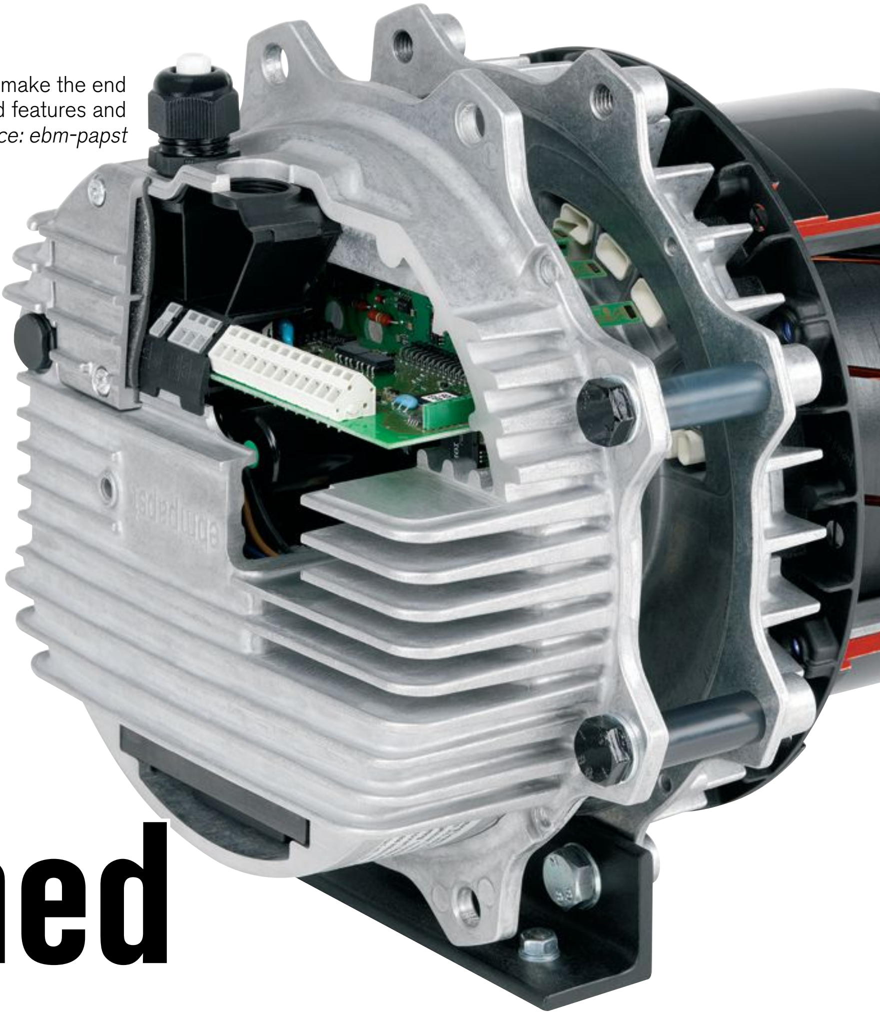

Switching to EC motors can make the end products smarter with added features and higher performance. *Source: ebm-papst*

EC Motors, Explained

EC motors can make your life easy.

by george riker

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It's no secret that government regulations and energy incentives are forcing manufacturers to create or redesign products to meet more demanding energy restrictions. Systems and components that have always been used now must be redesigned. One of the biggest energy consumers of any product has been electric motors. Converting electrical energy to mechanical energy is not always very efficient. The most common type of AC motor, the induction motor, has been around for over 100 years, and is still the workhorse of many industries. They come in a variety of sizes and power levels and are widely available. However their efficiency is limited due to their outdated design. The alternative, EC motors or Electrically Commutated motors, are now gaining popularity in many fields and applications, and are proving to be a major source of energy savings. EC motors are now available in more and more sizes and power outputs. When integrated into a system such as a fan, they not only provide energy savings, but reduction in size, weight and noise. At first glance they may seem complicated, but look more closely, and these motors can make products simpler. Switching to EC motors can make the end products smarter with added features, more reliability and higher performance. Let's look at how EC motors can make your life easy.

First let's review the difference in design between an AC induction motor and an EC motor.

AC induction motors come in various sizes and designs, and are used in all industries: HVAC, refrigeration, appliances, etc. Their operation is fairly simple. The AC power supplied to the stator creates a magnetic field. This field rotates with the frequency of the supply voltage, inducing an opposing current in the rotor. The rotor will then turn to oppose the direction of the rotating magnetic field. This may be an external rotor connected to fan blades, or turn a shaft to do the needed work. The speed of such a motor cannot be higher than the synchronous speed, which is dependent on the frequency of the input

voltage and the number of poles in the motor. There are different types of induction motors available. The most common are: 1) Shaded pole, smaller fractional hp, with low torque; 2) capacitor run and capacitor start motors, both requiring an additional capacitor to operate; 3) three phase motors which run on three phase supply voltage.

EC motors are brushless DC motors with external electronics. The rotor contains permanent magnets and the stator has a set of fixed windings. A circuit board continually switches the phases in the fixed windings to keep the motor turning. Because the speed of the motor is controlled by the commutation electronics, these motors are not limited to synchronous speeds. DC motors and EC motors have typically been reserved for smaller power output applications, filling such applications as small fans, pumps, servomotors and motion control systems. However, advances in electronics and materials are allowing larger output motors, up to the 12kW and higher. These motors are now finding homes in everything from small appliances to conveyor belts, and large rooftop condenser units.

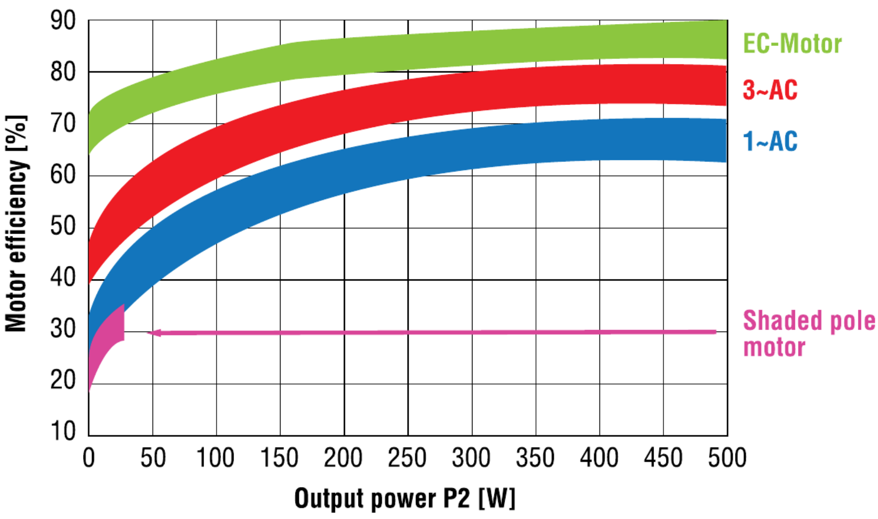

Chart 1: Efficiencies of different motor types. *Source: ebm-papst*

As mentioned, efficiency is the most common reason for choosing an EC motor over an AC motor. With an EC motor, the commutation is done by the electronics reducing the losses internal to the motor. (Chart 1 shows the efficiency of each motor type.)

Perhaps the biggest energy gains come from the ability to speed control EC motors. While AC motors are available with multiple speeds or can be controlled with external devices, these can bring about other problems. Two speed AC motors can be noisy, or not optimized for the system. Three phase motors can be controlled with VFDs, but a complicated system of filtering and protection is needed to properly protect the motor from damage. (Chart 2 shows the energy saved by speed controlling a multiple fan system using EC powered fans vs. AC powered where fans are turned on and off as needed.)

Energy savings aside, how can EC make the designer's life easier, and the end product better?

Size

Since efficiency is improved, a smaller motor size may be used to achieve the same power output. A smaller motor also equals lower weight, and more space makes for a smaller product or more room for additional features. Many EC manufacturers also offer external rotor designs rather than shafted motors, and their compact design allows for even more space savings.

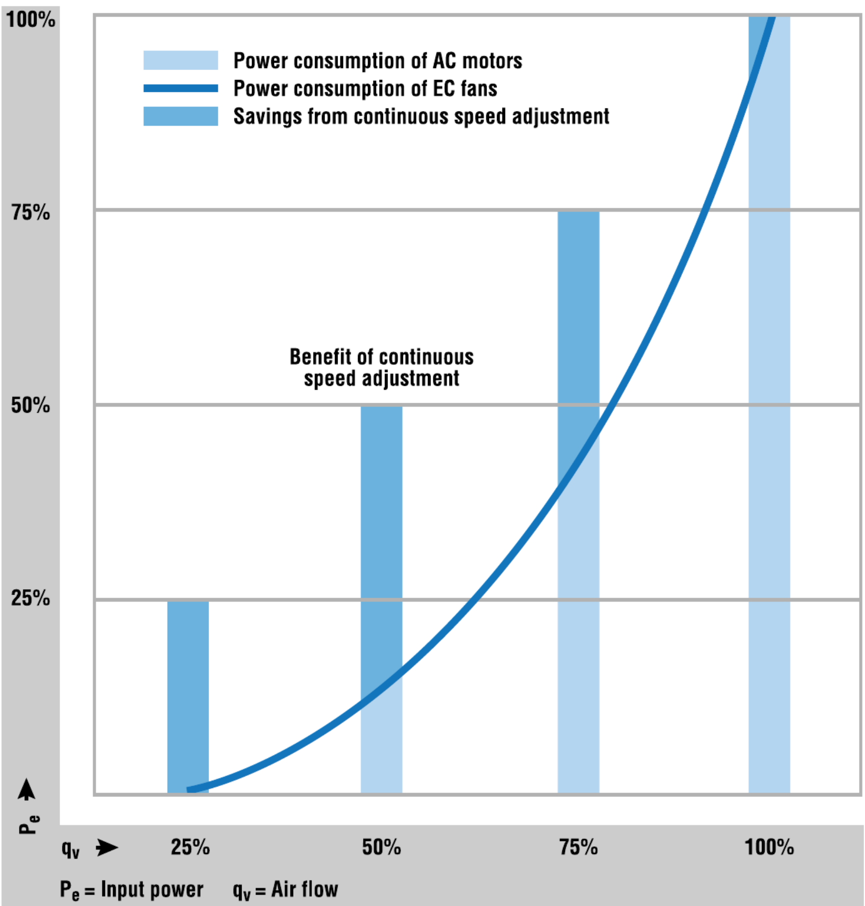

Chart 2: Power saved with speed controlling a system of EC fans vs. cycling AC fans. *Source: ebm-papst*

EC motors are now gaining popularity in many fields and applications, and are proving to be a major source of energy savings. *Source: ebm-papst*

Voltage

EC Motors are not completely dependent on voltage and frequency, small changes in voltage do not have an effect on motor output, and 50 or 60 Hz can be used without a performance difference. This means regardless of what voltage or frequency is coming out of the wall, or what country that wall is in, the motor will always perform the same.

Speed control

AC motors are available with multiple speeds, and with optional external speed controllers. Multiple speed fans are usually offered at a premium, and don't always operate at optimum efficiency at reduced speeds. External speed controls typically adjust the incoming voltage by altering the smooth AC sine wave. This is not always good for motor lifetime, and could increase noise. This is especially true with three phase motors using a VFD. A complicated system of filters and grounding is needed to protect the motor, never mind properly matching the VFD to the motor and the complexity of programming the VFD to achieve the performance needed. All this can be avoided with EC. Most EC motors will come with multiple speed control inputs, not as an option, but standard. The commutation circuit can easily accept inputs such as PWM, 4-20mA, and 0-10V linear, to control the speed typically in the range of 10% to 100%. The control side of the motor is a low voltage circuit separate from main power. This circuit can even provide voltage to power external sensors, eliminating the need for separate DC power supply for these sensors.

Protection

Included in most EC motor electronics is protection against: voltage overload, low voltage conditions, phase loss, power surges, locked rotor and overheating. On larger three phase input EC motors, there is no longer guessing which wire is L1, L2 or L3—it doesn't matter. These added protective features are typically not available or available as an external component to an AC motor.

Output

With current AC motor technology even simple feedback such as motor RPM would require a mix of sensors and external DC circuits. The already existing internal monitoring functions of an EC motor can be easily accessed by the designer to provide end user feedback about the motor or the appliance. Parameters such as error code, motor life, motor temperature, and tachometer are readily available to the designer.

Additional advantages

Soft Start: The electronics of an EC motor can provide a soft start, reducing startup current and preventing nuisance breaker trips, and allowing lower component ratings in the system.

Noise: With speed controlled AC motors, noise levels will show spikes corresponding with the voltage frequency (motor hum), but not so with EC motors.

Heat: Increased efficiency of an EC motor creates a cooler motor. In some refrigeration applications motor heat is undesirable, adding to the heat load of the system. Also, lower motor temperature equals lower bearing temperature equals better reliability.

Optional Features

Some features are not always available as standard on EC motors, but can be incorporated easily in certain EC motors.

BUS communication: EC motors are perfect for integration into existing building management systems. BUS communications, such as Modbus, is available on many motors. Now each motor can be referenced through the buildings management system and the status of individual fans can be seen, and changed as needed, individually or in groups. Bus communication now offers two way communications between the device and the motor, with information rich feedback.

Complicated control scenarios: This includes things like reverse rotation on startup to loosen a blocked rotor, and soft start override to loosen frozen fan blade. The electronics can also be programmed to a default setting under bus communication interruption.

Multiple motor operation: In systems such as rooftop condensers, it's possible to program one fan as the master and control the remaining fans. All the logic can reside in the motor, eliminating the need for a separate controller.

It's amazing how a more complicated motor can make your life easier. ■