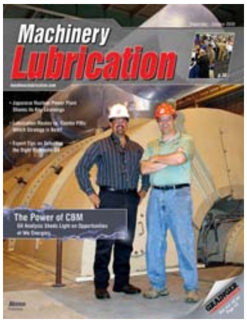
Reprint from *Machinery Lubrication*
September - October 2009



Mining for Money through Energy Monitoring and Management

Drew Troyer, *Noria Corporation*

I've always been interested in the connection between reliability management and other functional responsibilities within a manufacturing organization, such as quality and safety. Clearly, reliable manufacturing processes improve quality, one of the three primary elements of overall equipment/business effectiveness (OEE/OBE). Also, when manufacturing processes are reliable and predictable, there is less chance for injury. Lately, I've been giving much thought to the relationship between reliability and energy management. In my opinion, there is a close connection – one that is worth exploring.

Monitoring and managing energy consumption is good for the organization and good for the environment. It's a win all the way around. In the United States, 30 to 40 percent of the electricity we generate is required to power industrial electric motors! Even a small energy-efficiency gain can significantly increase the aggregated demand for power, reducing capital expenditure to build more power plants and the consumption of fossil fuels and associated emissions. For your firm, spending less on energy translates into real dollar savings. Plus, by reducing strain, wear and tear on your machine assets, manufacturing reliability is improved, creating even more value for your organization.

Outline of Benefits

Over the life cycle of a machine asset that supports manufacturing processes, energy consumed is frequently the largest expense. Some aspects of the cost to energize a machine can't be controlled, but some can.

Energy Savings Calculator - 200 HP Motor Example	
Horsepower (HP)	200
Load Factor	80%
Kilowatts (kW)	119.36
Hours Used	8,000
kW Hours Consumed	954,880
Cost per kW Hour	$0.06
Annual Energy Cost	$57,293
Energy Consumption Reduction Target (%)	10%
Projected Annual Energy Cost Savings	**$5,729.28**

Figure 1. Simple math and solid savings.

Let's look at the economics of energizing a 200-horsepower electric motor. Assuming a load factor of 80 percent and a modest energy cost of $0.06 per kilowatt hour (kWh), it requires more than $57,000 each year to power the motor, assuming an 8,000-hour operating year (Figure 1). A quick scan of the Web revealed that the price for a three-phase, 460-volt electric motor is in the $5,000 to $8,000 range. I'm sure there are motors that cost more or less, but the point is that the cost to energize the electric motor is about 100 times its purchase price, assuming a 10-year life. Carving 5 to 10 percent off of this cost can profoundly affect the bottom line.

In my example, a 10 percent improvement in energy efficiency drives an extra $5,700 to the bottom line – and that's for a single, garden-variety 200 hp electric motor! How do you get this savings? I've listed a few items for you to consider. Some have direct, positive effects on operational reliability in addition to the obvious energy cost savings.

1) Select high-efficiency motors – comparing brand-to-brand performance. High-efficiency motors cost more money up front. Don't be lulled into accepting the up-front savings. Assuming a regular-efficiency electric motor costs $5,000 at purchase and uses 10 percent more energy than a high-efficiency motor, you could spend up to $60,000 on a high-efficiency motor and still be ahead money in terms of the economic rate of return over the 10-year life cycle of the asset (assuming an 8,000-hour operating year). Paying a 50 percent up-front premium for a high-efficiency electric motor yields an internal rate of return of 229 percent. That's the equivalent of finding a bank that will pay you 229 percent interest annually on your deposits. A 5 percent energy efficiency for which you must pay a 50 percent price premium up front still yields a 115 percent internal rate of return. You'll be hard-pressed not to justify this investment if you're employing decision-making tools based on life cycle cost.

2) Design drivetrains for energy efficiency. Failure to consider energy losses in mechanical drivetrain decisions can significantly affect your overall energy bill for an asset. Sure, we want motors to be efficient, but improving the efficiency of the driver is only half the battle. We need to manage the efficiency of the driven components, too. Selecting energy-efficient gearbox and coupling designs, for instance, can substantially affect the total energy bill. Apply the precision balance, alignment, looseness, resonance and lubrication principles discussed in points 6 and 7 to the entire drivetrain.

3) Manage electrical system integrity. If your motor control center (MCC) has bad connections, degraded or undersized wiring,

LEAST ENERGY COST

Infor EAM: Asset Performance...

at the Least Energy Cost

INFOR

- Maintain availability, reliability, and operational safety of all assets - plant equipment, facilities and IT assets
- Improve maintenance strategy with cost picture that includes energy consumption
- Pinpoint underperforming assets, including the detection of energy waste
- Reduce energy costs and carbon emissions
- Meet sustainability and compliance goals

To find out how we can help you do business better, call us at 1.800.260.2640.
www.infor.com/green

ENERGY STAR PARTNER

or shorts, energy efficiency will be compromised. If circuits run hot or become hot, energy isn't being carried efficiently. Moreover, the reliability of the MCC and (in some cases) the motor itself can be compromised. In the case of stray current, the high buildup of potential also can lead to electrical discharge erosion, a wear mechanism often referred to as "fluting." Here again, the loss of energy compromises reliability.

4) Operate in ideal load range. Using our electric motor example, operating above or below its rated load range produces poor energy efficiency and decreases reliability. For most electric motors, energy efficiency degrades precipitously when the motor is operated at less than 40 percent of its rated load.

5) Make optimized rebuild/replace decisions. When an asset wears out, it gets loose and sloppy, which of course results in energy waste. Getting that last few days, weeks or months of service may be costing you dearly in terms of energy efficiency.

6) Manage balance, alignment, looseness and resonance. Imbalance, misalignment, looseness and resonance all generate mechanical friction. It takes power to create friction – which converts electrical energy into thermal energy – and you have to pay for it. In some instances, friction is desirable. When it's caused by lack of precision in managing balance, misalignment, looseness and resonance, you're literally paying for the energy required to increase wear and reduce the reliability of your machines. Precision maintenance pays off, both in terms of reliability and in energy management.

7) Employ precision lubrication. Improper selection of lubricant viscosity can significantly affect both energy consumption and reliability. If the viscosity is too low, surface-to-surface friction occurs. If the viscosity is too high, viscous drag results. Both waste energy. A common mistake is to employ multi-purpose grease in electric motors. The viscosity of this grease is typically around 320 centistokes at 40 degrees Celsius. Most electric motors require grease that is formulated using base oil with a viscosity of 100 to 150 cSt at 40 C. The extra viscosity reduces energy efficiency and compromises the motor's reliability. Likewise, motors frequently are over-greased, further compromising energy efficiency and reliability.

8) Monitor energy consumption. Changes in asset condition are frequently revealed with energy monitoring. We traditionally have employed vibration analysis, thermography and other condition monitoring tools to identify and troubleshoot abnormal asset conditions. By definition, if a machine starts vibrating or getting hotter, it is using more energy or converting energy with reduced efficiency, so monitoring energy efficiency is a natural condition monitoring activity. Moreover, it is comparatively easy to do and can be done on a continuous basis. Energy monitoring also enables you to compare the efficiency of various equipment and component designs, helping you make better design and procurement decisions that minimize life cycle cost of ownership and maximize return on net assets (RONA).

It's Worth the Energy

Monitoring and managing energy consumption is a slam dunk. Gaining just 5 percent improvement can translate to considerable savings for your organization. If you're mismanaging several of the above-named factors, 10 percent, 15 percent or more improvement may be possible. Because this wasted energy is frequently converted to heat and/or mechanical displacement (vibration), good energy management policy and good reliability policy are natural allies. To sweeten the pot, there are several government programs that are intended to motivate you to be energy conscious, often covering all or part of the up-front investment required to improve your energy efficiency.

To recap: reduced electric bill, improved reliability, economic support from the government and good environmental citizenship. What's stopping you? Start monitoring and managing energy consumption today in order to minimize life cycle cost of ownership. ML

About the Author

Drew D. Troyer is a champion of effective reliability management and passionate about helping companies find hidden profits inside their plants. As a highly sought consultant to Fortune 500 manufacturing firms, award-winning columnist and teacher, he understands both management expectations and plant-floor realities. Troyer is a Certified Reliability Engineer (CRE), a Certified Maintenance and Reliability Professional (CMRP), and chairs the standards committee of the Society for Maintenance and Reliability Professionals (SMRP). Contact Drew at dtroyer@noria.com.