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Five Reasons for VFDs in HVAC Applications

Save Money and Improve Performance with HVAC-Specific Drives

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Introduction

When I was a young sales engineer, right out of college, I rode on sales calls with an older gentleman whose driving skills left much to be desired. In Chicago city traffic, he controlled his car's speed in three ways: accelerator off, accelerator to the floor, and brake. You can imagine how energy-efficient his method was and also the extra wear and tear on the vehicle.

But that is exactly how many HVAC systems are controlled today. Induction motors with across-the-line starters have only one speed – full – and then mechanical dampers, vanes, or valves restrict the flow depending on the need. This is like keeping your gas pedal to the floor and controlling your speed with the brake.

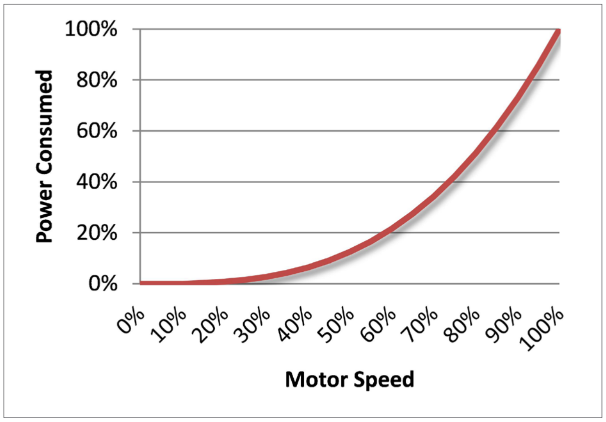
VFDs (variable frequency drives) enable a method of control analogous to how you drive your car, that is, you vary the speed of the engine to match the requirement of speed and acceleration for the traffic at hand. And, of course, use the brake only when necessary.

VFDs employ sophisticated electronic designs to accomplish a simple basic task, to take in a constant AC voltage and a frequency input (typically 230V or 460V, 60Hz three-phase in the U.S.), rectify it to DC, and then electronically generate a variable voltage and frequency to drive an induction motor. Since the motor's speed is dependent on the frequency, its speed will vary accordingly. Voltage varies as needed by the load by virtue of the selectable parameters built into the drive.

Besides the variable frequency and voltage, today's drives have myriad other functions built-in for control and monitoring of the work to be done. HVAC-specific drives can benefit your system in at least five ways.

Yaskawa Z1000 Variable Frequency Drive

1. Energy Efficiency



Just as your mileage goes way down when you put the pedal to the floor, motors running at full speed use maximum power. The nature of HVAC loads is that power consumed varies with the cube of the speed. That means that if the demand of the system requires only 75 percent of full output, and the VFD drives the motor at the associated ¾ speed, it only consumes 42 percent of its full speed power. At 50 percent speed, it uses only 13 percent power. In typical commercial buildings, peak load conditions that require full speed occur less than 5 percent of the time.

In across-the-line starts, an induction motor's inrush current is many times its full load amperage rating as it tries to get to full speed as fast as possible. VFDs can be configured to ramp up to speed (and down) at a deliberate rate most suitable to the application, resulting in additional savings.

So you can see that VFD speed control can result in dramatic energy savings. In retrofit installations, energy bills can be cut significantly to result in savings to equal the VFD's cost in a year or less. In new systems, it only makes sense to start with the energy efficient approach.

2. Mechanical Life

Just as the pedal to the floor stresses your vehicle, across-the-line motor starts put tremendous stress on the mechanical components that transfer the motor's shaft rotation to pumps, fans or other parts of the HVAC system. Belts, pulleys, gears, pumps and fans all sustain the majority of their wear and tear during starts and stops in traditional systems. VFDs can be configured to ramp up to speed and ramp down to stop at rates that are much gentler on your system's components.

Additionally, VFDs have the ability to be programmed to avoid speeds that are known to suffer from resonant mechanical frequencies that have potential to damage equipment or are particularly noisy.

VFDs also have a wide range of monitoring capability and can take action to prevent failures before they occur. These include sensing and responding to overcurrent and overvoltage conditions, overtorque and undertorque, and others. Examples such as broken belts (undertorque), jammed impellers (overtorque) are conditions a VFD can sense. Actions for each are programmable to match the need. They include shutting down and generating an alarm.

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The Z1000 Family of Drives is designed specifically for HVAC applications, such as fans, pumps, and cooling towers

4. Connectivity

VFDs come with communication protocols built-in or as options for a wide range of networks, such as BACnet, Metasys, Apogee, Modbus, and others to provide connection to your building automation system (BAS). Your BAS can give the VFD a signal to vary its speed according to the demand of the system.

Additionally, monitors in the VFD sense conditions, status, and any problems, then send those back to the central BAS. VFD displays can be mounted on the drive or an enclosure door to give operators real-time information on system status. Problems are dealt with and logged for future reference.

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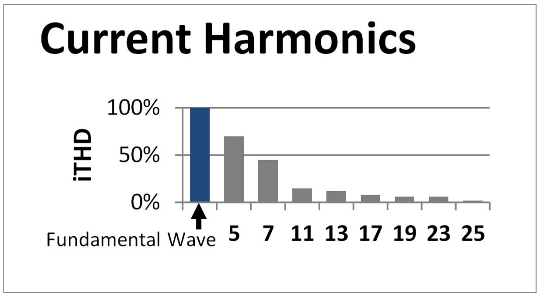
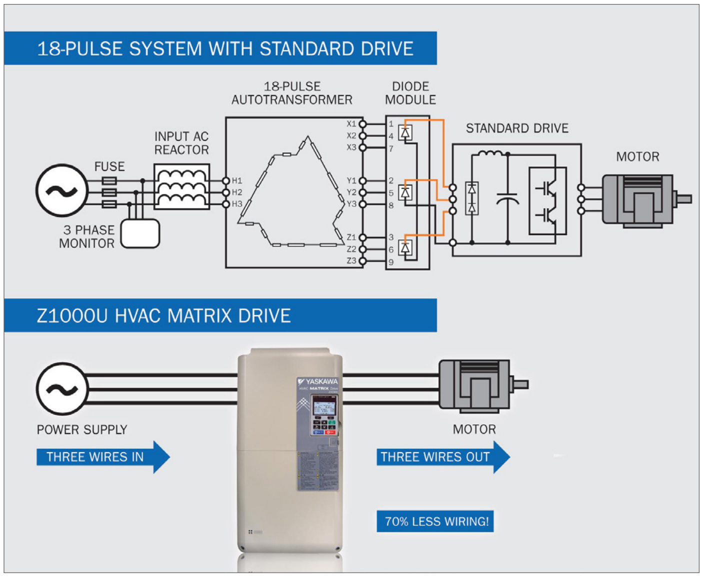
5. VFDs Former Problems Have Been Solved

Early VFDs, as well as some current designs, cause significant current and voltage harmonics, which are momentary fluctuations outside the power grid's pure sinusoidal voltage and frequency. These harmonics result in circulating currents above and beyond those necessary to drive the motor and that must be handled by all parts of the electrical infrastructure, including the motor, conductors, and transformers. If system harmonic content becomes significant, oversizing of source components and/or harmonic reduction may be required.





Comparison of 18-pulse drive system with Z1000U HVAC Matrix drive system

The significance of the effects of harmonics depends largely on the proportion of the system's load that is producing harmonics and the degree of harmonics produced by the VFD and other nonlinear loads, such as battery chargers and electronic ballasts. Modern drives have harmonics suppression features built in, such as DC link chokes.

A newer design drive, though, produces virtually no harmonics. Whereas traditional VFDs use the AC to DC to AC approach, Matrix drives skip the DC bus and go directly from constant AC voltage and frequency to variable AC. This drive design is more expensive than the traditional VFD, but can be less expensive and require significantly less space than other harmonics mitigation techniques, such as multi-pulse transformers. And, Matrix drives have the added benefit of sending braking energy back on the grid.

Conclusion

So, in light of all the benefits of VFDs, it only makes sense to consider them for upgrades to your existing HVAC system to save money and improve performance. When choosing a VFD, look for models that have features specifically designed for your HVAC system requirements. Also, consider the manufacturer's reputation for quality, support, and local availability.

After all, your HVAC system is all about comfort, and you need to be comfortable with the products that drive it.

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