Working through the electric motor replacement maze

TAKING A TOTAL COST OF OWNERSHIP APPROACH TO MOTOR REPLACEMENT CAN SAVE BIG DOLLARS -- AND HELP SAVE THE PLANET

The Department of Commerce currently estimates that there are more than 12.4 million electric motors of more than 1 HP in service throughout industry in the United States, and that nearly 3 million of these workhorses will fail this year. So chances are, that you will be faced with the prospect of selecting the right motor to replace a failed unit within your facility sooner rather than later. And we believe that you should also be evaluating the replacement of all the motors in your plant going forward, to save energy costs and contribute to improving our environment.

When compared with other equipment, an electric motor is an exceptionally reliable device. Lifetime for a properly installed motor of 20 to 30 years is not unusual. That leads to an interesting fact – the energy consumed by a motor over its useful life costs many times its purchase price. In fact, studies have shown that the purchase price of a motor represents just 2 percent of its lifetime cost while the electricity it consumes accounts for more than 97 percent. This clearly indicates that lifetime costs are the right way to evaluate motor selection.

There are also several governmental regulations to consider as part of the selection process, as well as new opportunities for savings in terms of tax credits and utility rebates that will impact your decision. With this in mind, let's take a look at the options that you have for replacing a motor that is failing or has failed catastrophically. (Note that several of these options can also be used for evaluating the replacement of serviceable motors too.)

EFFICIENCY OF MOTOR REPLACEMENT OPTIONS

If your standard efficiency motor is still in serviceable condition, and was installed before the October 24, 1997 when the motor efficiency standards of the Energy Policy Act (EPAct) of 1992 came in force, you may choose to rewind it rather than replace it. In general rewinding a motor costs about 40 percent of purchasing a new unit – a reasonable savings. But the Department of Energy (DOE) indicates that even the best rewinding comes at a penalty in operating efficiency, which raises the energy consumed and therefore the operating cost of the motor substantially over time. In fact, the DOE suggests that motors of less than 70 HP should not be rewound but replaced.

If your motor is beyond repair and rewinding you also have several options to consider for replacement. Since EPAct grandfathers in purpose-built motors that were installed before 1992, you may be able to replace your motor with a new custom-built standard efficiency unit. Here you would expect the same ongoing energy costs over the next two or more decades. But remember that electricity costs have been rising over the past five years and this trend is not expected to moderate in the near future.

As an alternative, you could consider selecting a high efficiency motor that meets the current EPAct efficiency standards. Such high efficiency motors (also called NEMA High Efficiency motors) are readily available at a purchase cost premium of less than 10 percent over standard efficiency motors, but deliver 1- to 4-percent better operating efficiency (See Table 1). This gain in efficiency can easily offset the purchase cost premium within a couple of months. In fact, the reduction in energy usage will actually pay for the entire motor itself within a few years on average, and deliver further savings over the two decades or more of useful life you might expect.

Finally you should consider selecting a NEMA Premium® Efficiency motor to replace your existing standard efficiency unit. NEMA Premium motors meet the efficiency standards that will

come into force under Energy Independency and Security Act in the end of 2010, and deliver a further 1- to 3-percent improvement in efficiency over EPAct high efficiency units at a purchase cost premium of about 30 percent over standard efficiency motors (See Table 1). Such high energy efficiency results in payback of the purchase premium over standard efficiency motors in less than 2 months, and can payback the entire cost of the NEMA Premium motor in significantly less than 3 years.

HP	Std Efficiency motors avg. eff. @ 75% load	EPAct Motors avg. eff. @ 75% load	NEMA Premium motors avg. eff. @ 75% load
5	84.0	88.2	90.5
10	86.75	90.0	92.2
15	87.55	91.0	92.6
20	89.3	92.6	93.4
25	89.9	93.1	94.0
50	91.6	93.9	94.5
100	93.6	94.1	95

Table 1. Average efficiency for various sizes of standard efficiency, EPAct and NEMA Premium motors.

Utilities and state and federal energy regulators have a multitude of programs in place that actually make the last alternative -- NEMA Premium motors -- even more attractive for industry. These combinations of rebates, tax incentives and cost sharing programs vary by state and municipality, but can be substantial and significantly reduce the payback period for installing energy efficient motors. In fact, these incentives are causing a number of companies to replace perfectly serviceable motors with their high efficiency counterparts as part of green initiatives that improve their brand position in the marketplace.

CALCULATING THE SAVINGS

Calculating the potential savings from replacing a standard efficiency motor with a NEMA Premium unit is straightforward, using Eq. (1).

Savings = [0.746HP/Effold – 0.746HP/Effnew] x Hrs x days x $/kWh (1)

Where:

HP -- rating of motor(s) in horsepower (1 HP = 0.746 kW)

Eff_{old} -- efficiency of the existing motor

Eff_{new} -- efficiency of the replacement motor

Hrs -- hours of continuous daily operation

Days -- operating days per year

$/kWh -- cost per kilowatt hour

Replacing a 100 HP standard efficiency motor that runs 8,000 hours (two shifts per day for 50 weeks) a year with a NEMA Premium equivalent will result in an annual energy savings of more than $755, using an average cost per kWh of $0.08. Clearly this would cover the cost premium for the motor in just a few months and the entire cost of the motor in a few years, while producing significant savings in lifetime costs going forward.

Simply replacing a standard efficiency motor with either a NEMA premium alternative does not guarantee lower electricity bills. Factors like duty cycle, improper motor over-sizing, unbalanced phases and other application factors can reduce the potential savings significantly. You should always consult with your motor manufacturer to determine exact expected savings.

GOING FORWARD

To gain maximum economic benefit from making the right motor replacement choice, the Industrial Efficiency Alliance (IEA), a nonprofit organization dedicated to making energy efficiency a core business value, suggests establishing a Continuous Energy Improvement program within your company. The first step in such a program is to appoint a motor system Champion who has the training and authority to make decisions on motor purchases going forward. The Champion can then conduct a comprehensive motor management assessment or energy audit to gather appropriate data about all the motors installed in your plant. Using this data, he can then advise plant management on ways to improve motor purchasing, rewinding and maintenance issues. In addition, the Champion can work with qualified vendors and contractors, as well as utility representatives to optimize the efficiency of motor systems throughout the plant.

If you are not currently evaluating NEMA Premium efficiency motors as replacements for failed or currently installed standard efficiency motors, you are probably leaving a lot of money on the table. It should be noted that the IEA estimates that a dollar saved on energy, maintenance and production is equivalent to $17 in sales income (assuming a 6% gross margin). Further, estimates from the Department of Energy indicate that by switching from standard efficiency to NEMA Premium efficiency motors could save more than $10 billion annually and reduce carbon emissions by nearly 80 million metric tons – the carbon equivalent of taking 16 million autos off the road. That's not only good business – it can make a real environmental difference going forward.