BUSINESS PROGRAMS

Variable Frequency Drives

TECHNICAL DATA SHEET

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Many types of equipment do not need to operate at 100 percent capacity all the time. Yet, many do, and this practice wastes energy, a lot of it. For example, electric motors power the fans and pumps that operate air-conditioning systems and the compressors that run refrigeration systems. This equipment wastes energy unless it is outfitted with a capacity control device such as a variable frequency drive (VFD).

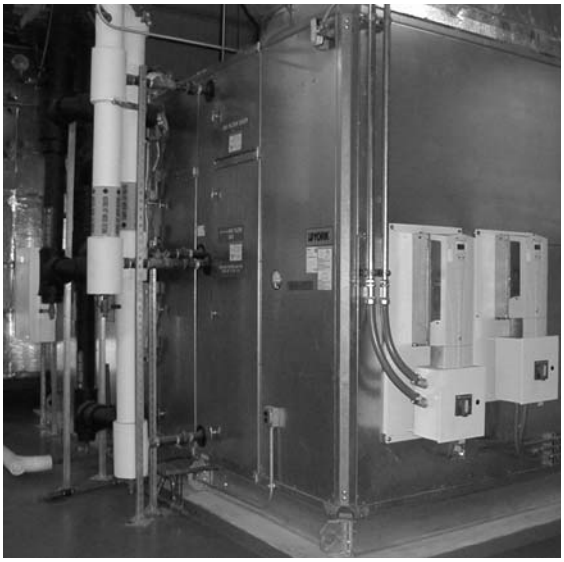
The benefits of retrofitting existing equipment with VFDs or installing new equipment that contains VFDs are real and measurable. You will reduce energy use, cut energy costs and improve your operation's efficiency. Due to advances in microelectronics and control technology in the past ten years, VFDs have become an efficient means of controlling motor speed; there is no reason to delay taking this practical and results-oriented energy efficiency action.

Overall, motor-driven equipment accounts for 64 percent of the electricity used by U.S. industries, according to the U.S. Department of Energy. The installation of VFDs can make a real difference in improving U.S. energy efficiency.

WHAT ARE VARIABLE FREQUENCY DRIVES?

Variable frequency drives reduce electrical energy consumption by matching the motor's speed to the load, allowing the motor to be continually adjusted relative to the power needed. VFDs are sometimes called variable-speed drives, adjustable speed drives or adjustable-frequency controllers.

A motor usually operates at a single speed; however, in the case of fan motors, there may be two speeds. Without a VFD, a motor runs at a constant speed. When full power isn't needed, a motor cycles on and off frequently, causing wear and tear and reducing the lifespan of the motor and its related components. In some cases, mechanical devices such as sheaves, flow-restricting valves or inlet guide vanes, can also be used to modulate flow.



Variable frequency drives installed for supply and return fans on air handler.

COMMON APPLICATIONS

Some of the most common applications for VFDs are found in the pumps and fans used for heating, ventilating and air conditioning (HVAC) systems, such as chiller condenser water pumps, domestic water booster pumps, air handling fans and cooling tower fans. VFDs also control loads such as refrigeration compressors, conveyors, cranes, elevators and water and wastewater pumps.

Manufacturing businesses as well as large institutions such as universities, hospitals or office buildings should consider installing VFDs for the motors driving their pumps and fans. In

industrial settings, VFDs can be used in many applications that use motors to drive equipment, such as hydraulic plastics injection-molding machines.

VFDs can operate on motors ranging in size from 1/3 horsepower to several thousand horsepower (hp). Energy savings are highest when VFDs are used with variable torque loads, such as fans and pumps for HVAC purposes. The best applications are large motors that can operate for many hours at reduced speed, such as with fans for cooling towers, where loads vary from season to season and from day to night. For motors that continuously operate at or near full speed, a VFD might actually increase energy use as a result of minor electrical losses in the VFD.

HOW THEY WORK

The primary purpose of a VFD is to allow motors that run at constant speeds to run at variable speeds instead. It does so by converting the incoming alternating current (AC) power to a direct current (DC) signal and then retransmitting the power signal to the motor at voltages of varying lengths of time that mimic an alternating current at the frequency desired. Nearly all VFDs currently being manufactured are known as pulse width modulation (PWM) drives, referring to the use of DC voltage that is "pulsed" in varied widths that mimic AC power.

The increased energy efficiency of a VFD is a property of physical science and the basic affinity laws of fan and pump operation - in particular, torque varies as the square of speed and horsepower varies as the cube of speed. As a result, even a small reduction in speed can lead to a large reduction in horsepower and in electricity consumed.

Consider this example for a HVAC system using centrifugal pumps and fans. A traditional 10 hp pump that operates with a bypass valve system runs at 100 percent full motor speed. If only part of that power is needed, bypass valves are used to control the water flow, while the motor keeps operating at full power. But if a VFD is used, the pump motor speed can be reduced. And thanks to the laws of physics mentioned above, electrical savings can be significant.

POTENTIAL SAVINGS

You may have a 25 hp motor that runs 23 hours a day, however, it is unlikely that it operates at 100 percent capacity for the entire 23 hours. If this unit actually runs for two hours at 100 percent speed, eight hours at 75 percent, eight hours at 67 percent and five hours at 50 percent, a VFD will reduce this unit's energy use by 45 percent.

How might this affect your energy bill? A hospital located in the metropolitan Milwaukee area recently retrofitted several air handling units of its HVAC system with VFDs to replace inlet guide vanes. A total of 330 hp of supply air fans and return air fans were updated with VFDs. The new systems, operate 24 hours a day and are saving approximately $36,800 per year (from $61,800 per year to about $25,000), based on an energy cost of $0.05 per kilowatt-hour (kWh). With the cost of the retrofit at $108,990, the simple payback was within three years, according to Focus on Energy.

The steady decline in VFD cost, combined with the increase in energy savings, make VFDs a solid long-term investment. Paybacks are especially good on larger motors because the cost per horsepower often decreases with size. As a rule of thumb, adding a VFD to an applicable system costs approximately $200 to $250 per horsepower installed.

To ensure proper operation, VFDs must be installed by qualified personnel. Installation costs will depend on the size and complexity of the project and in some cases may equal or exceed the cost of the drive itself. When retrofitting, check with the motor manufacturer to make sure the motor is rated for use with a VFD. Exact savings will vary depending on the load profile.

ADVANTAGES OF VARIABLE FREQUENCY DRIVES

As shown above, VFDs can significantly cut electricity costs. But they also reduce wear and tear on the motor and related components, which not only reduces maintenance costs but also prolongs the life of the motor. On typical start-up, constant speed motors are subjected to high torque and current surges of up to ten times the full-load current. VFDs, however, offer a "soft start" capability, which gradually "ramps up" a motor's operating speed. VFDs also allow more precise control of the motor, which is useful in processes, such as water aeration for wastewater treatment plants. Finally, VFDs reduce pump noise.

FOCUS ON ENERGY CAN HELP

Focus on Energy's Energy Advisors can help Wisconsin businesses learn more about the operational benefits of variable frequency drives. Call 800-762-7077 for more information or assistance, or visit our Web site at www.focusonenergy.com.