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Motor, Drive Selection Key to Future HVAC Fan Efficiency Standards

Six things the fan industry should know

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EFFICIENCY: Integrated motors and controls (IMACs) are an energy efficiency solution for HVAC fan applications. (Courtesy of Nidec Motor Corporation / U.S. MOTORS)

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When the U.S. Department of Energy (DOE) issues the final versions of it its long-awaited fan efficiency test and efficiency standards rules over the coming months, it will apply regulations t critical application in the country's energy management puzzle. In the meantime, industry

members are debating how the new rules — the first-ever for commercial and industrial fans — will impact their operations.

Two things are certain. First, the rules should reduce fan power consumption, helping to lower overall building energy costs. Fans currently account for about 18% of all the electricity purchased in commercial and industrial buildings. As proposed, the DOE's new rules are expected to produce a 2-3% gain in efficiency, saving approximately seven quadrillion BTUs of energy over the next 60 years.

Second, more aerodynamic fan design will not necessarily deliver the energy savings needed to comply with the proposed rules. That's because fan design changes can be extremely difficult to implement in an existing system and power consumption is easier to address through upgrading the motor, which accounts for all of the fan's power. Increasing motor efficiency will, in many cases, be integral to achieving fan efficiency.

The DOE understands this. The DOE Notice of Data Availability released in 2022 included a fan redesign for only the maximum technology option, which far exceeds the stated savings goals. The word "motor," however, appeared more than 300 times in the 28-page document.

Motor manufacturers are already fielding calls from fan manufacturers who wonder if their existing products will comply with the proposed new standards. Many have also begun seeking motor and drive alternatives that will allow them to achieve the required efficiency output at the most economical cost.

To improve efficiency in new installations, the commercial fan market is shifting toward the use of direct drive fans instead of traditional belt-driven fans. As the name implies, the fan propeller is connected directly to the motor shaft on a direct drive fan.

There are several practical reasons for this shift. Because the propeller is directly connected to the motor shaft, direct drive fans do not suffer power transmission losses. By comparison, a belt-driven fan can have between 10 and 30% efficiency loss. Direct drive fans are also more reliable and easier to maintain, with some operating virtually maintenance-free. Belt-driven fans require periodic maintenance and run the risk of breaking.

As we all await the final test and efficiency standards rules, here are a few other things to keep in mind:

1. Motor technology has evolved rapidly in the years since the DOE began formulating fan efficiency rules.

This is due in large part to manufacturers developing motor/drive technologies that other industries have needed to meet their own DOE energy-efficiency regulations.

The residential HVAC industry led the way with its early adoption of integrated motor and control (IMAC) technology. By pairing the motor with on-board controls or variable frequency drives, IMACs

make it possible to operate motors ranging from 1 to 15 hp at different speeds based on system demand. First introduced 15 years ago, IMACs have now become standard in residential HVAC systems.

The commercial HVAC and pump industries are now following suit, replacing less efficient single-speed motor applications with research-backed and field-tested IMACS and other power drive systems (PDS). (A PDS includes a motor and an adjustable speed drive or control. Unlike the IMAC, however, the two may or may not necessarily be assembled as an integrated unit.)

All are paving a clear path that the fan industry can also follow to improve energy efficiency.

2. Integrated motors represent the future, with ECMs likely to become a fan industry standard.

Most of today's commercial fans and blowers also rely on oversized single-speed motors that have been designed to meet maximum system demand, even though the equipment they power rarely operates at full capacity. Not all fans will need new more efficient motors to achieve the required efficiency output, but those that do will have multiple alternatives from which to choose.

Current product offerings include both induction and synchronous IMAC designs. Now available in up to 15 hp, IMACs that are integrated with a synchronous motor and VFD — a combination known as an ECM, or electronically commuted motor — could become the gold standard in commercial fan applications.

3. The energy savings when switching to an integrated motor can be substantial.

How substantial? According to the DOE, reducing IMAC speed by 20% can in some cases cut power usage in half. A study by NEEA (Northwest Energy Efficiency Alliance) calculated that IMAC and PDS payback is 10 months for constant load systems and only four months for variable load systems.

Replacing an induction motor with a synchronous motor produces even greater savings. When paired with Smart Building technology, ECMs match application demands with variable speed, creating less wear and tear on equipment.

4. ECMs will be instrumental in helping commercial buildings become Smart Buildings.

Many ECM units today connect to sensors that provide motor control system information. In a fan application, for example, a heat sensor would continuously send the motor control the current equipment temperature. If the temperature is higher than the target rate, the motor control would increase the RPM of the motor to meet the target.

Newer systems utilize IoT between the sensors and ECM. As commercial buildings move further towards becoming Smart Buildings, this trend is expected to continue. In a Smart Building, a single building maintenance person with a notebook computer can monitor and control the operation of elevators, heating/cooling systems, pumps, cooling towers, and fans.

5. ECMs offer other operational advantages.

Because the motor and control have been designed to operate together, ECMs require minimal setup and system integration. The design eliminates the need for on-site wiring between the motor and the control.

An ECM's controls are mounted on top or in line with the motors, which use the same base mounting dimensions as the single-speed motors they replace, enabling them to fit onto existing fans. The only major issue an installer could encounter when installing an ECM is the available clearance above or behind the motor where the drive is now located.

Motor to control optimization is easier, too, because specific motor parameters are factory-installed into the drive. Motor and control efficiency improves because the control is better matched with the motor.

6. The testing method the DOE will designate to measure motor drive efficiency includes the motor and the VFD losses.

The DOE has adopted a fan efficiency index (FEI) as the metric for evaluating fan system efficiency. FEI considers the electrical power input to the fan system, including the efficiency impact of motors and drives.

By creating standards that apply not only to fans but also motors and drives, the DOE allows designers to analyze the return on investment for different fan types, sizes, and motor/drive combinations when developing new solutions.

The method to be used for measuring the efficiency of commercial and industrial fans and blowers, however, is still in development. DOE has proposed fan efficiency be measured using the protocols described in AMCA 214. Once the method is in place, fan manufacturers that choose ECM

technology should be able to look to their motor manufacturer for help in determining motor efficiency value. Because the same manufacturer provides both the motor and drive, the manufacturer should be expected to provide data on the motor efficiency they create in combination.

It should be noted that the DOE has also not assigned efficiency standards to ECM motors as a motor/VFD combination. Many other DOE rules do require synchronous motors to meet higher-level system efficiency, including those used on consumer furnaces.

The bottom line

The DOE's new fan efficiency standards will drive changes in how engineers design air systems to minimize fan energy.

Whatever final form the rules may take, motor technology efficiency will play an important role. Those who haven't considered integrated motor and control technologies, including ECM, would be wise to put them on their radar. The time to begin talking to their engineering and procurement teams about their alternatives is now.

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