belts on electric motor drives, you can implement a simple, cost-effective solution to achieve energy savings in your facility.

A combination of best practice approaches — including proper maintenance and the latest drive belt technology — can improve efficiency through reduced energy consumption and enhance drive performance, protecting your product prices and securing company profits.

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Regular Maintenance - Synchronous and V-Belt Drives

Proper Tensioning

One third of electric motors employed in industrial and commercial applications use belt drives. The majority of these drives use wrapped (fabric covered) V-belts, relying on the friction between the belt and sheave groove to transmit power. Relatively inexpensive, wrapped V-belts are designed to allow for limited slippage; intended to slip only in potentially problematic situations, this slippage prevents damage to expensive driven equipment by acting as a safety fuse. The belt can slip or break rather than damaging the more expensive driven unit.

But without frequent periodic maintenance, these belt drives tend to slip excessively during normal operation and result in reduced efficiency and increased operating costs. A correctly installed wrapped V-belt drive can attain 95-98% efficiency soon after installation, rapidly declining to approximately 93% efficiency during the course of normal operation. Without continued periodic tensioning maintenance, efficiency will decrease even further and components will wear more quickly.

Belt drive tensioning maintenance is often neglected due to higher maintenance priorities, meaning that belt drives tend to receive attention only when a belt finally breaks. This situation can be avoided by periodically adjusting the tension, which will help increase the lifespan of your belts and reduce the frequency of service interruptions.

Under-Tensioning

Under-tensioning is the most common tensioning problem in V-belts. In addition to reduced efficiency, under-tensioning of the V-belts can cause slippage (resulting in lost power and reduced belt life), noise and premature sheave wear. Energy loss from under-tensioning can be high, so keeping V-belts properly tensioned is a worthwhile time investment.

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HOW CAN UNDER-TENSIONED DRIVE BELTS BE IDENTIFIED?

V-Belts: Look for a "glazing" effect on the sidewalls of the belt

Glazing, a shiny appearance on the sidewalls, is the result of the V-belt moving independently of the sheave and sliding within the sheave groove. Glazing reduces the friction even further, decreasing drive efficiency.

Other noticeable signs include the belt and pulley both being hot to the touch — especially the pulley — and excessive rubber dust from belt wear collecting either on the floor or within the safety shrouding.

Finally, you may notice cracks on the underside of the belt caused by excess material stress. Under-tensioned V-belts will harden due to excess heat from the lost energy, making the belts inflexible and requiring even more energy to make the V-belt bend around the sheaves.

Synchronous Belts: Look for belts stripping or jumping teeth

With Synchronous Belts, under-tensioning may result in stripped teeth or the drive ratcheting or jumping teeth, which creates a noticeable noise. Should either of these faults be present, the belt is likely already damaged and will need to be replaced.

Over-Tensioning

Over-tensioning of a belt drive is equally as undesirable as under-tensioning. By causing undue stress on the motor, belt, shaft, and bearings from the increased load, over-tensioning wears down these components far more quickly than normal. It also decreases drivetrain efficiency, which in turn increases power consumption and leads to increased heat output. The additional heat generated will harden the belt and reduce its lifespan.

SYMPTOMS OF AN OVER-TENSIONED BELT DRIVE

Broken belts are a common sign of over-tensioning. This can result from misaligned pulleys, caused by the increased load, thus reducing efficiency. Finally, the increased stress on the bearings will lead to early or recurrent bearing replacement, another typical indicator of over-tensioning.

Note: The term "pulleys" is used interchangeably to refer to the drive components for non-synchronous as well as synchronous drive components. Technically speaking the term for v-belts is "sheave" and for synchronous belt the term "sprocket" is used. We will refer to both as "Pulleys" in this document.

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Pulley Conditions

To achieve an energy-efficient system, it is also important to keep the pulleys in good condition. Misaligned or worn pulleys will contribute to inefficient operation and increased downtime to allow for servicing, making them an important and costly consideration.

PULLEY MISALIGNMENT

While proper alignment between pulleys is a prerequisite for achieving the correct tension, it also contributes to increased efficiency and reduced maintenance.

Pulleys can have parallel misalignment, in which the pulleys are not in a straight line, or angular misalignment, in which one pulley is at a different angle to the other. Misaligned pulleys will quickly wear down belts, shortening the operational lifespan of both and creating damaging stress on other drive components.

On misaligned drives, belts can roll or shift within the pulleys or throw the load to one side, stretching and damaging the belt. The pulleys will also wear unevenly, resulting in reduced lifespan. Angular misalignment can cause differential tension on the belt, wearing it out more quickly. Finally, bushings that have deteriorated or become loose can also affect alignment by causing the pulley to shift.

To address these problems, regular checks on the pulleys will help increase drive lifespan and efficiency.

Unsure if the pulleys are misaligned?

Check the pulleys with a yardstick or other straight edge; this is a quick and simple way to assess potential alignment issues. The straight edge should make contact at four points across the drive and driven pulleys.

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Worn Pulleys

Over time, friction between sheaves and the V-belt will gradually erode the groove material. This leads to reduced surface contact between the belt and the sheave groove, resulting in limited friction, unwanted slippage and increased energy consumption. Worn sheave walls will also cause the V-belts to generate more heat, which reduces their lifespan.

Ensure that the sheave grooves are checked every time a V-belt is replaced. It's best to check the grooves with a sheave gauge rather than by touch, as the dished profile of a worn groove can be easily missed; even as little as 1/32" of wear within the grooves can significantly impact efficiency. A major component such as the pulley can be an expensive outlay but a worthwhile investment that should last several years through proactive maintenance.

Uncertain if the pulleys are worn?

If V-belts are wearing down or breaking sooner than anticipated, it could be a sign that the pulley is damaged. In addition to the groove wearing, damaged pulleys can have small nicks that create a burr issue. These burrs lead to abrasion cuts and other damage, which can be another way to identify a worn sheave. Synchronous sprockets also experience wear through normal use and require periodic inspection to determine replacement intervals.

Belt Considerations

The U.S. Department of Energy recommends replacing V-belts with proven belt drive solutions, including cogged raw edge V-belts and synchronous belts, as best practice for increasing belt drive energy efficiency.

Upgrading from a wrapped V-belt to a raw-edge cogged belt yields an average 2% increase in efficiency, a good return for a very low-cost investment. For new drives, using synchronous belts can provide an average 5% efficiency increase compared to V-belts. While increases of 2–5% may seem insignificant, when considering the energy cost savings over multiple drives and longer running times, the savings soon become substantial.

The following overview of the available belt options, as well as the pros and cons of each solution, is a useful guide for evaluating and selecting the best V-belt for the task. Ultimately, there is a balance between achieving the best performance for the lowest cost, so Megadyne offers the following solutions for belt drives, rated by energy efficiency.

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Good: Standard Wrapped V-Belt

The wrapped V-belt is typically the standard belt utilized in many applications. The excellent mechanical characteristics and high transmission efficiency make this type of belt a popular choice.

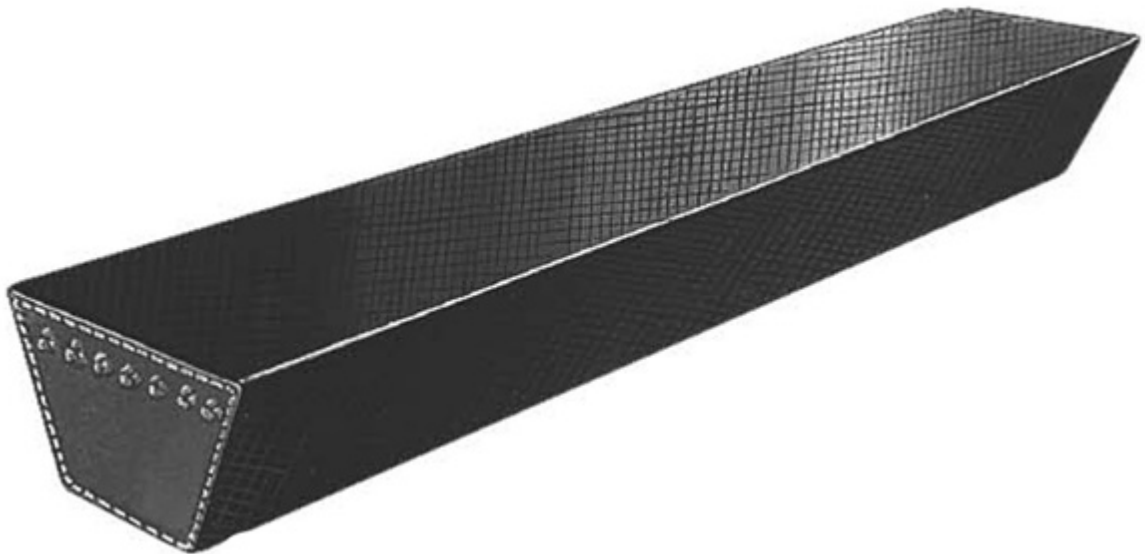
TYPICAL EFFICIENCY = 93% OR LESS

✔ PROS

- The wrapped V-belt will protect the drive from shock loads where torque spikes are present, by allowing some slippage and act as a safety fuse reducing risk of damage to valuable components.
- Any application where some slippage is desirable will be better suited to using a wrapped V-belt.
- A wrapped V-belt offers more protection against contamination as the cover offers protection to the rubber body of the belt.

✖ CONS

- Among available belt drive options, wrapped V-belts are the least efficient.
- This type of V-belt requires frequent tensioning to maintain its initial efficiency. If not properly maintained on a regular basis, it will lose up to 20% efficiency.



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Better: Cogged Raw Edge V-Belt

"Raw Edge" construction differs from wrapped v-belt in that it does not have external fabric on the sides of the belt. This puts rubber in direct contact with the pulley grooves greatly reducing slippage. The cogged raw edge V-belt also has notches cut in the underside for cooler operation and greater flexibility, making it ideally suited for smaller diameter pulleys. More efficient than a wrapped V-belt, this type of belt is the best choice where a synchronous drive is not cost-effective but greater efficiency is desired.

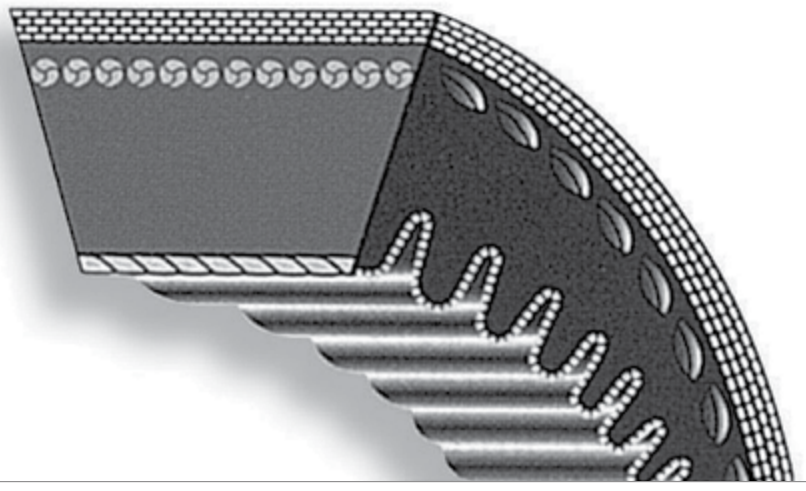
TYPICAL EFFICIENCY = 95% OR LESS

✔ PROS

- The cogged or notched construction reduces bending resistance in the belt, so it is able to bend around smaller diameter pulleys than a wrapped V-belt. Smaller pulleys require less material to produce, meaning they are generally cheaper than larger versions.
- The raw edge sidewall construction (meaning no fabric cover) has a greater coefficient of friction than a wrapped V-belt, making it more slip-resistant and allowing it to transmit more power.
- A cogged V-belt runs cooler than a wrapped V-belt, and, as a result, will last longer. The US DoE estimates that this belt type is 2% more efficient than standard V-belts.
- This belt runs on the same pulleys as a standard V-belt, so upgrading is a simple process of changing the belt without incurring the cost of new components.
- Unlike a synchronous belt, a cogged V-belt provides better vibration damping where excessive vibration is a concern.

✖ CONS

- Initial cost of raw edge v-belt is higher although return on investment is rapid.



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Best: Synchronous Belt

Also known as a timing belt drive, a synchronous belt features teeth that engage with corresponding pulley teeth. This belt eliminates slippage and provides the highest efficiency, thus offering consistently predictable results. However, it is not a direct replacement for existing v-belt drives as it requires a new drive design that will require all new components (belts and pulleys).

TYPICAL EFFICIENCY = 98% OR LESS

✔ PROS

- The teeth in a synchronous drive create positive engagement with the sprockets for zero belt slippage and maximum efficiency.
- A synchronous belt is the best choice for new drive applications, as the initial cost is offset against the increased efficiency and reduced downtime for maintenance that it offers.
- This belt maintains its efficiency over its lifespan, unlike a standard V-belt, which loses efficiency over time.
- This type of drive runs cooler and with less tension than V-belts, which extends the life of both bearings and belts.
- Capable of operating in wet and oily conditions that would hinder a V-belt, a synchronous belt requires only minimal maintenance and re-tensioning.

✖ CONS

- Installation of a synchronous belt will require both new belts and pulleys, making it a higher initial cost than other options.
- Synchronous belt generates more noise than V-belt.
- A synchronous drive is less suited for applications where some slippage is desirable.
- Alignment and tension of this drive is critical, as it is not as tolerant as a V-belt and is more sensitive to misalignment due to the teeth. If the teeth do not engage correctly, the drive will generate excessive noise and experience rapid wear and early failure.

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Potential Savings

An example of potential energy savings achieved by replacing a V-belt with a synchronous belt is provided below:

A continuously operating, 100-horsepower (hp), supply-air fan operates at an average motor load of 75% while consuming 527,000 kilowatt-hours (kWh) of electrical energy annually.

What are the annual energy and dollar savings if a 95% efficient ($\eta 1$) V-belt is replaced with a 98% efficient ($\eta 2$) synchronous belt? Electricity is priced at $0.08/kWh.

Energy Savings = Annual Energy Use x $(1 - \eta 1/\eta 2)$ = 527,000 kWh/year x (1 – 95/98) = 16,130 kWh/year
Annual Cost Savings = 16,130 kWh x $0.08/kWh = $1,290

Source: *http://www.nrel.gov/docs/fy13osti/56012.pdf*

Conclusion

Inefficient drives and infrequent equipment maintenance often contribute to lost profits; forced to spend more money than planned on replacement parts, new operating equipment, and increased energy usage, manufacturers waste budget that could have been invested elsewhere in the business.

By reducing your energy consumption and maintenance expenditures, innovative drive designs achieve the most significant gains in production while keeping spending low. Rising energy costs, increasing raw material prices, and growing pressure to reduce energy consumption make drive efficiency more important than ever.

Finally, good periodic maintenance programs play a key role in keeping equipment in peak operating condition. Establish a regular maintenance schedule to keep all equipment in working order and running efficiently. During these maintenance checks, look for tension, alignment, vibration, and wear to identify drive issues before they lead to more serious problems.

Have a belting challenge? Contact an expert on the Megadyne team today. We can help you identify the right type of drive for your application and provide innovative drive designs for the most energy-efficient belting solutions.

References:
US Department of Energy Advanced Manufacturing Office: Motor Systems Tip Sheet #4 The Importance of Motor Shaft Alignment.
US Department of Energy Advanced Manufacturing Office: Motor Systems Tip Sheet #5 Replace V-Belts with Notched or Synchronous Belt Drives.

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About The Megadyne Group

Founded in 1957 in Mathi, Italy, Megadyne is a leading global manufacturer and fabricator of power transmission, product handling, materials handling and linear positioning belts, hose and metal products.

With manufacturing operations in Europe, Middle East and Africa (EMEA), Asia Pacific (APAC) and the Americas, Megadyne is well poised to be your partner. From a broad selection of materials and processes, we service over 20 major industries offering high quality product, outstanding service, technical support and state of the art logistics to ensure we develop the right product for your application and have it at the right location when you need it.

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