

More For Less

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The growing trend toward efficiency has designers engineering motors to absorb less energy while maximizing output

By Carrie Ellis, Editor, Product Design & Development magazine

According to the Department of Energy (DOE), "Over half of all electrical energy consumed in the United States is used by electric motors." One way some design engineers are improving efficiency is by carefully selecting motors and drives. Experts say the use of energy-efficient motors can improve efficiency from three to eight percent.

As always, the choice of motor must depend on its designated application. The cost effectiveness of an energy-efficient motor in a specific situation depends on several factors, including motor price, efficiency rating, annual hours of use, energy rates and more, according to the DOE. There are three factors design engineers are considering these days before choosing a certain motor for their design:

- Motor size. According to the DOE, "Motors should be sized to operate with a load factor between 65 and 100 percent" at full-load rating.
- Operating speed. The operating speeds of motor at full-load RPM should be displayed on motor nameplates.
- Inrush current. Design engineers should try to circumvent overloading circuits.

What's The Difference For You?

According to John Malinowski, Baldor product manager, "Brush-type DC motors are relatively efficient but when operated from an SCR control, the form factor is very poor. Plus the brush and commutator maintenance is expensive. A premium efficient AC induction motor may be four to six percent more efficient than a DC motor."

In brushless DC motors, "There is a huge increase in efficiency and power density when compared to an AC induction motor."

Applications Engineering Manager for Intelligent Motion Systems, Bob Parente, says one energy-efficient feature that his company has implemented into their stepper

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motors is "programmable run and hold currents [that] can result in consuming less power by taking advantage of the stepper's high torque at low (including zero) speed performance."

Materials Selection

One trend that has swept the design engineering field is the trend toward aiming for the most application-specific energy-efficient materials. "High efficiency is obtained by careful design of the motor parts that cause losses (i.e. brush commutations, bearings, laminated iron stack)," says Urs Kafader, technical director at maxon motors. Some of those decisions are relative to what kinds of materials are used in the design. Continues Kafader, "One of the ways [maxon motors] has strived to improve efficiency was to have a special material for laminated iron stack."

"Lower loss steel and more copper improve efficiency," Adds Baldor's Malinowski. "Motors with better efficiency allow the end-user a lower life cycle cost. The motor price is only about two percent of the life cycle cost; around 97 percent is electricity. Improved materials may help offset price increases."

The Driver Behind It All

Says Malinowski, "An adjustable speed drive does not improve the efficiency of the motor; it improves the efficiency of the system it drives. This needs to be split into the two basic types of loads-constant torque and variable torque. Constant torque loads, such as conveyors, require the same torque to operate regardless of motor speed. As speed decreases, the current required remains relatively constant and provides little or no energy savings. Savings can be realized through improvements in process flow.

"Variable torque loads, such as centrifugal pumps and fans, fall into applications covered by the affinity law. On these applications, as speed is decreased, the load to the motor is decreased by the cube. This means that there are incredible energy savings as the motor speed is adjusted, instead of using a valve or damper to control flow. Payback for a drive and premium motor may be less than one year if there is a need for reduced flow."

According to the Public Service of New Hampshire, electronic variable speed drives control the speed and torque of an AC electric motor by varying the frequency and voltage of the electricity supplied to the motor. These types of drives can have some advantages, including:

- No friction loss, because there are no moving parts.
- Instant and accurate control of equipment speed-one variable speed drive can manage several motors.
- Gradual startups and slowdowns, which reduces motor stress.
- A small profile that makes them easy to install in retrofitting applications.
- Energy savings up to 20 percent.

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Peripheral Benefits

"Because they are constructed with improved manufacturing techniques and superior materials, energy-efficient motors usually have higher service factors, longer insulation and bearing lives, lower waste heat output, and less vibration, all of which increase reliability," says the DOE.

Paul Webster, CNC Product Manager, GE Fanuc Intelligent Platforms, adds, "Direct energy reduction efforts can result in many related benefits for end-users, including:

- Power source regeneration.
- Power loss reduction by latest switching device.
- Spindle motor temperature rise reduction by maximum efficiency control.
- Iron loss reduction of motor by higher frequency of pulse-width modulation."

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