Introducing MotorMaster: An Energy Efficient Motor Performance, Price, and Payback Analysis Software Package

Gilbert A. McCoy and Todd Litman
Washington State Energy Office

Introduction

The "stand alone" MotorMaster software consists of a motor price and performance database, and an energy conservation analysis report. Designed for utility auditors, facility managers, and consulting engineers, MotorMaster can be queried to identify the most efficient motor(s) for a given application, and to compute the energy and demand savings associated with selection of the energy efficient over a standard efficiency model.

Using the MotorMaster Database

MotorMaster's comprehensive database contains performance and price information for over 5,000 1- to 500-hp National Electrical Manufacturers Association (NEMA) Design B electric motors. Information is available from the 14 manufacturers which account for the bulk of all motor sales in the United States. The database is "validated" as motor manufacturers are given the opportunity to review information for accuracy and completeness.

The database's full and part load nominal efficiency and power factor values are obtained in accordance with the IEEE 112 Method B test--where the motor power output is directly measured by a dynamometer when the motor is operated under load. Since motors vary significantly in efficiency, the motors database can be used to identify a more efficient and cost effective motor than would otherwise be purchased. The database also contains the manufactures' name, motor model, catalog number, full load speed (RPM), service factor, frame size, and list price. Information is readily available for motors:

- In the 1- to 500-horsepower size range
- With totally enclosed fan cooled (TEFC), open drip proof (ODP) or explosion proof enclosures
- With synchronous speeds of 900, 1,200, 1,800 or 3,600 RPM
- Designed to operate at 115, 200, 208, 230, 460, and 575 volts

You need only specify the synchronous speed, enclosure type, motor size, and voltage rating to obtain a list, ranked in order of descending full load efficiency, of available premium, high and standard efficiency motors. The NEMA MG 1 nominal full load energy efficiency standard is also indicated. Scanning this list enables the user to quickly identify the most efficient motor(s) for a given application.

MotorMasters' Energy Conservation Analyses

MotorMaster also contains motor change out energy savings analysis capability. Energy, demand, dollar savings, and simple paybacks can readily be displayed for three purchase scenarios including:

- Initial or new purchase of a standard or energy efficient motor
- Rewinding versus replacement of a failed motor, and
- Replacement of an operable oversized and under loaded motor with a high efficiency unit

MotorMaster is especially useful in that it exhibits "intelligent defaults." For instance, the average price and performance for all standard efficiency motors currently marketed is used as the default "base case" analysis for a given motor size, horsepower, and enclosure class. Average high efficiency motor performance and list prices are also displayed. An analysis for a specific energy efficiency motor purchase is initiated by querying the motor database to obtain full and part load efficiency values. Annual operating hours, motor load factor, utility energy and demand charges, plus rebate magnitude then are entered. The analyst can thus quickly illustrate cost effectiveness based upon purchase of industry "average" or specific standard and high efficiency motors.

High Efficiency Motor Rebate Program Support

MotorMaster is specifically designed to support utility sponsored motor rebate programs. For instance, multiple utility rebate structures and motor qualifying standards can be stored within MotorMaster. When a utility service area is identified, that utility's actual rebate for a given motor size is automatically entered as an economic analysis default. The utility's qualifying efficiency standard is also indicated in the database listing. MotorMaster is also designed such that utility specific rebate applications can be printed. The application contents include the motor manufacturer, class, and purchase price, annual energy and demand savings, and rebate entitlement. This feature is especially attractive when motor distributors market rebate programs on behalf of utilities.

Maximizing Energy Savings With MotorMaster

As many as two to four points of additional efficiency improvement can be obtained--often at little or no additional cost--by procuring a "premium efficiency" motor, an energy efficient motor with the best available efficiency characteristics.

Other things being equal, motor purchasers should attempt to maximize motor efficiency while reducing their purchase price. This approach minimizes running costs and maximizes conservation savings. MotorMaster is designed to assist purchasers to "make the right choice." The MotorMaster database in effect can serve as an "electronic shopping guide."

The benefits attainable through high efficiency motor "comparison shopping" are indicated in Figure 1 (McCoy, Litman and Douglas 1991). This Figure illustrates the additional energy savings attainable through selection of motors with superior operating characteristics over industry average or marginally qualifying energy efficient motors. Energy savings can be tripled by choosing motors with the top performance in their class instead of motors that barely satisfy the minimum NEMA energy efficiency standard. The base case for computing energy savings in Figure 1 is an industry average standard efficiency motor.

High Efficiency Motor Cost Effectiveness

For motors driving loads which require prolonged running times--such as continuously operating hospital HVAC equipment--simple paybacks on investments in energy

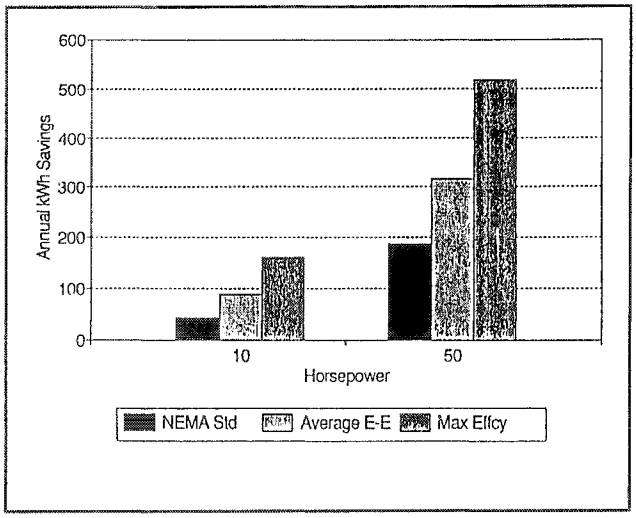

Figure 1. Savings Over Standard Effiency Motor 8,000 Hours/Year; 3/4 Load; $0.5/kWh

efficient motors can be extremely attractive. For instance, the simple payback on the incremental investment for the initial purchase of a 50-hp energy efficient motor--in the absence of any utility rebate--can be as rapid as 0.5 years. In the operable motor change out scenario, where the total costs of procuring and installing a high efficiency replacement motor must be borne--a simple payback of 4.0 years is attainable, even with an electrical rate as low as 4 cents per kWh.

From a utility standpoint, the levelized nominal motor conservation acquisition costs--given 12-year 8 percent financing--are 3.4 and 27.6 mills per kWh for the initial purchase and motor replacement scenarios, respectively. (One mill is one-tenth of one cent.) These costs double if the operating time is reduced to 4,000 hours, then double again at 2,000 hours to 13.6 and 110 mills per kWh, respectively. This sensitivity of cost effectiveness to operating hours is illustrated in Figure 2.

Depending on motor price, efficiency, operating hours, load factor, electrical energy and demand charges, and purchase scenario, energy efficient motors can be wonderfully cost effective or woefully expensive investments. MotorMaster enables users to maximize energy and demand savings by quickly identifying the most efficient units available and by performing application specific cost effectiveness analyses.

Electric motors in the 5-horsepower and larger size range are estimated to use over half of all electricity consumed in the U.S. (Nadel et al 1991). Identifying candidates for retrofit with energy efficient motors and encouraging the purchase and use of high efficiency models in new

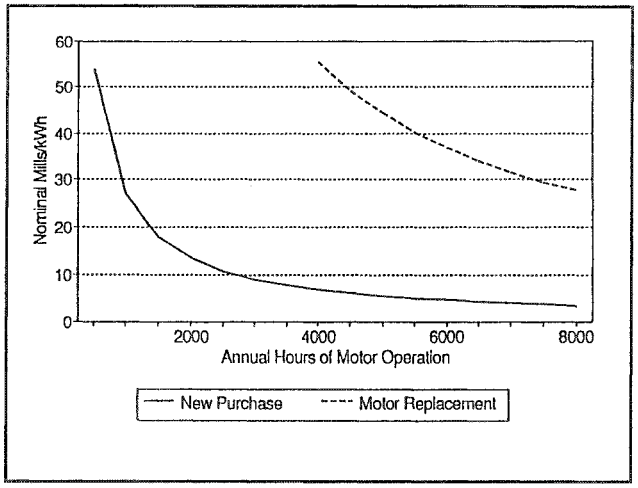

Figure 2. Energy-Efficient Motor Life-Cycle Cost Analysis

facilities represent significant opportunities for conserving our nation's energy resources. MotorMaster offers a simple, user friendly way to provide the information necessary to achieve this goal.

MotorMasters' Development

MotorMasters' development was jointly funded by the Bonneville Power Administration and the U.S. Department of Energy.

References

McCoy, Gilbert A., Todd Litman, and John G. Douglass. 1991 *Energy Efficient Electric Motor Selection Handbook* DOE/BP-34623-3, Bonneville Power Administration, Portland, Oregon.

Nadel, Steven, Michael Shepard, Steve Greenberg, Carl Katz and Anibal T. de Almeida, 1991. *Energy Efficient Motor Systems: A Handbook on Technology, Programs, and Policy Opportunities.* American Council for an Energy Efficient Economy, Washington, D.C.