VFDs and fire safety: Four benefits for facilities

The use of variable frequency drives (VFDs) are increasing in the HVAC market, and they provide particular value when it comes to the issues of fire safety and fire control. Larry Gardner, Product Manager for HVAC Drives for Yaskawa, discusses some of these issues and how VFDs have become a valuable asset for facility managers.

Q: Talk about some of the issues with indoor air quality and the design of HVAC systems. What are some of the keys for facility managers when they spec HVAC systems?

GARDNER: 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 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 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.

Q: Given these issues, what are some of the most important reasons to use a VFD as part of the building design?

GARDNER: There really are four reasons to utilize a VFD in an HVAC application:

- Save energy
- Save money
- Increase occupant comfort
- Reduce wear and tear on mechanical parts

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% of full output, and the VFD drives the motor at the associated 3⁄4 speed, it only consumes 42% of its full speed power. At 50% speed, it uses only 13% power. In typical commercial buildings, peak load conditions that require full speed occur less than 5% of the time.

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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. All of these will save money.

The VFD's ability to vary motor speed in real time according to the building's demand means greater occupant comfort as compared to the older, slower reacting mechanical means of damper and valve controls.

Q: In case of fire, why is a VFD critical to getting people out of danger and out of the building?

GARDNER: In the process of fire, fuel is combined with oxygen to produce light, heat and smoke. In a building fire, this usually mean solid objects are being converted to gas, so what was a relatively small volume is now many, many times its original size as molecules heat and expand. So in that process, fire creates its own pressure within a structure. Added to that, is the pressure from the steam that results from the water that responders apply to suppress the fire.

Undeterred, this pressure causes the smoke and gases to seek areas of lower pressure, and since commercial buildings rarely have wide openings to the outside, that means the smoke and gases will travel through any internal openings to all other parts of the building.

So VFDs are an important means to control smoke by controlling pressure in selected areas to either pull smoke out or prevent smoke infiltration.

Q: What are some of the important factors in pressurizing escape routes, including stairwells and hallways?

GARDNER: For all except single-story buildings, the exit path during a fire event is almost always the stairway. And the usual means for the HVAC system to keep the stairway safe is to pressurize it to prevent smoke infiltration from the source.

However, this is not always as simple has having the VFD run the fan at full speed. There have been documented cases where fans at full speed pressurized stairwells to the point where those attempting to get away from the fire could not overcome the pressure on the door to gain entrance. Codes vary by location, but usually they prescribe a limit of 30 pounds or less force to open the doors, which means the building engineer must calculate maximum allowable pressure very carefully.