Lowering Energy Consumption Using Lubricants

JOHN SANDER, VICE PRESIDENT OF TECHNOLOGY, LUBRICATION ENGINEERS, INC., USA, TELLS HOW THIS OFTEN OVERLOOKED PURCHASING DECISION CAN IMPACT ENERGY EFFICIENCY.

It is a simple fact: better lubrication can lead to dramatic energy savings and an improved bottom line. This ought to interest any cement plant manager who is looking for ways to reduce operating costs, and is especially significant at a time when stricter government regulations are in direct contradiction to reducing costs. Lubrication reliability is the solution. This article describes how cement plants can use lubrication reliability best practices to reduce their energy consumption, emissions and operating costs – all at the same time.

Table 1. Lubricant types	
Automotive (transportation)	**Industrial (factories)**
Heavy-duty diesel engine oils	Compressors
Passenger car engine oils	Bearings
Automatic transmission fluids	Gear boxes
Aviation engine oils	Hydraulics
Mobile hydraulic	Turbines
Differential fluids	Chains/wire ropes
Torque fluids	Slideways
Chassis lubricants (grease)	Grease

Table 2. Lubricant categories by ingredient	
Category	**Ingredients described**
Mineral oil	Base fluid derived from refined crude oil
Synthetic	Synthesized base fluids such as: PAO, esters, PIB, PAG and more
R&O (rust and oxidation)	Contains rust and oxidation inhibition additives
AW (anti-wear)	Contains wear-reducing additives
EP (extreme pressure)	Contains extreme pressure wear reducing additives
Multigrade	Contains viscosity index improving additives
DI (detergent inhibitor)	Contains detergent, dispersant, oxidation, wear, anti-corrosion additives
Others	Defoamants, emulsifiers, demulsifiers, pour point depressants, thickeners

Introduction

Energy usage is a cornerstone of today's society. Economic development and improved standards of living both rely upon the availability of energy. According to *The Outlook for Energy: A View to 2030* by ExxonMobil, energy usage per person varies dramatically around the world, but equates to an average of 200 000 Btu a day, which is 15 billion Btu per second.[1] This same study points out that each person has direct and indirect energy demands. Direct demand of energy is the energy that drives their personal vehicles and operates their homes, while indirect demand is the energy that heats and cools buildings, generates power, produces goods and services, and provides mass transportation of goods and people.

As the lesser developed parts of the world modernise, their needs for energy will grow, resulting in increased costs for fuel worldwide. Along with this, many of the world's governments are passing stricter laws regulating clean air and water, toxic waste, pesticides, endangered species and more. These factors – combined with a struggling economy – result in a challenge for cement plant operations managers, which is to reduce operating costs. Often, this means doing more with less.

One way to reduce operating costs is to reduce energy consumption. Upgrading cement plant equipment to take advantage of newer, more energy-efficient technologies can reduce energy costs. Unfortunately, in a challenging economic environment, capital may not be available for plant upgrades. Simple changes in habits can also create considerable savings. One such change is improving the lubrication reliability programme. According to Peter Thorpe, product application specialist at Shell South Africa, "from a cost point of view alone, lubricant costs are negligible when compared to energy costs, even before the production efficiencies of high-performance lubricants are factored in."[2]

Electric utility bills generally dwarf maintenance and lubricant costs. All three are part of any cement manufacturing operation. So, while controlling or reducing maintenance and lubricant costs is important, reducing electric utility usage is critical. There are tremendous opportunities that exist to use an improved lubrication reliability programme to decrease cement plant energy costs, thereby increasing profitability.

Energy for work

During conversions from one form of energy to another, some useable energy is lost. These energy losses can be extremely costly to society. The science of physics reveals that lubrication can play a role in reducing energy losses by reducing friction. Placed between two moving surfaces, a lubricant decreases the coefficient of friction. Naturally, this would also mean the more a lubricant decreases friction, the less energy the lubricated machine consumes.

Lubricant formulation basics

It has been said that "Oil's oil … just pour it in," but this statement is far from the truth. Simply described, a lubricant is composed of a base fluid and additives. However, many lubricant suppliers formulate their lubricants according to unique recipes intended for specific purposes. The following is a primer on the basic types of lubricants and the specific ingredient-driven categories.

Each of the lubricant types in Table 1 are usually broken down into narrower descriptions based upon the product formulation chemistry. Table 2 lists the categories and the additive types that dictate the categorical description. These descriptions are extremely simplified, as there are various base fluid types and even more additive types. Each formula category has its strengths and weaknesses and should be chosen based upon the needs of the application type (Table 1).

It becomes obvious that lubricant formulations can be rather complex. When searching for the best lubricant to minimise energy loss due to friction, it is often a case of "you get what you pay for." In other words, an inexpensively priced lubricant does not necessarily provide maximum lubrication performance. As such, they may require a higher amount of energy consumption, sometimes at higher costs than with a more expensive, better-performing lubricant. However, just buying an expensive lubricant does not ensure maximum lubricant performance and energy savings. The lubricant must be the right one for the application and must

Table 3. Typical savings with 5% amperage reduction (US$)		
Electric motor (hp rating)	Type of operation	
	40 hrs/week	Continuous
10	74	297
50	372	1487
100	746	2986
200	1493	5472
*$0.10 kWh electricity rate		

be properly maintained in order for it to provide maximum performance. This means proper storage and handling, filtration, oil analysis, training and more.

All electro-mechanical equipment requires periodic maintenance to operate at peak efficiency and minimise unscheduled downtime. Inadequate maintenance can increase energy consumption. It can also lead to high operating temperatures, poor moisture control, excessive contamination and unsafe working environments. Depending on the equipment, maintenance may include the addition or replacement of filters and fluids, inspections, adjustments and repairs.[4]

So, how does the end-user know what to do? The answer is to find a lubrication partner that can help develop a comprehensive lubrication reliability programme that includes lubricant selection, protection and maintenance. This partner could be a consultant, but it could also be a lubricant manufacturer that offers customised, comprehensive solutions, including lubricants and all of the related lubrication reliability products.

Lubricants and energy savings

It is possible to measure energy savings in a variety of ways, including production output, temperature changes or electrical reduction, as mentioned in the following. Another measurement is fuel consumption.

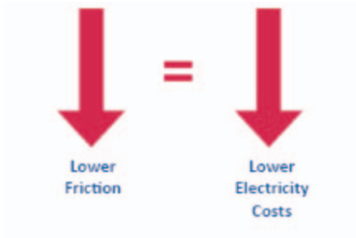
Production output

When using equipment, it is possible to evaluate the equipment's energy efficiency by recording its production output. For example, if a machine is capable of producing a certain number of parts in a given amount of time and the lubricant is changed, resulting in a higher volume of parts being produced in the same amount of time, then the machine has become more energy efficient. One must be careful when using this technique to ensure that nothing changed in the process except the lubricant. This can be overcome by using a larger number of test units, or by evaluating productivity over a longer period of time.

Temperature changes

Monitoring temperature changes is another way to optimise lubrication programme performance. Increased friction in a piece of moving equipment results in higher operating temperatures. Friction is a result of metal-to-metal contact that occurs between two opposing surfaces moving relative to one another. Even between highly machined surfaces, under microscopic view, asperity contact occurs.

The greater the amount of contact, the greater the amount of friction. As a result, more energy is required to move the surfaces relative to one another. This friction results in higher electrical power costs. Lubricants can reduce that friction. Therefore, when friction is reduced, less electricity is required to drive a gearbox, compressor, pump or other piece of equipment.



Sometimes, the bulk oil temperature is monitored in a piece of operating equipment. Another technique for evaluating lubrication performance is thermography, which involves using infrared detection equipment to look for "hot spots" on a piece of equipment that could result from insufficient lubrication, improper lubricant selection or faulty operating parts. In any of these cases, higher temperatures result in wasted energy. It is important, however, to account for ambient environmental temperatures when performing this type of energy efficiency study. Obviously, a piece of equipment will run hotter on hot days than on cold days.

Case study

The Lafarge cement plant in Alabama, USA, has an SEW Eurodrive helical right angle separator gearbox on the top of the raw mill. It is driven by a 200-hp electric motor and is constantly exposed to the elements – dust, wet, cold and heat, along with a lot of vibration. Whilst using a synthetic hydrocarbon gear oil, they were experiencing high operating temperatures of 82 °C to 95 °C (180 °F to 205 °F), depending on the ambient temperature and load on the gearbox. This particular gearbox was also suffering from foaming and seal leakage.

The local LE lubrication consultant was able to recommend Duolec Vari-Purpose Gear Lubricant (ISO VG 220) – an EP gear lubricant with excellent thermal stability. The customer partially drained the gearbox of the synthetic product and filled it with Duolec and ran it for one month. They then fully drained the gearbox, installed a Des-Case Hydroguard disposable breather and refilled with Duolec. After running production for two weeks, they observed much lower gearbox temperatures of 76 °C to 81 °C (169 °F to 178 °F) – a maximum 14 °C drop in temperature. Maintenance Inspector Derek McIntyre stated, "I am pleased and a bit surprised to see such a temperature drop."

Electrical reduction

When most think about energy consumption, they immediately think about electrical consumption. Tracking electrical consumption is a highly reliable way to evaluate improvements in plant energy use. In fact, various companies have been able to document improvements in electrical energy efficiency related to their lubrication programmes. Typically, companies that upgrade their lubricants and reliability practices have

> As the lesser developed parts of the world modernise, their needs for energy will grow, resulting in increased costs for fuel worldwide.

been able to document a 5 - 15% reduction in power requirements, more than enough to pay for a better-performing lubricant. Average documented savings were 15% in gearboxes, 12% in air compressors and 4% in electric motors.[5]

Electric motors power most plant machinery, including gearboxes, compressors, refrigeration systems, pumps, hydraulic systems, and ball mills. The following equation can determine the amount of electricity used by an electric motor:

a) **kW = V/1000 x A x 1.73** (where V is volts and A is amperes)

Both are common metric measurements of electrical current measured using a voltmeter or ammeter. For a three-phase motor, 1.73 is a standard factor. Data logging equipment is available that allows one to measure and collect data for either amperes, volts or both. Yet, most electrical consumers pay for electricity by kilowatt-hour (kWh) per month. The following formula is commonly used to determine the electrical charge per month (ECM):

b) **ECM = kW x h x EC** (where h is hours of service and EC is the electrical charge)

Air compressors are an excellent source for energy savings. Compressed air is one of the most expensive uses of energy in a manufacturing plant, and approximately 70% of all manufacturers have a compressed air system. These systems power a variety of equipment, including machine tools, material handling and separation equipment, and spray painting equipment. According to the US Department of Energy (DOE), compressed air systems in the US account for 10% of all electricity and roughly 16% of US industrial motor system energy use. This adds up to US$1.5 billion per year in energy costs and 5% in emissions. Energy audits conducted by the DOE suggest that more than 50% of compressed air systems at industrial facilities have significant energy conservation opportunities.[6]

Following are manufacturing case studies in which lubricant changes in air compressors and other plant equipment helped manufacturers reduce their electrical consumption.

Case study

A Pennsylvanian concrete casting company has a Wiggert HPGM 2250 concrete mixer driven through a planetary drive reduction box requiring an ISO 150 extreme pressure gear oil. Upon conversion to Duolec Vari-purpose Gear Lubricant, a dramatic drop in energy requirements was experienced for the mixer – the amperage dropped from 24 to 19 amps. This represents a significant energy saving of 21%.

Case study

A South Dakota wastewater treatment plant was interested in reducing operating expenses by using higher quality lubricants to achieve extended drain service and possible energy savings in three Spencer 50 hp rotary blowers, which were part of a biological contactor system. The average electrical reading was 50 amps on each of the blowers while using the current lubricant. After changing to a high-performance lubricant, the average dropped to 38 amps. Based upon electrical rates at that time, the estimated yearly savings were US$2968 per blower, or US$8904 total for all three.

Conclusion

Today, there are various reasons to reduce energy consumption, such as conserving natural resources, reducing emissions and improving profitability. Governments and corporate management in the cement industry alike are looking for ways to reduce energy consumption.

Indirect energy use, more commonly called industrial use, is greater in all regions of the world than direct or personal use. That makes industry the largest consumer of energy and, therefore, the greatest source of potential reductions. Energy use can be measured through production output, temperature changes and electrical consumption. It is possible to make dramatic gains in energy efficiency by reducing friction, and one of the best ways to do that is to employ good lubrication practices, including the use of high-performance lubricants and the adoption of lubrication reliability best practices. The key to success is finding a lubricant company that can not only provide the right high-performance lubricants for the applications but can also recommend reliability solutions that will further reduce friction and maximise the efficiency of equipment in cement plants.

References

1. ExxonMobil Corp., *Outlook for Energy: A View to 2030*, December 2009.
2. *25 Degrees in Africa*, "Correct Lubricants Save Ample Energy," accessed March 24, 2010, www.25degrees.net/index.php?option=com_zine&view=article&id=239:correct-lubricants-save-ample-energy&Itemid=81
3. HINRICHS, R. and KLEINBACH, M., *Energy: Its Use and the Environment*, Thomsen Brooks/Cole Corp., 2006
4. US Department of Energy, "Compressed Air Tip Sheet #6," August 2004.
5. Lubrication Engineers, Inc., ZAP flyer, www.le-inc.com/documents/Zap_Flyer.pdf.
6. US Department of Energy, "Energy Efficiency and Renewable Energy," accessed April 1, 2010, www1.eere.energy.gov/industry/bestpractices/compressed_air_ma.html