THE NEXT STEP IN THE EC MOTOR REVOLUTION

Not only are EC motors growing in horsepower, new standards are making it possible to compare system efficiency.

BY TIM ALBERS

Images courtesy of Nidec Motor Corporation.

EC motors with "bolt-on" upgrades, like the VFD attached to the ECM shown here, are cost-effective solutions to providing energy-efficient upgrades.

New government energy-efficiency standards, combined with advances in materials and electronics, are compelling many end users and OEMs in the heating, ventilation, air-conditioning and refrigeration industry to design—or redesign—their systems to be more energy efficient.

Because blowers are one of the biggest energy consumers in an HVAC or refrigeration system, the motors that power them are "low-hanging fruit" and have been a primary target for these efficiency improvements.

Over the past decade, for example, as many as 50% of all new residential furnace blowers have been upgraded with efficient electronically commutated (EC) motors. EC motors are electric motors that have brushless permanent magnets and have been integrated with a tuned variable-frequency motor drive. Because they use electronics to control the voltage and current applied to the motor, EC motors do not waste power inducing the rotor field like induction or other motor types.

Until recently, however, EC motor upgrades have been performed primarily on smaller, residential applications that require motors of one horsepower or less.

Advances in materials and electronics, however, are now changing all that. Switching to EC motors is today one of the most cost-effective "bolt-on" energy-efficiency upgrades that can be made to a commercial or light industrial HVAC or refrigeration system.

The transition

EC motors are proving to be an especially good upgrade option for HVAC and refrigeration systems that currently depend on induction motors to power the fans, blowers and pumps that drive air and water through their systems. OEMs and end users, alike, see switching to EC motors as a way to boost their systems' overall efficiency with one relatively easy-to-make change.

EC motors are now available in an increasing number of sizes and power outputs. Some of today's most advanced integrated EC motor and drive systems can operate up to 10 hp and have achieved or exceeded the IEC defined IE4 Super Premium efficiency rating. That makes them good candidates for those who want to capitalize on energy-rebate opportunities, as well.

Migrating to the growing IE4 motor category offers customers a smaller, lighter and quieter option while providing higher efficiency and performance.

Even though the industry is still a few years away from mandating these super premium efficiency motors, HVAC and refrigeration manufacturers and their customers are choosing to migrate to the growing IE4 motor category, in large part, because of the high efficiencies they gain and the quicker return on investment they achieve. When integrated into a system, these motors not only save energy, they also can be used to create systems that are smaller, lighter and quieter to operate. In fact, switching to physically smaller EC motors can free up space so an end product can add features that make it smarter and more reliable, while also improving its performance.

Specific advantages include:

Energy savings—EC motors that meet IE4 efficiency levels have been shown to offer up to 91% system efficiency for the motor, drive and fan. In some cases, that exceeds the efficiency required by NEMA for a premium-efficient motor alone. At that level of efficiency, a single 5-hp motor can reap energy savings of between $180 and $250 a year, compared to an induction motor and VFD.

Improved reliability—An integrated EC drive/motor system that has been precisely tuned can reduce common VFD-related issues, such as electromagnetic interference and corona discharge, which can produce electronic noise and disturbance. In addition, because EC motors are not prone to overheating, they do not require additional measures to offset heat generation.

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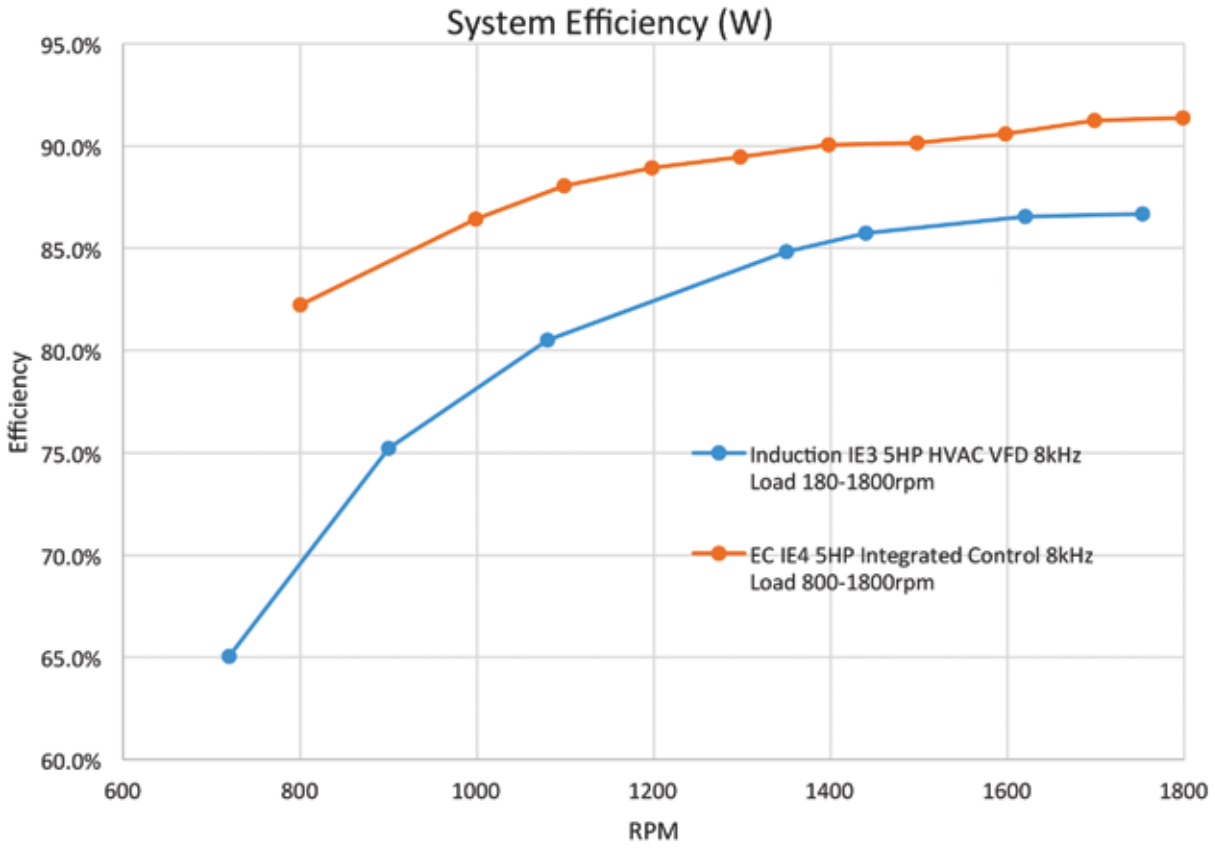

Figure 1 **Advanced EC motor designs with IE4 efficiency ratings and tuned VFD experience less efficiency loss at low speeds than traditional induction motors.**

> **When a motor and drive are packaged together and include an integrated user interface, system installation and integration are easier.**

Easier system installation and integration—When a motor and drive are packaged together and include an integrated user interface, system installation and integration are easier. In some cases, costs and lead-time can be minimized because cabling between the motor and separate control are unnecessary. An integrated drive and motor package also avoids the complex setup that standalone VFD units typically require.

Flatter efficiency curve—A motor in a commercial HVAC or refrigeration system operates at less than full output much of the time, reaching full output only during times of peak demand. A traditional induction motor operates most efficiently at its peak speed, but efficiency drops off dramatically when it is operated under slower speeds. EC motors, on the other hand, suffer much less efficiency loss at slower speeds, resulting in a flatter efficiency curve and dramatically higher overall efficiency (see Figure 1).

New standards and system-efficiency comparisons

One of the bigger challenges users and OEMs face is comparing

> **The IEC IE4 super premium efficiency requirements set a high bar for the future.**

the overall efficiency of the systems these EC motors support. Historically, it has been accomplished by comparing all the individual parts—motors, drives and other system components—one by one. With no national standards for all to follow, a comparison might focus on a motor's efficiency at full speed, with no consideration of its efficiency at slower speeds, or the impact of a particular drive might have on overall performance. A lot of apples-to-oranges comparisons resulted.

But that is changing. After raising the bar for industrial motors and making small motor efficiency rules—the latest of which take effect in June 2016—the U.S. Department of Energy is now working in conjunction with a consortium of component industry groups, energy organizations and utilities to develop regulations governing the minimum efficiency requirements for pumps, fans, compressors and other industrial parts, with the goal of improving overall system efficiency.

On Dec. 31, 2015, the DOE issued its final rule for the Pump Efficiency Index, which provides common standards that manufacturers, utilities and end users can use to compare and evaluate system components against new stricter efficiency standards. But the new rules also go a step further, making it possible to evaluate "extended products"—a pump and motor, or a pump, motor and drive control—at multiple setpoints on an efficiency curve, making it possible to compare the overall efficiency of one system against another. A system with a high-performance drive or a flatter efficiency curve for example, can achieve a higher rating on the Pump Efficiency Index than a system that relies only on an efficient pump because those factors are integrated into a measurement of total system efficiency.

Similar efficiency indexes for fans, blowers and compressors are in development and are expected to be published in the next 18 months. The fan and blower rules are expected in calendar year 2016.

What is next

The IEC IE4 super premium efficiency requirements set a high bar for the future. To reach that bar, motor manufacturers can be expected to continue extending the power outputs and other capabilities of integrated EC motors and drives, thereby expanding the range of commercial and industrial applications they can serve. Larger hydronic pumping systems, and rooftop and other commercial blower systems will be among the next to benefit.

The good news is as more IE4 efficiency motors become available and all the new efficiency regulations are in place, end users will be the ultimate winners. The new, more efficient systems they will generate will consume less energy, saving money and improving overall industry performance in the long run.

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