Suggested Actions

- Conduct a survey of belt-driven equipment in your plant. Gather application and operating hour data. Then, determine the cost effectiveness of replacing existing V-belts with synchronous belts and sprockets.
- Consider synchronous belts for all new installations as the price premium is small due to the avoidance of conventional pulley costs.
- Install cogged belts where the retrofit of a synchronous belt is not cost effective.

Resources

U.S. Department of Energy—DOE's *MotorMaster+* and *MotorMaster+ International* software tools help you make motor comparisons and selection on a broad range of motors.

Visit the BestPractices Web site at www.eere.energy.gov/industry/bestpractices to access these and many other industrial energy efficiency resources and training.

Replace V-Belts with Cogged or Synchronous Belt Drives

About one-third of the electric motors in the industrial and commercial sectors use belt drives. Belt drives provide flexibility in the positioning of the motor relative to the load. Pulleys (sheaves) of varying diameters allow the speed of the driven equipment to be increased or decreased. A properly designed belt transmission system provides high efficiency, decreases noise, requires no lubrication, and presents low maintenance requirements. However, certain types of belts are more efficient than others, offering potential energy cost savings.

The majority of belt drives use ***V-belts***. V-belts use a trapezoidal cross section to create a wedging action on the pulleys to increase friction and improve the belt's power transfer capability. Joined or multiple belts are specified for heavy loads. V-belt drives can have a peak efficiency of 95% to 98% at the time of installation. Efficiency is also dependent on pulley size, driven torque, under or over-belting, and V-belt design and construction. Efficiency deteriorates by as much as 5% (to a nominal efficiency of 93%) over time if slippage occurs because the belt is not periodically re-tensioned.

Cogged belts have slots that run perpendicular to the belt's length. The slots reduce the bending resistance of the belt. Cogged belts can be used with the same pulleys as equivalently rated V-belts. They run cooler, last longer, and have an efficiency that is about 2% higher than that of standard V-belts.

Synchronous belts (also called timing, positive-drive, or high-torque drive belts) are toothed and require the installation of mating toothed-drive sprockets. Synchronous belts offer an efficiency of about 98% and maintain that efficiency over a wide load range. In contrast, V-belts have a sharp reduction in efficiency at high torque due to increasing slippage. Synchronous belts require less maintenance and retensioning, operate in wet and oily environments, and run slip-free. But, synchronous belts are noisy, unsuitable for shock loads, and transfer vibrations.

Photo Courtesy of Gates Rubber Company

Example

A continuously operating, 100-hp, supply-air fan motor (93% efficient) operates at an average load of 75% while consuming 527,000 kWh annually. What are the annual energy and dollar savings if a 93% efficient (η_1) V-belt is replaced with a 98% efficient (η_2) synchronous belt? Electricity is priced at $0.05/kWh.

Energy Savings = Annual Energy Use x $(1 - \eta_1/\eta_2)$
= 527,000 kWh/year x (1 – 93/98) = **26,888 kWh/year**

Annual Cost Savings = 26,888 kWh x $0.05/kWh = **$1,345**

Further Considerations

For centrifugal fans and pumps, which exhibit a strong relationship between operating speed and power, synchronous belt sprockets must be selected that take into account the absence of slippage. Operating costs could actually increase if slippage is reduced and a centrifugal load is driven at a slightly higher speed.

Synchronous belts are the most efficient choice. However, cogged belts may be a better choice when vibration damping is needed or shock loads cause abrupt torque changes that could shear a synchronous belt's teeth. Synchronous belts also make a whirring noise that might be objectionable in some applications.

About DOE's Industrial Technologies Program

The Industrial Technologies Program, through partnerships with industry, government, and non-governmental organizations, develops and delivers advanced energy efficiency, renewable energy, and pollution prevention technologies for industrial applications. The Industrial Technologies Program is part of the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy.

The Industrial Technologies Program encourages industry-wide efforts to boost resource productivity through a strategy called Industries of the Future (IOF). IOF focuses on the following eight energy and resource intensive industries:

- Aluminum
- Chemicals
- Forest Products
- Glass
- Metal Casting
- Mining
- Petroleum
- Steel

The Industrial Technologies Program and its BestPractices activities offer a wide variety of resources to industrial partners that cover motor, steam, compressed air, and process heating systems. For example, BestPractices software can help you decide whether to replace or rewind motors (MotorMaster+), assess the efficiency of pumping systems (PSAT), compressed air systems (AirMaster+), steam systems (Steam Scoping Tool), or determine optimal insulation thickness for pipes and pressure vessels (3E Plus). Training is available to help you or your staff learn how to use these software programs and learn more about industrial systems. Workshops are held around the country on topics such as "Capturing the Value of Steam Efficiency," "Fundamentals and Advanced Management of Compressed Air Systems," and "Motor System Management." Available technical publications range from case studies and tip sheets to sourcebooks and market assessments. The Energy Matters newsletter, for example, provides timely articles and information on comprehensive energy systems for industry. You can access these resources and more by visiting the BestPractices Web site at **www.eere.energy.gov/ industry/bestpractices** or by contacting the EERE Information Center at **877-337-3463** or via email at **www.eere.energy.gov/informationcenter/.**

BestPractices is part of the Industrial Technologies Program Industries of the Future strategy, which helps the country's most energy-intensive industries improve their competitiveness. BestPractices brings together emerging technologies and best energy-management practices to help companies begin improving energy efficiency, environmental performance, and productivity right now.

BestPractices emphasizes plant systems, where significant efficiency improvements and savings can be achieved. Industry gains easy access to near-term and long-term solutions for improving the performance of motor, steam, compressed air, and process heating systems. In addition, the Industrial Assessment Centers provide comprehensive industrial energy evaluations to small- and medium-size manufacturers.

FOR ADDITIONAL INFORMATION, PLEASE CONTACT:

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A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

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