Motor Repair or Replacement? *The Green Solution*

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The ever present emphasis on technological efficiency is just one of several forces behind the pressure on companies to "go green" despite a trying economy. Yet green investments, particularly as they relate to motors in plants, are likely to lead to conflict between two forces: plant management, which is convinced that the best path to a green operation is to operate motors at the highest efficiency, and the accounting department that will always question whether expenditures produce an acceptable return on investment (ROI) in the shortest possible time.

Some will argue that investment in a large motor with a higher efficiency rating than equipment currently in use may be more expensive, but will pay off in the long run because of productivity, output, and lower long-range costs — a point inevitably debated by accountants who may not be so enthusiastic about long-range ROI and may consider a green initiative as cost-prohibitive.

It's a classic battle fought in corporations large and small, but it does not have to be zero sum — all or nothing. Technology, long the key to efficiency, can help resolve this issue through detailed computerized analysis of the motor, the power environment in which it operates, and even its reliability. All of these relate to cost savings as much as they do with the growing green movement in industry.

Applying Green Technology to Motors

The ultimate criterion that determines whether a motor is truly green is energy efficiency. In this case, we are talking about less use of electricity or other resources, such as water. Clearly any motor that offers optimum levels of production and energy conservation qualifies for a green or environmentally friendly designation. Considering that electric motors at most facilities are the largest sources of energy consumption and costs, efficient, outlay-reducing green machinery should be in demand.

The goal with any green technology is to eliminate waste. In many facilities, older motors are the primary culprits and the biggest energy "offenders" because they are likely to be less efficient. That also makes them more costly in the long run because the largest single lifecycle costs for any motor are the payments to utilities necessary to keep it functioning. Companies leery of additional capital expenditures, particularly during a difficult business climate, are content with the status quo under the mistaken assumption that the motors producing at optimum levels are as efficient as can be reasonably expected.

However there is another barometer of a motor's efficiency, and it's one that is usually overlooked when discussing motor technology. That standard is reliability, and it deserves to be included as part of any efficiency evaluation. Bear in mind that if an older motor requires

maintenance well above routine scheduled work, the end result is most likely higher costs due to maintenance, parts, labor, and, of course, the additional electricity required to keep it operational. Elevated costs and power usage due to unreliability fall far short of green standards.

Another impact on a motor's efficiency is the process in which it operates. When a motor functions at well below its rated horsepower, the motor's environment is considered "unloaded" and its troubles attributable to an inefficient power system. It is a process failure that is more accurately described as waste rather than unused capacity. The energy required by every piece of rotating machinery can be quite variable, particularly in the method of delivery. A brand new high efficiency motor will be flawed if it is operated in an unreliable application. One example is a voltage imbalance from the transformer to electric lines to the motor — a classic case of a high-performance asset in a low-performance environment. Imbalance always has a negative impact on efficiency and performance, regardless of the motor's efficiency rating.

The green movement as it relates to motors is the result of industry becoming environmentally conscious and more aware of reducing its carbon footprint. While that term originally applied to the release of greenhouse gasses, it has been broadened to include waste and inefficiency associated with factory operations in general and motors specifically. Still, a company regardless of its green intentions has to factor in the costs of reducing carbon-related emissions when making the important decision to repair or replace. New green-related technology provides some tools that can help companies make the right choice.

Efficiency and Fault Zone Analysis

One such tool is the technology used to conduct a real-time analysis of six crucial areas of motor function. These areas are referred to as fault zones, and all require independent testing because problems in any one of the six will likely impair efficiency and output. An effective analysis of each fault zone will play a major role in determining whether replacement or repair will achieve maximum efficiency and a green production environment. The fault zones are:

1. *Power Quality.* The focus on this fault zone follows the increasing use and reliance on AC and DC drives. An ongoing concern about power quality is the possibility of distortion of voltage and current levels from variable frequency drives. Other sources of trouble with power quality include harmonic distortion, voltage spikes (sometimes resulting from excessive cable length between the drive and motor), and unbalanced voltage. Another factor that wreaks havoc with power quality in particular and efficiency in general is heat. Harmonics in a distribution system produce excessive heat because of increasing current demands. Left undetected, heat above acceptable levels can either lead to malfunctions or shorten the motor's lifespan.

2. *Power Circuit.* This fault zone is defined as the system of conductors and connections running from the point of origin of testing to connections at the motor. The circuit can include breakers, fuses, contactors, and lug connections. There should be no doubt that a problem in the power circuit impairs efficiency. A study conducted in the mid-1990s determined that more than 46 percent of the faults found in industrial power distribution systems stemmed from difficulties within either the

connectors or conductors. Faulty power circuit conditions place the most efficient and well maintained motor at risk for reduced horsepower that can lead to excessive heat and insulation damage.

3. *Insulation.* There is potential damage to insulation between the windings and the ground, which is generally caused by dirt contamination, high temperatures, moisture and age. A faulty power circuit is a culprit in insulation damage, but advanced testing is required to ascertain if the damage was the cause of a motor disruption or something else — a symptom of another problem yet to be analyzed. It should also be noted that a system that ensures the dryness of insulation could as much as double the life of the motor as can testing and maintaining the ground insulation.

4. *Stator.* This fault zone is sometimes misunderstood. A stator consists of copper windings connected with solder joints between the coils. Electrical engineers sometimes differ on the role of the stator as the root cause or symptom. Outside of design or manufacturing defects, the stator is often the symptom of another fault mechanism. The real goal for stator-related incidents is to identify conditions conducive to stator faults and correct them before they result in a stator failure. Stator failures can often be catastrophic, resulting in unplanned outages and defective products, which increase the use of energy and create waste.

5. *Rotor*. In more specific terms, the rotor fault zone refers to the rotor bars, laminations and end rings. The percentage of motor failures attributed to rotor problems is low, but its trouble spots can cause extensive damage to the motor if left unchecked. The stator is also at risk because of its close proximity to the rotor. For example, a cracked rotor bar will lead to a heat build-up intense enough to melt insulation on its laminations as well as on the nearby stator. Again motor efficiency will be compromised without the advanced technology necessary to detect a crack or break in the bars.

6. *Air Gap.* The gap between the rotor and stator assures efficiency when it is evenly distributed around 360 degrees of the motor. When distribution is uneven or non-symmetric, the usual result is an unbalanced magnetic field that can lead to failure of the stator windings and stress on bearings that are also likely to fail.

All six fault zones have one requirement in common: ongoing testing of the highest standards and tolerances that will help assure efficiency. Chances of achieving green-oriented goals are unlikely with anything less.

Greenwashed vs. Greenwise

Going green can be compared to a pressure point applied to companies seeking to reduce waste in their usage of electricity and water while maximizing efficiency. Constant pressure to be environmentally responsible is bound to take its toll on firms trying to balance out green-related efficiencies with cost. Sometimes the balance tilts unfavorably.

That, in essence, is what happens when a company is *greenwashed*. It decides to invest in new motors based solely on high efficiency ratings. Certainly no company is going to make such a decision without a serious cost/ROI analysis. In the desire to achieve two outcomes (green energy and increased profits), a company may find itself yielding to its laudable desire to show its green colors. It's not that the firm has placed its ROI on the backburner; it's more likely that the company has not adequately considered the possibility of attaining its green goals without a massive investment in new motors.

The term "greenwash" is a play on brainwashing, the interrogation tactic which influenced a prisoner's mind and action through constant repetition. The repetition in this case comes from the not-so-subtle demands from within and outside the company to display its environmental responsibility on a daily basis, so what could be better than using the highest efficiency motors available? Unfortunately, it's not that simple. Any assumption that purchase of a higher efficiency motor is an automatic step into green nirvana may well be viewed as a greenwashed-based decision.

Why? Because the decision was reached through a simple math process based on motor design information (usually referred to as the nameplate) instead of evaluating a number of critical variables. Simple math is limited to rated horsepower and production output, use of energy to achieve that output, savings due to less energy requirements and, of course, the time it takes to achieve ROI. At first glance, the savings from the massive investment may be viewed as astronomical and a "no-brainer," but there is a caveat: these calculations should be recognized as limited and the savings that they project may not be close to accurate. Variables such as distribution system, load history, and accurate efficiency calculations are left out of the equation.

The technology is available to measure the data of these variables, which may well determine whether being green means a full-scale motor replacement or a less costly repair. A *greenwise* decision examines all of the variables and projects actual savings. True, manufacturers are providing the highest efficiency motors available on the market, but their value and performance have to be predicated on the plant environment where they will operate. Greenwise testing and computations take into account the actual running conditions of the motor in addition to the motor's nameplate rating. The company may conclude that the payback for the purchase of a new motor may be less than preliminary calculations indicated because of information revealed through fault zone testing. That is especially true when utility costs, the largest expenditure in a motor's life cycle, are factored in along with wasted capacity — the result of a power condition that forces the motor to work at less than its rated horsepower.

Green Technology for Motor Maintenance and Management

Software for motor maintenance has evolved to the point that its use can be considered a valuable step towards going green. The arrival of Reliability Centered Maintenance (RCM), which created a centralized base to coordinate motor asset management, is one of the recent advancements. RCM became the first step in the evolution to predictive maintenance software that represents a "cradle to grave" diagnosis of a motor and its fault zones — a coordinated package that communicates between separate software analysis systems. The lesson these advanced systems provide is that motor maintenance and management must be coordinated

throughout the entire life cycle. Without it, a company could waste money, energy, labor, and utilities trying to repair a recurring problem without recognizing the actual cause of the breakdown.

Some businesses have responded with the creation of the Machinery Information Management Open System Alliance – a consortium that promotes a standard protocol to reduce difficulties in data conversion from disparate software applications. This too should be considered a step in the green direction since it aids enterprise resource planning while providing useful data to determine ROI for either motor replacement or repair. Its goal is maximum efficiency, which is rapidly becoming a synonym for green industrial operations because it is understood to include minimum requirements for power and resources.

One of the newest types of software, the energy cost analysis module, produces real data for any existing motor application. The actual running condition is analyzed prior to any consideration of replacement. All of the nameplate data is considered along with the variables that impact operations. Following information input, the software produces data on actual efficiency, repair based on fault analysis, or necessity of replacement.

Equally important, don't forget reliability. High efficiency ratings mean little if the motor is unreliable especially after its warranty has expired. The new technology can accurately assess the motor's reliability while projecting its years of useful life.

ROI Decisions from a Green Perspective

By now, it should be clear that going green requires a significant reduction of energy consumption, which is what the newest maintenance software is designed to determine. Motor circuit evaluation has unified everything from fault zones inside the motor to the exterior environment and all of those variables associated with it including a realistic assessment of the motor's lifespan — all necessary for the projection of ROI.

It is the software revolution that may turn the tide to green's favor and bring an end to those "greenwashed" decisions based solely on motor efficiency ratings. Accountants who tend to equate conversion to green technology with questionable ROI may be swayed by the bigger picture that the new software information can provide.

It is not a stretch to consider upgrades in energy efficiency among the most important steps a company can take with its green conversion. One may not immediately connect the operation of a 1000 hp motor with environmental improvement, but consider that the more efficient the operation of the motor *and its environment*, the less the requirement for electricity and power, which means lower operating costs. That merits the green label by any contemporary standard. Motor reliability should be considered the same way.

Analysis technology can improve motor efficiency and reliability, and its sophisticated evaluation software may well be one of the best opportunities to maximize a motor's lifespan while limiting its carbon footprint. One does not have to be an ardent environmentalist to appreciate the value of this green strategy.

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