Efficient Electrical Machines

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Motors are found in a variety of industrial applications, powering everyday tools such as fans, blowers, and pumps. According to the U.S. Department of Energy, over half of all electrical energy consumed in the United States is used by electric motors. And the National Electrical Manufacturers Association says electric motor systems account for 70 percent of manufacturing electricity consumption, presenting one of the largest opportunities for energy conservations, and efficiency. Therefore, in the face of economic uncertainty and growing sustainability initiatives, motor efficiency and lifetime energy consumption should be a major factor in the decision-making process when making a new purchase versus rewinding a motor.

Energy-efficient motors, which can be two to eight percent more efficient than standard motors, owe their premium performance capabilities to new technologies and design manufacturing improvements. Better electrical steel and more copper in the winding help reduce a motor's energy loss, which requires a smaller fan to dissipate heat. Neodymium magnets, which are used in electric vehicle motors, allow motors to be produced with a higher power density—higher horsepower in a smaller frame. Manufacturing motors with lower-electrical-loss steel and thinner stator laminations can reduce electrical losses. Lengthening the core and using more aerodynamic cooling fans can further reduce energy waste. Energy-efficient motors, though more expensive initially, have longer insulation and bearing lives, less vibration, and increased lifetime reliability.

"The motors purchase price is only about two percent of its life cost based on a 20 year life," says John Malinowski, senior product manager, AC Motors with Baldor Electric Company. "When compared to a motor's purchase price, electricity to run the motor continuously is about 11 times the purchase price." Looking beyond first cost thinking could save a manufacturer thousands of dollars a year in energy costs alone.

The Technological Threshold

The NEMA Motor and Generator Section has established a premium energy efficiency motors program to provide standardized, highly energy efficient products based on a consensus definition of "premium efficiency." The U.S. Department of energy is also continually encouraging motor manufacturers to improve efficiency, but Malinowski says, "we're at about the technological threshold—there is no more."

He adds that motor manufacturers are now looking at new technologies for future industrial motors, such as manufacturing them with neodymium magnets, which allows for a more power dense, high efficiency motor. "Although these motors are very efficient, payback on them has been extended because of the cost increases from China on magnet materials," he says.

An energy efficient motor can be up to 96 percent efficient, but an efficient motor's potential will go unseen if other system components are only working at 50 percent efficiency. Manufacturers who want to maximize efficiency in their processes are looking at all possible opportunities—not just the motor. "One must look beyond simple component replacement," Malinowski says, and advises that manufacturers look at the entire motor system, which may consist of the power distribution transformer, smart starter, or adjustable speed drive, electric motor, mechanical power transmission components, as well as the driven load.

The efficiency of the driven load sets the required horsepower level necessary to drive the device, and an older pump or compressor may not be as efficient as new technologies available today. Switching to a new pump or compressor can reduce the motor rating. An older gearbox, used to connect the motor to the load, may have an efficiency rating of 50 to 60 percent, where a new gear may have 95 to 96 percent efficiency. Switching to a newer helical or bevel gear can reduce the motor size and power requirements by nearly half.

"Although systems are more complicated to do, this is where the real low hanging fruit is today," Malinowski says. To help customers assess the energy requirements of their motor and its related systems, Baldor Electric energy assessment teams are available to look at the processes currently in use and see if there are opportunities to save energy and increase productivity.

A Motor's Real Enemy

While energy consumption is a major concern with motors, Malinowski says "the enemy of a motor is really heat. It's heat and friction." He explains that for every 10 degrees C hotter the motor gets, the insulation life is cut in half. The bearings run hotter, causing grease to last for a shorter period of time and the risk of bearing failure to increase. Malinowski says that the number one cause of motor failure is because of bearings being incorrectly greased, with either too much, too little, or an incompatible type of grease.

"So preventive maintenance is good," he adds. A number of new monitoring systems are available today that can now watch bearing temperatures, vibrations levels, resistances, and voltage to ground levels. Once limited to large, critical industrial motors, this level of monitoring is becoming more and more available for smaller, less integral motors. Wireless connectivity options are also being introduced, further expanding once cost-prohibitive monitoring options by cutting out the thousands of feet of wire that would be necessary to connect a motor to the control room.

Motors have a significant impact on the total energy usage of an industrial manufacturer, and as more manufacturers look to maximize efficiency in their processes, higher efficiency motors and systems will become a priority. And a good preventive maintenance program will help to improve system reliability.

Malinowski says, "As people get more comfortable with how to do these things, and

they get adopted, that’s going to be a good thing.”