Energy-Efficient Motors

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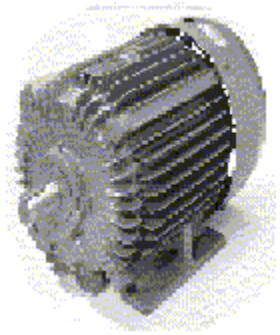
The Washington State University Cooperative Extension Energy Program produced this technical brief.

Efficiency is an important factor to consider when buying or rewinding an electric motor. This Technical Brief answers some frequently asked questions about how to obtain the most efficient motor at the lowest price while avoiding some common problems.

Why Improve Motor Efficiency?



Over half of all electrical energy consumed in the United States is used by electric motors. Improving the efficiency of electric motors and the equipment they drive can save energy and reduce operating costs.

Energy efficiency should be a major consideration when you purchase or rewind a motor, as well as the more common considerations "What's the price and how soon can I get it?". The annual energy cost of running a motor is usually many times greater than its initial purchase price. For example, a typical 20 hp, continuously running motor uses almost $8,000 worth of electricity annually at 6 cents per kWh, about 9 times its initial purchase price.

What is an Energy-Efficient Motor?

Motor efficiency is the ratio of mechanical power output to the electrical power input, usually expressed as a percentage. Energy-efficient motors use less energy. Because they are manufactured with higher quality materials and techniques, they usually have higher service factors and bearing lives, less waste heat output, and less vibration, all of which increase reliability. This is often reflected by longer manufacturer's warranties.

To be considered energy-efficient, a motor's performance must equal or exceed the nominal full-load efficiency values provided by the National Electrical Manufacturer's Association (NEMA) in their publication MG-1. The Energy Policy Act of 1992 (EPACT) required most general purpose motors between 1 and 200 horsepower for sale in the U.S. to meet these NEMA standards by October 24, 1997.

What Efficiency Value Should I Use?

When comparing two motors, be sure to use a consistent measure of efficiency. "Nominal" efficiency is best. This value is obtained through standardized testing. "Minimum" or "guaranteed" efficiency is slightly lower to take into account typical variations in efficiency within a population of motors.

When Should I Consider an Energy-Efficient Motor?

Assuming 6 cents per kWh electricity cost and a payback criteria of 2 years, most motors should be replaced with an energy-efficient model if they operate over 4,000 hours per year. In general, energy-efficient motors should be considered in the following circumstances:

- New installations, both separate and as part of packages such as HVAC systems
- When major modifications are made to a facility or a process
- Instead of rewinding older, standard-efficiency motors
- As part of a preventive maintenance or energy conservation plan

How Do I Determine Cost Effectiveness?

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, cost of installation and downtime, and the availability of utility rebates or other incentives.

Whenever possible, obtain actual price quotes from motor distributors. Motors are typically discounted by 20-60 percent, with the discount varying with the number and type of motor purchased.

The best way to select and compare motors is to use MotorMaster+ software. It contains a database of over 17,500 one-to-700-horsepower motors from which you can make selections based on size, speed, enclosure type, and features needed. It provides economic comparisons of two new motors, a new versus existing motor, or replacing versus rewinding an existing motor. The newest version allows you to enter nameplate and test data from every motor you own and run a batch analysis of the best upgrade opportunities based on existing and new efficiency, annual operating hours, energy rates, percent full load, and utility rebate criteria.

Should I Rewind a Failed Motor?

Although failed motors can usually be rewound, it is often worthwhile to replace a damaged motor with a new energy-efficient motor to save energy and improve reliability. When calculating operating costs for rewound motors, deduct one efficiency point for motors exceeding 40 hp and two points for smaller motors. In general, it is best to replace a motor if it is less than 40 hp, the cost of the rewind exceeds 65 percent of the price of a new motor, or the motor was rewound prior to 1980.

Have motors rewound only at reliable repair shops that use low temperature (under 700 degrees F) bakeout ovens, high quality materials, and quality assurance programs based on EASA-Q or ISO-9000. Ask the repair shop to conduct a core loss or loop test as part of their rewind procedures.

What Design Characteristics are Important?

Motor Size

Motors should be sized to operate with a load factor between 65% and 100%. The common practice of oversizing results in less efficient motor operation. For rare peak loads, use a pony motor.

Operating Speed

While the average speed of energy-efficient motors is slightly higher than the average speed of standard-efficiency motors for any given size, models of each type are available with a wide range of speeds. Installing a new motor with a higher speed can result in diminished energy savings. It is particularly important in centrifugal pump or fan applications to select replacement motors with a comparable full-load speed.

Inrush Current

Avoid overloading circuits. Energy-efficient motors feature low electrical resistance and thus exhibit higher inrush currents than standard models. The inrush current duration is too short to trip thermal protection devices, but energy-efficient motors equipped with magnetic circuit protectors can sometimes experience nuisance trips during start-up.

How Should I Begin a Motor Efficiency Program?

Survey your motors. Gather nameplate information and obtain field measurements (voltage, amperage, power factor, operating speed, operating hours) under typical operating conditions. Initially focus on motors with the following criteria:

- three-phase, NEMA design B motors
- non-specialty motors
- 10-600 hp
- at least 2,000 hours of use annually
- constant load (not intermittent, cyclic or fluctuating)
- older or rewound standard efficient motors
- easy access, and readable nameplates

Conduct motor replacement analysis with MotorMaster+ software and proceed accordingly.

Where Can I Get More Information?

- Western's Energy Services:
  - Power Line Hotline at (800) 769-3756
  - Energy Services Web site

This Technical Brief, and others, are available on-line at this Energy Services website.

  - E-Mail your question to Western's Power Line
  - Fax your question to Western's Power Line at (360) 586-8303
- The Energy Ideas Clearinghouse Web site
- **MotorMaster+ software.** To find out more about this energy-efficient motor selection software, check out the Industrial Technologies Program Web site.

Western's Energy Services

Western's Energy Services offers customers information, resources and solutions to improve their energy efficiency, use of renewable energy, and competitive positions. For additional information about energy efficient motors or any other commercial, industrial, agricultural or residential technologies, programs or products, use the Western contacts listed above.