YASKAWA

Technology, Low Cost, Flexibility, equal broad acceptance of AC drives. The nearly-universal acceptance of AC variable speed drives (VSDs) in the HVAC industry is well documented. Overall, the market for VSDs maintains a strong growth profile and has exceeded more than $1 billion annually.

This growth results from a variety of factors, but centers on constant improvements in AC drive performance and capabilities, coupled with decreasing prices for ever more versatile and powerful drives.

Today's AC variable speed drives bring flexibility and efficiency to a wide variety of industrial applications, through their own capabilities and through PC and PLC interfacing.

VSDs provide the energy savings and efficiency required in today's institutional and commercial environments, where power cost is nearly always passed along as part of the pricing structure.

Substantial Energy Savings. In most HVAC installations, the adjustable speed drive delivers its savings by controlling the motor so that it spins the fan only fast enough to maintain the desired air volume. The ability to adjust system air volume by changing fan and motor speed and, therefore, power consumption, produces significant energy savings; typically ranging between 10 and 75 percent.

The savings are produced as a function of universally-accepted centrifugal fan laws: System volume varies directly with fan speed. System pressure varies with the square of fan speed. Power consumption, however, varies with the cube of fan speed. Therefore, a small reduction in speed produces a significant reduction in power consumption

In other words, the same system that requires 100 percent of full power to produce 100 percent of volume needs only 28 percent of full power to deliver 60% of volume. Obviously, significant savings are achieved by the drive's ability to reduce fan speed during the 90 percent of the day when full system capability is not required.

Likewise, incorporation of VSD technology into pumping, cooling tower, compressor and pumping applications -- as well as conveyors, material handling. manufacturing or food processing -- provides cost savings through precise speed regulation, digital repeatability of operating parameters, production flexibility, and simplified automation control.

Variable Speed Drive Fundamentals. The most widely used control method in AC drives is referred to as pulse width modulation (PWM). Its operation is a variation on the process through which any AC drive must first convert three-phase AC line voltage into DC "link" voltage.

In a PWM control scheme, link voltage is then "inverted" into a voltage output which is applied to the motor. This output consists of pulses of varying widths. The pulse widths control the magnitude of the output voltage waveform. The rate at which the pulse train changes polarity dictates the frequency of the power output to the motor. Since the mid-1980s, "solid-state AC" has evolved into the predominant VSD for new drive installations. The move to AC drives has been propelled by:

- Continued advancements in AC drive technology and capabilities,
- The quest for energy savings,
- Computer interface technology,
- Drive reliability.

At the same time, many existing solid-state DC drives (most prevalent in the early 80's), electromechanical and fluid drives are rapidly being replaced by AC variable speed technology.

Proven Advantages of AC Drives. The popularity of AC drives is based on a variety of factors centering on cost, flexibility and efficiency. AC motors are cheaper to purchase and maintain than their DC counterparts, especially in hostile environments.

The operational capabilities of AC drive/motor combinations - including soft starting, pre-programmable acceleration and deceleration ramps and DC injection braking, reduce stress on both structural and mechanical components.

VSDs offer multiple advantages over across-the-line motor control, the most obvious being the ability to control speed. A VSD, for example, permits a blower fan to run faster or slower to match cooling or heating requirements.

As another example, consider the fact that every time a motor is started across the line it draws in excess of 600% full load motor current - even more on premium-efficiency designs. A VSD reduces this inrush current demand to 150% or less, and without affecting accelerating torque.

This eliminates electrical and mechanical stresses on the motor associated with across-the-line starting. Additionally, power demand from the line is significantly reduced, while the drive applies its inherent power factor correction, typically 95-98%.

Deceleration and stopping can also be controlled, something not possible with conventional across-the-line starters. Times can be programmed in the drive. Additionally, DC injection braking can reduce stopping times, prevent a motor from turning in the "stop" condition, or ensure a fan is not freewheeling before a start. Dynamic braking resistors can be added for faster or emergency stopping.

Other VSD benefits include energy savings schemes that can automatically reduce power consumption when the motor is not fully loaded - a feature that is particularly useful on fans and pumps

Expensive, specially designed motors and complicated control schemes formerly used on centrifuges can be eliminated. The VSD is capable of controlling the acceleration time, allowing the use of standard off-the-shelf motors. Stopping times also can be greatly reduced through use of built-in software designed to control deceleration of high inertia loads.

High-maintenance DC drives and motors have been eliminated on extruders through the installation of Flux Vector AC drives, which match DC performance while eliminating its headaches.

Application-Specific Software. Advances in software continue to speed the growth of VSDs in large motor installations. Application specific software tailored to individual industries or even facilities provides easy transitions to eliminate excessive downtime during retrofits and at changeover from DC to AC operations.

Today's operator-friendly software provides seamless transitions, increased production and quality. Simplicity of programming and digital repeatability of input information assures continuity and easy operational changeovers. Safety checks for constant monitoring of soft start, brakes, and torque output sufficient to handle the load are built in.

Selecting a Variable Speed Drive. Factors to consider in determining how large a drive is needed, and the mode in which it will operate, include:

- The application and its duty cycle,
- New installation or drive retrofit,
- The operating environment,
- Load weight, speed and braking requirements.

Although the horsepower rating of the drive can often be matched to that of the motor, oversizing the drive slightly prevents it from constantly having to operate at its peak rating.

Conclusions:

- Installation and operation of AC variable speed drives has become altogether simple, whether as a retrofit or in a new installation in an industry that formerly relied on DC systems.
- From an operator's point of view, acceleration and deceleration will be smooth and steady, as opposed to the jolts and bumps experienced with previous "step" control installations. Maintenance problems associated with those controls will have disappeared, along with DC motor upkeep.
- In many applications the operator's control will be virtually the same - or a little simpler. At the same time, the user will experience substantial energy savings and maintenance economies produced by improved control and performance.