Motor energy saving tips

This fact sheet will help you calculate your motor operating costs, develop a policy for motor repair and replacement and develop strategies to reduce energy used by motors at your facility.

Industrial fans, pumps and air compressors use more than 50% of the total motor related electricity used. According to the U.S. Department of Energy (DOE), industry could reduce energy used by motors by 11 to 18% if it implemented all existing cost-effective technologies and practices for improved efficiency.

Significant air emissions are released when electricity is produced. In Minnesota, one-fourth of the energy-related emissions of carbon dioxide, sulfur dioxide, lead and mercury are from generating electric power. Industry uses over 50% of this electricity. Reducing electricity use by motors will help improve Minnesota's air quality.

As of October 1997, the Energy Policy Act (EPACT) requires all motors sold in the U.S. to meet efficiency standards. In 2001 a new class of premium efficiency motors was designated, setting efficiency standards for new motors beyond those of EPACT.

Although high efficiency motors have been available for years, they make up less than 10% of all industrial motors in current use.

If your motors are not part of this 10%, they could be using excess electricity—increasing your operating costs.

Motor Energy Costs

Use the following equations to calculate demand and energy costs. Together these equal your annual cost to operate motor driven equipment. Once you have calculated your annual cost, compare it to the annual cost to operate EPACT and premium efficiency motors.

To calculate the energy cost per year, multiply:

- motor's horsepower (hp)
- conversion factor 0.746 kW/hp
- number of operating hours per year (hr/yr)
- cost per kilowatt-hour ($/kWh)
- load factor (LF) = average amps / full load amps

Divide the product by the motor's efficiency. Load factor is the fraction of the motor's horsepower actually used to drive a load. One way to determine load factor is to measure the amperage (amp) draw of the motor under load then divide by the motor's full load rating.

Energy cost per year =

$$\frac{(hp)(0.746 \text{ kW/hp})(hr/yr)(\$/kWh)(LF)}{\text{motor efficiency}}$$

To method estimate the demand cost per year for operating a motor depends on how power factor is taken into account. A power factor—ratio of true power used to the power drawn from the source—is found on a motor's specification sheet where there is a demand charge in KW and separate power factor adjustments.

Multiply:

- motor's horsepower (hp)
- conversion factor 0.746 kW/hp
- load factor (LF)
- cost per kilowatt amp per month ($/kW/mo)
- 12 months per year (12 mo/yr)

Divide the product by:

- motor's efficiency

The cost per kW is found on your electric bill.

Demand cost per year =

$$\frac{(hp)(0.746 \text{ kW/hp})(LF)(\$/kW/mo)(12 \text{ mo/yr})}{(\text{motor efficiency})}$$

Example Calculations

Use these factors for example calculations

- Motors are five horsepower
- Motors run 4,000 hours per year
- Motors run at 0.75 load factor
- Energy cost is $0.05 per kWh
- Unit demand cost is $3.00 per kW per month

	Standard	EPACT	Premium
Efficiency	83%	86%	88%
Power Factor	0.82	0.84	0.86

The following is an example of how to calculate the annual energy, demand and total cost of a standard efficiency motor.

Energy cost per year =

$$\frac{(5\ hp)(0.746\ kW/hp)(4{,}000\ hr/yr)(\$0.05/kWh)(0.75)}{0.83} = \$674\ \text{per year}$$

Demand cost per year =

$$\frac{(5\ hp)(0.746\ kW/hp)(0.75)(\$3.00/kW/mo)(12\ mo/yr)}{(1.21)(0.83)} = \$148\ \text{per year}$$

The total annual cost to operate the motor is $795.

After 10 years the motor's operating cost exceeds its purchase cost more than 20 times.

The table below summarizes the cost per motor. Payback periods for EPACT and premium efficiency motors, compared to standard efficiency motors, are based on purchase price and energy savings.

	Standard	EPACT	Premium
Purchase price	$375	$445	$575
Energy cost (yr)	$674	$651	$636
Demand cost (yr)	$148	$140	$133
Operating cost (yr)	$822	$791	$769
Payback years	—	2.3	3.8

Motor Repair and Replacement Policy

Implement a motor replacement policy to replace older, rewound motors. This can benefit your operation in many ways, including:

- Increased efficiency, which lowers operating costs
- Reduced downtime, which lowers production costs
- Lower operating temperatures, which lowers maintenance cost

Policy Example

The following policy was developed by the Industrial Electrotechnology Laboratory. It covers open drip-proof (ODP) and totally-enclosed fan-cooled (TEFC) motor enclosures.

- When purchasing a new motor or piece of equipment, specify energy efficient motors.
- When an existing motor fails:

  - If it is energy efficient, send it for repair. This applies to ODP and TEFC enclosures and one to 200 hp motors.

  - If its not energy efficient and is an ODP enclosure, replace with an energy efficient model. This applies to 100 to 200 hp motors.

  - If it is not energy efficient and is a TEFC enclosure use the table below to select a breakpoint horsepower—a motor size that provides at least a two year payback—for the number of hours you operate motors.

Annual Operating Hours	Horsepower*
One shift (2,912 hr/yr)	25
Two shifts (5,824 hr/yr)	70
Three shifts (8,736 hr/yr)	130

* For energy cost at $0.05 per kWh.

When a motor is larger than the breakpoint horsepower send it for repair. When a motor is smaller than the breakpoint horsepower replace it with an energy efficient motor.

- When repairing a motor costs more than 60% of the purchase cost of a new energy-efficient motor, buy the new motor.

Conservation Strategies

Energy efficient motors. When purchasing a motor choose the most energy efficient and affordable. Premium efficiency motors cost about 20% more, but will payback in under four years with one-shift operation and a cost of $0.05 per kWh. Payback will be shorter for a 24-hour, seven-day-per-week operation.

Oversized motors. Motors are oversized when they power end uses that require less horsepower than the motor is capable of producing. For example, when a 10hp motor is used for an application that calls for a five hp motor, the motor is 100% oversized, or operates at 50% full-load. At smaller load factors motor efficiency is lower, leading to increased operating costs. Select a lower power motor and operate it at a higher load factor to help justify the motor replacement. Motors operated at low load factors have lower power factors.

Motor replacement. Some motors may warrant replacement before they fail. Evaluate motors that are used for two or more shifts per day and are oversized.

Synchronous belts. Optimize transmission efficiency by using synchronous belts instead of v-belts. V-belts can slip and deteriorate efficiency at higher loads.

Variable speed drives. Consider using a variable speed drive motor system instead of traditional motors when loads vary significantly over the course of daily use.

Voltage. The voltage at the motor should be as close to the design limits, found on the nameplate, as possible. Changes of more than five% can lead to two to four% drops in efficiency and increase temperatures, which decrease the motor's life. Voltage at the motor that is not within the design limits leads to a decrease in power factor. Low power factors may be penalized by your power company.

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