• Japanese Nuclear Power Plant Shares its Key Learnings

• Lubrication Routes vs. Combo PMs: Which Strategy is Best?

• Expert Tips on Selecting the Right Hydraulic Oil

The Power of CBM
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Features

12 Cover Story
The Power of CBM

We Energies, one of the nation's most progressive utilities for maintenance and reliability performance, derives great benefits from its oil analysis, vibration analysis and infrared programs. Jim Rescheske and Don Kerber (both shown on the cover) lead and guide efforts in these areas.

Features in Detail

4 As I See It
Virgin Particles and Weak Signals:
Finding Meaning in Wear Debris
When wear particle technologies and tactics are used in combination, they can expose a current or impending failure condition.

6 Viewpoint
Lube Routes vs. Combo PMs:
What's Best? What are the Issues?
Mark Barnes outlines "hybrid" PMs and the problems that they create.

8 The Exponent
Mining for Money through Energy Monitoring and Management
Drew Troyer examines the close connection between reliability and energy management.

24 Hydraulics at Work
How to Control Contamination from Hydraulic Hoses
Where you source replacement hoses from - and how they're made, cleaned and stored (prior to installation) - warrants your attention.

26 From the Field
How to Select the Right Hydraulic Oil
Picking the best product for your system requires that you collect and utilize pertinent information.

32 Case Study
Practice Makes Prefecture
A nuclear power station in Japan shares its learnings on lube storage, oil analysis and proactive strategies.

50 Perspective
Take a Breather and Learn About Headspace Management
This subject requires a focus on stabilizing the cleanliness and dryness of the environment inside a component’s casing. This task may seem simple, but it can be difficult.

52 Back Page Basics
General Guidelines to Starting an Electric Motor Lube Program
Jeremy Wright details effective strategies to minimize the likelihood of failure modes in rolling-element bearings.
Auto Exec Shares Lessons Learned, Keys to Succeed

Attendees of Noria’s RELIABLE PLANT 2009 conference, held earlier this month in Columbus, Ohio, received expert analysis on the state of manufacturing, the health of the auto industry and the future of uber-role model Toyota during a keynote address and interactive session presented by Mike DaPrile.

DaPrile, a 47-year auto industry veteran, recently retired from his role as vice president of manufacturing and operations support at Toyota Motor Manufacturing North America. Prior to his 22 years as an executive with Toyota, he spent 25 years as a manager and senior manager at General Motors. In “retirement”, DaPrile will retain his role as chief operating officer and executive vice president at Shiroki-North America, a position he has held for several years as part of Toyota’s supplier executive exchange program. He is also considering an offer from the University of North Florida to serve as an educator and consultant for its manufacturing programs.

At RELIABLE PLANT 2009, DaPrile shared his views and opinions on a host of topics.

On the most important career lesson he’s learned: “At Toyota, I learned that I had to leave my ego at the door. I made a lot of mistakes initially by thinking that I knew it all. One of the biggest blockages or barriers is people’s egos. They think they know more than the people doing the job. What I learned to do was learn from the team members.”

On the role of plant-floor employees: “I really care for the team member. As a matter of fact, that has been a point that many people have brought up throughout my career. They thought that maybe I was too overly focused on the team member and not focused enough on the management side.”

On how upper management can either enable or derail success: “General Motors has been good to my family – my dad worked there 40 years, I worked there 25, my brother worked there 20. But one of the problems GM has had is upper management and its inability to give team members the responsibility to do what needs to be done. I think GM’s middle management is some of the strongest I’ve ever been associated with. They have the heart to do what needs to be done. They knew what needed to be done, but their backing was not quite there.”

On the auto industry’s plight: “I think it will be 2013 before the auto industry gets back to where it should. I think GM will come back stronger, but smaller. I think size has been one of their biggest problems. They were working so many plants at half capacity instead of working fewer plants at full capacity. They couldn’t build a car and a truck back to back in the same plant. Until they can learn how to do that, they are going to have problems.”

On Toyota’s future: “The biggest strength is to know your weakness. Toyota has discovered its weaknesses through this ordeal over the past year-plus. The old weaknesses will now become the company’s strengths. One thing about Toyota is that they learn.”

- Paul V. Arnold, editor-in-chief
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Virgin Particles and Weak Signals: Finding Meaning in Wear Debris

I often mention the wear debris universe when I lecture on oil analysis topics. This refers to the extensive array of wear particle technologies and tactics that can help reveal the true tribological condition of a machine. Individually, these tools are often inconclusive when it comes to identifying the source, cause and severity of abnormal wear conditions. They may not even be able to identify the problem at all. Yet when used in combination, they can expose a vivid image of a current or impending failure condition.

A skilled analyst should be well aware of the strengths and weaknesses of these technologies and tactics. Not all of these tools need to be at your fingertips, but nonetheless should be available when called upon. Too often, an inexperienced technician will attempt to draw a premature conclusion from little more than a sliver of information in the wear debris universe. Examples might be a muted iron trend from elemental data or stabilized ISO codes from particle counting. Used alone, these technologies might telegraph to the diagnostician the erroneous appearance of machine health (or disease). Unseen may be an incipient but serious wear condition in need of attention.

Common front-line technologies used for screening purposes include ferrous density analysis, elemental spectroscopy, particle counting and patch testing. Collectively, these technologies pack a powerful punch and are credited with scores of predictive maintenance "saves". However, in a high percentage of cases, these technologies would not have earned their hero status if it weren't for the other tests and methods that peered deeper into the core of the problem. These include secondary sampling points, filter debris inspection, magnetic plug analysis, sump sediment analysis, SEM-EDS, XRF, ferrography (all methods), acid-dissolution spectroscopy, particle heat treatment, particle impaction testing, chemical microscopy, digital shape profiling, percent of large ferrous particles, rotrode filter spectroscopy, TGA, gravimetric analysis, ultracentrifuge (separation of soluble metal fraction), and the list goes on.

In Search of the Pin Drop

We all know that when diseases are caught early, they frequently can be remedied without long-term consequences. The key is early detection and swift corrective measures. The same is true with lubricants and machinery. In fact, for the lubricant analyst, ignoring the information potential of early detection could border on maintenance irresponsibility. While the previously mentioned screening technologies are essential to this strategy, much more is needed for vigilant and comprehensive early stage fault detection.

One of the keys to this is the weak signal, also known as the "pin drop". Don’t wait until problem trends shout the need for an unscheduled outage or repair. Instead, search for the quieter weak signal that doesn’t demand urgent downtime to remove the root cause and remediate the problem. By this, I’m not referring to proactive maintenance but rather incipient-stage predictive maintenance. Instead of catching a problem hours or days before a catastrophic event, the fault is red-flagged months earlier without costly business interruption.

Common strategies for detecting weak signals include:

- **Frequent sampling** – Frequent sampling enables data to be reported earlier in the failure-development period.
- **Downstream sampling** – By sampling downstream of the wear-generating source and upstream of filters and reservoirs, the data is not stripped by filtration or muted by dilution.
- **Clean oil** – Clean oil strengthens the signal-to-noise ratio. Without the background noise of dirty oil, even the weakest signals sometimes can be detected.
- **Tight cautionary limits** – Set your cautionary limits on key parameters sufficiently low to direct attention to a potential weak (but important) signal for further inspection.
- **Bundle trend plots** – By combining several trend plots, even subtle data inflections can become more pronounced. Individually, they might go unnoticed, but when two, three or even four trend lines move in lockstep, you have the equivalent of a strong signal that needs immediate attention.

Seeking the Virgin Particle

Visual inspection of particles is always important to expanding the informational wear debris universe. There are various methods...
for doing this, but glass slide and patch ferrography are the most common. Success is often more about searching for the right particles to analyze than trying to interpret the meaning and identity of particles found in the routine sample pulled from a primary sampling port.

Too often, the primary sampling port only possesses the weak signal, but more revealing and comprehensive information must be sought out and found somewhere else for diagnostic purposes. What we’re looking for are freshly minted and unadulterated particles. These are the particles in their original size and shape as produced from their generating source (bearing, gear, cam, etc.). Older particles can become nearly impossible to recognize because they have been “reworked” by the machine and its environment through crushing, laminating or corrosive action. This can render the wear mode and location nearly impossible to recognize.

The best places to find virgin particles are used filters, sump sediment, magnetic plugs, chip collectors and similar sources. For circulating systems with high-capture filters, any particle larger than the mean pore size of the filter might represent a virgin particle (when sampling upstream of the filter). While the number of these particles may be few, their appearance and composition could be highly meaningful.

In sum, take wear debris analysis to another level by digging deep to expand your wear debris universe. Leverage contract specialty laboratories to provide analytical capabilities needed only “on exception”. Develop new in-house skills and tactics that enable weak signals to be detected and virgin particles to be found and analyzed. {

About the Author

Jim Fitch has a wealth of “in the trenches” experience in lubrication, oil analysis, tribology and machinery failure investigations. Over the past two decades, he has presented hundreds of lectures on these subjects. Jim has published more than 200 technical articles, papers and publications. He serves as a U.S. delegate to the ISO tribology and oil analysis working group. Since 2002, he has been director and board member of the International Council for Machinery Lubrication. He is the CEO and a co-founder of Noria Corporation. Contact Jim at jfitch@noria.com.

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Lube Routes vs. Combo PMs: What’s Best? What are the Issues?

MARK BARNES
NORIA CORPORATION

It’s efficient, effective and cuts down on paperwork by having just one work order for tens or even hundreds of tasks. The key here is “ideal world” – few if any of us live in this utopia, which causes some very real problems when it comes to executing what I tend to call “macro” lube routes.

First, let’s talk about management of change. Let’s assume that you want to change the frequency of one or more of the tasks on a route. To do this properly, the only option is to go back into our routes and refactor the lube routes, moving the task(s) with the new frequency to a different route. Or, how about changing the task details (i.e. lubricant type or quantity of grease), which I wrote about in Part 1 of this series. Again, we must delve into the route and edit the work instructions. In reality, this rarely happens, causing a deviation from optimal lubrication over time.

The next issue with macro routes is the addition or subtraction of machines. I recall one plant where only 80 percent of machines were on its lube routes because the addition and subtraction of machines over time had rendered the routing obsolete. Just like changing detail or frequency, any addition or subtraction of machines requires us to edit the route. And since many machines have several different tasks on different routes, we must edit not just one but several routes at once. Again, few plants take the time to modify the routes, resulting in work either being missed or performed at a suboptimal interval.

The final issue is with the tracking of lube PM compliance. With a macro route (one work order for many tasks), if we miss just one task, we’re faced with an impossible conundrum: Close out the work order because we completed 99 of the 100 tasks, or leave the work order open until the last task can be completed. In reality, most would choose to close out the work order – after all, 99 out of 100 isn’t bad, right? The issue is that the incompletion of one task is usually due to a systemic problem. For example, the machine was not running but needed to be for completion of the task, or vice versa. It’s not at all uncommon to find machines that simply haven’t been lubricated in plants for this reason.

What’s required to resolve all of these problems is a more dynamic approach to lube routing. With dynamic routing, instead of compiling a list of tasks up front (including tasks details, area,
lube points, etc.) and saving this in perpetuity as a "lube route", we should generate routes on demand. Whenever the work order system generates the work request, our knowledge management system compiles a list of machines and tasks that match the lube route criteria (currently due, same task, same area, etc.) on demand. The advantage is that any change in the underlying data (change in lubricant, addition of a new machine, change in task frequency) results in an automatic modification to the lube route to reflect the plant's current reality.

**Combination PMs**

The second most common method of aggregating lube tasks is the “combination PM”. In this mode, different maintenance tasks (lubrication, mechanical inspections, electrical checks, adjustments, time-based component replacements, vacuum and steam checks, etc.) are combined into one PM for a single machine or group of machines.

Some of the same problems apply to the combination PM as to the lube route. Any change in a single task frequency requires a complete refactor. But now, refactoring affects more than just the lubrication schedule. And with combination PMs often tied to production schedules, the barrier to “do the right thing” is so great that it is almost impossible to adjust the “ideal world” combination PM. This can and does result in suboptimal lubrication and, for that matter, suboptimizes other maintenance tasks.

Combination PMs also require greater depth of skill and knowledge in our maintenance team. Now, instead of handing off a lube PM to a qualified lubrication technician, we require a multi-craft person with skills in many different disciplines. And while this can work, more often than not, we see suboptimal performance due to a lack of knowledge, lack of training or insufficient task details issued with the work order.

Just like lube routes, many of the issues surrounding combination PMs can be resolved with a dynamic approach to work planning, whereby pertinent task details are compiled “on the fly” vs. in a hard document. Where this is done, combination PMs can work for lubrication, although personally I do not like to see combination PMs for lubrication unless accessibility or geography make different PM plans impractical.

In the third and final part of the series, I’ll talk about knowledge logistics: getting the right information into the hands of the people that need it – the technicians performing the task.

As always, this is my opinion; I’m interested to hear yours.

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*About the Author*

As a skilled educator and consultant in the areas of oil analysis and machinery lubrication, Mark Barnes has helped numerous clients develop effective machinery lubrication programs and troubleshoot complex lubrication problems through precision lubrication and oil analysis. As vice president of Noria Reliability Solutions, Mark and his group work on projects in the areas of: plant audits and gap analysis, machinery lubrication and oil analysis program design, lube PM rationalization and redesign, lubricant storage and handling, contamination control system design and lubrication, and mechanical failure investigations. Contact Mark at mbarnes@noria.com.
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**

<table>
<thead>
<tr>
<th>Horsepower (HP)</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load Factor</td>
<td>80%</td>
</tr>
<tr>
<td>Kilowatts (kW)</td>
<td>119.36</td>
</tr>
<tr>
<td>Hours Used</td>
<td>8,000</td>
</tr>
<tr>
<td>kW Hours Consumed</td>
<td>954,880</td>
</tr>
<tr>
<td>Cost per kW Hour</td>
<td>$0.06</td>
</tr>
<tr>
<td>Annual Energy Cost</td>
<td>$57,293</td>
</tr>
<tr>
<td>Energy Consumption Reduction Target (%)</td>
<td>10%</td>
</tr>
<tr>
<td>Projected Annual Energy Cost Savings</td>
<td>$5,729.28</td>
</tr>
</tbody>
</table>

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,
at the Least Energy Cost

- 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

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Here again, the loss of energy compromises wear mechanism often referred to as “fluting.” Also can lead to electrical discharge erosion, a result of stray current, the high buildup of potential energy. The motor itself can be compromised. In the case of resonance, you're literally paying for the energy 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.

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 are 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.

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.

Catch Drew on the Road

Make plans now to attend Drew Troyer’s upcoming seminar, “Plant Reliability in Dollars & Sense”, being held December 1-2 at the Wigwam Golf Resort and Spa in suburban Phoenix. To learn more, visit www.noria.com and click on the Training link at the top of the home page.
In the food processing industry, having lubricant performance and safety concerns hold up productivity is a little hard to swallow. That’s why we created the Mobil SHC Cibus Series, a range of NSF-H1 registered synthetic food machine lubricants that are designed not only to protect your food processing machinery, but also your brand. And that’s an idea that’s easy to digest. We don’t just make industry run, we make it fly. Visit www.mobilindustrial.com for more.
Do you have the energy to continuously pursue maintenance and reliability best practices? Do you have the power to make that happen? If you answered “no”, can you afford not to?

We Energies has earned a reputation as one of the most progressive utilities in the nation when it comes to maintenance and reliability. As condition-based maintenance (CBM) champion Don Kerber tells it, “I started working here in 1979, and predictive, preventive and proactive strategies were utilized then. They were there before I came, and I can say without a doubt that they will be here long after I retire.”

Given that history, it’s not surprisingly that We Energies (the trade name of Wisconsin Electric Power Company and Wisconsin Gas LLC, an entity whose 26 power plants have a peak generation capability of 5,676 megawatts) has won the ReliabilityOne award for the Midwest region five out of the last seven years. The accolade, given by a major utilities industry consulting group, recognizes superior system reliability. Similarly, We Energies’ 1,210-megawatt Pleasant Prairie (Wis.) Power Plant is generally acknowledged as among the country’s best coal-based plants when it comes to overall productivity.

“The recognitions are kind of a pride thing, but this isn’t a race. There is no finish line,” says Jim Rescheske, a corporate predictive maintenance specialist who has been with the utility since 1978. “Our program is continually evolving, and it always will be so. New technologies, new ideas, new methods are continually being added.”

Vibration analysis. Infrared thermography. Oil analysis and lubricant optimization. Acoustic ultrasound and ultrasonic testing. Each is a part of We Energies’ past, present and future.
Roots of Oil Analysis

Kerber and Rescheske admit that oil analysis is not the most developed maintenance tool in We Energies’ arsenal, but that’s understandable when you compare it with vibration analysis, which has a long and storied history at the plants.

“A few months after I hired on, 31 years ago, an engineer I was working with bought a little vibration analyzer,” says Rescheske. “From that point on, I grabbed that technology and flew with it.”
Dave Groshek, the vibration lead person at the Pleasant Prairie Power Plant in the southeast corner of Wisconsin, provides his own anecdote. “From the day this plant was built in 1980, we’ve had a vibration program in place. We still have a cabinet full of old Scientific Atlanta cards. I could go back and find vibration data from 1980.”

The company also has utilized acoustic ultrasound for 15 years and infrared thermography for more than a decade.

Oil analysis is a little brother to vibration analysis in We Energies’ PdM history, but it can stand tall. Its roots within the company go back nearly 20 years, when samples were drawn from major pieces of equipment and analyzed at either the corporate laboratory in downtown Milwaukee or by the main lubricant supplier, Mobil, at its own labs. But back then, the process was less proactive in nature and wasn’t always about finding the root cause of issues.

“We’d get the samples, send them out, and if they came back with a recommendation that the oil sample may be contaminated, we’d change the oil,” says Groshek.

Oil analysis and lubricant health gained greater emphasis when We Energies ushered in a formal CBM program for its Fossil Operations (coal-based power plants) in mid-1994. “We concluded that predictive achievement wasn’t going to be defined by a single tool,” says Kerber. “This was about coordinating the plants in
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a standard direction and about maximizing all that we had or could have at our disposal."

To achieve common direction and purpose, the CBM reporting structure in Fossil Operations was drawn up to include:

- a champion (Kerber);
- plant-based CBM coordinators who work with the champion;
- corporate (based in Milwaukee) CBM technical coordinators for vibration, thermography, oil and acoustics who report to the champion; and,
- CBM technical leads (for vibration, thermography, oil and acoustics) at each plant who communicate with the plant and the technical coordinators.

Plant leads and technical coordinators are aligned by CBM tool, thus creating four teams: Shake, Rattle and Roll (vibration), Thermography Dudes (thermography), OPEC (oil), and Rattler and Leaker Seekers (Acoustics).

**Oil Minister and Oil Czars**

Today, machinery lubrication and oil analysis is about making the best decisions. As is the case with the other CBM tools, that starts with subject matter experts.

Mike Finco was installed as the oil coordinator (or “oil minister”, as he’s listed in the organization chart). In this position, he is responsible for ensuring progress is being made to quality and performance goals established by Kerber and the plant CBM coordinators. He provides oversight and support to the oil leads (or “oil czars”) at each of the plants, determines training needs and works to establish standard practices.

“On a regular day, Mike may be working to standardize oil sampling methods and getting that information to the plant level,” says Kerber. “Or, if we are putting in a new piece of equipment at a plant, he would decide how often they should sample and what the criteria should be for acceptance and non-acceptance.”

Oil czars focus on the technical needs of their particular plant. One to three oil czars may be found at a plant.

“They take the data from an oil analysis report and determine what we need to do from that,” says Kerber. “If they have a cooling tower fan motor that has high metals, they are the ones that decide what to do with it. If they see moisture in it, they are the ones that

**Investing in Education and Certification**

We Energies has a history of supporting maintenance certification. It’s practiced and it’s preached.

Jim Rescheske, a corporate-based predictive maintenance specialist, holds Level III certifications in vibration analysis and infrared thermography.

Other examples:

- Dave Groshek, a vibration lead person at the Pleasant Prairie Power Plant, is Level III certified in vibration.
- Don Leiting, thermography lead at Pleasant Prairie, is Level II certified in that technology.
- Also, oil czar Sue Sorelle is a certified Level I Machine Lubrication Technician.

“As the technology coordinator, I set up many training classes over the years,” says Rescheske. “I’ve brought in a bunch of vendors to put on Level I, Level II and Level III courses. We have many people around the company who are Level I certified – mainly in vibration and infrared, but we have gotten more interested in programs related to lubrication and oil analysis.”

- CBM technical leads (for vibration, thermography, oil and acoustics) at each plant who communicate with the plant and the technical coordinators.

We Energies maintenance veteran Todd Maki (at left) checks on the health of a machine.
are going to ask for the filter cart to be put on. If it continues, they are the ones that will look for the source of the moisture. Do I need a breather or is the breather shot? They determine what the plant needs to do and make that recommendation."

**Signed on to Signum**

Smart oil decisions also are the product of a good work process.

Gone are the days of samples taken primarily after issues surface or breakdowns occur. No longer is “dump the oil” the final or fallback action.

Current practices were established four years ago after the company subscribed to Mobil’s Signum Oil Analysis program.

“We have standardized on that at most of our facilities,” says Kerber. “We have set up standard sample rates – periodic, monthly, quarterly. We submit samples to Mobil and have them do the analysis. The results come back to key people at the plants. The whole process was that it is automated on our end. We have one group that is responsible for determining what samples need to be taken. They print the labels, label the bottles and take them to the teams that take the samples. The teams look and see that their crate is filled with empty sample bottles; that means they have to go out and do rounds. They take samples and deliver the filled crate to the mailroom. The mailroom is responsible for packing them up, putting on the pre-made label and sending them out.

“That has really helped out in getting samples taken, shipped and analyzed. That process is working pretty good across most of our facilities.”

We Energies’ internal lab in Milwaukee does handle spindle- and turbine-related oil samples required for insurance purposes, performs spectrographic analysis on occasion, and is called upon for emergencies or when analysis results are required within 24 hours (instead of the standard three- to four-day service through Signum). But since this lab also analyzes everything from process water to environmental-related samples, use of its services is the exception rather than the rule.

“Mobil is our exclusive provider of oil, so we get a lot of free samples or samples at low cost,” says Rescheske. “It’s usually more cost-effective to send our samples out.”

Oil czars pore over analysis results to determine appropriate action steps and, if necessary, lead activities to determine the root cause(s) of anomalies.
Oil + Vibration + IR = Success

As Kerber stated earlier in this article, predictive achievement doesn’t come through a single tool. The strength of CBM is apparent when two or more technologies are used in concert.

For instance, using acoustic ultrasound while greasing motor bearings ensures correct, precise preventive maintenance.

Merging technologies also can confirm or refute a possible mechanical issue.

If an oil analysis report shows an emerging issue such as rolling element wear, a vibration lead may be called to perform a signature analysis on the equipment in question. A thermography lead also may join in and take a temperature reading. Trend reports may be accessed from the computerized operating data historian to compare the present state with past data.

“All of this will be done while the equipment is running,” says Pete Agerholm, the oil czar at Pleasant Prairie. “The last thing we want to do is get a mechanic to come in here and tear this piece of equipment apart, which impacts uptime and cost.”

CBM actions can deliver “saves” and savings.

“We had a problem with our circulators and started picking up higher vibration levels,” says Agerholm. “The last thing we want to do is get a mechanic to come in here and tear this piece of equipment apart, which impacts uptime and cost.”

CBM actions can deliver “saves” and savings.

Showing the Value

Savings can be substantial. Kerber and Rescheske state that CBM efforts logged more than $1 million in savings in each of the first several years of the program.

“However, we quit tracking dollars in 1996 because we were losing too much wrench time filling out paperwork to figure out what the saves were,” says Rescheske.

On top of that, they say, top management had been and still is a firm believer in the power of CBM.

Finally, as a CBM program matures, save totals (should) become smaller since there is less and less low-hanging fruit.

That doesn’t mean that company employees aren’t apprised of the program’s value. Kerber publishes “CBM Technology Saves”, a newsletter that provides case studies of noteworthy saves. Photos, lab data, screen shots, etc., help tell the story that CBM makes a difference.

One case study explained how effective use of oil analysis identified issues with a fan outboard bearing and a cooling line. Early identification prevented a boiler from potentially going off line, and required maintenance was performed during a scheduled outage.

In another example, significant gouging was found on fan bearings. Oil analysis provided insight into the root cause of the problem – believed to be contaminant ingress to the bearing housing from air flowing over the fan bearing housing into the fan suction. To rectify the issue, gearing seals were replaced with a contaminant-excluding design.

“I send the newsletter out to all Fossil Operations management. It goes to headquarters and to the plants,” says Kerber. “I ask them to share it with their own crews. Since our plants have very similar equipment, what is learned at one site is applicable to the others. The president of the company reads them. In fact, he recently asked me, ‘You’re going to write a few more of those, aren’t you?’ He believes there is benefit in this information.”

Plant employees and fellow maintenance workers also can get an up-close and personal look at saves. Technical leads such as Groshek collect damaged components and use them as learning tools to demonstrate failures and root causes.

Big Train Coming

Learning and education are exceptionally important for any organization, but it is even more so for maintenance at We Energies.
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HY-PRO
FILTRATION
The company has, as previously stated, a long history of progressive practices. That is a plus.

Continuous improvement is engrained in the culture. That’s another plus.

The company has a wealth of talented employees. Big plus.

But, the average age of the maintenance workforce is nearing 55, and a sizeable percentage of workers will soon be eligible for retirement. That’s a potential minus.

We Energies is addressing that proactively by greatly expanding its training center in suburban Milwaukee. This summer, Rescheske moved out of his role as the corporate coordinator of vibration analysis, thermography and acoustics and accepted a leadership role as a corporate maintenance trainer.

“Within a year, we will have lots of new maintenance classes because we realize that many senior, knowledgeable people will be leaving,” he says. “The focus of the training will be on the new employees and then branch into training new supervisors.”

Training in machinery lubrication-related topics will undoubtedly be on the docket. In the future, Rescheske says the center might host certification courses for budding lubrication technicians and lubricant analysts.

A primary goal is to have a cadre of maintenance workers trained and perhaps certified in multiple predictive/CBM technologies.

The Next Breakthrough

In assessing the components of We Energies’ CBM program, Rescheske provides the following ratings on a 1 (beginner) to 10 (best practice) scale:

- Vibration analysis – 7 (he gives Pleasant Prairie a 10)
- Oil analysis – 7 (Pleasant Prairie gets an 8)
- Thermography on electrical components – 9.5 (Pleasant Prairie gets a 10)
- Acoustic ultrasound – 1 (everyone is still learning how to apply and maximize this technology)

As witnessed here and in the previous section, challenges and opportunities do lie ahead. As a result, We Energies is far from done and far from satisfied.

“We aren’t there yet, and we know it,” says Kerber. “There’s always room for improvement. For example, one of the things that we want to do for training and everyday use is catch the acoustics, catch these sounds, so people can play them. This is what a bad bearing sounds like. This is what a dry bearing sounds like. This is what an overstuffed bearing sounds like.”

Adds Rescheske: “We’ll constantly be looking for what’s on the horizon. What can we learn from it and what can we implement? Technology is always changing and evolving. We learn about newer and faster ways. I’m waiting for my iPod Touch to be connected to a vibration pen instead of that big, bulky, 12-year-old data collector. That’s the next technological breakthrough. Stuff like that will be commonplace in the next few years.”

This type of work is definitely not for those who have a hard time with commitment. It requires energy, as well as a considerable amount of power and influence. Are you up to the challenge? Are you ready to be like We?
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Karl Fisher Moisture Meter

The new Grabner MINIHYD Karl Fisher (KF) moisture meter from AMETEK Petrolab determines the water content of crude oil, petroleum products, liquids, gases and powders. It uses an absolute technique that gives accurate results on water content within minutes without requiring the calibration of reagents. The unit conforms to industry standards such as ASTM D 1533, ASTM D4928, ASTM D6304, IP 386, IP 438, IEC/BS EN 60814, API MPMS Chapter 10.9, ISO 10101-3, ISO 10337 and ISO 12937.

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WD-40 Trigger Pro is a non-aerosol product with the same WD-40 formula. WD-40 Trigger Pro features an easy-to-hold ergonomic can and a multi-action nozzle that allows you to spray product as a wide spray or stream, with no overspray or leaking. Designed for on-the-job versatility, its trigger format gives you more control – a few drips at a time for drilling and cutting, or more for spraying down large surface areas. It is also easy to dispose of due to its non-aerosol format and recyclable steel packaging.

WD-40 Company
www.wd40.com/products/trigger-pro/
888-324-7596

Absorbent Drip Pan

The new Oil Eater absorbent drip pan is designed for leaks that are too large for an absorbent pad or that occur in tight spaces such as under machinery or pipes. The drip pan is made of sturdy plastic and houses an eco-friendly absorbent pillow made of plant fibers and other reusable resources. When soiled, the pillow is easily removed and replaced with a new one. The drip pan measures 10 inches x 12 inches x 4 inches.

Kafko International
www.oileater.com
800-528-0334

Lube Decisions Mini-Disc

Can you save money by automating your lubrication? The Sound Money Decisions mini-disc, a new tool from MEMOLUB, can tell you. It’s simple to use, quick and it’s free. Simply enter a few variables that describe your situation and this financial model will give you the answer. You can change the numbers to best describe different areas of your plant and get the answers for each operating area.

MEMOLUB / PLI LLC
www.memolub.com
costsavings@memolub.com

Ultrasonic Detection Software

UE Systems, developer of the Ultraprobe 10,000 digital ultrasound inspection system, introduced the improved Spectralyzer 4.0, a diagnostic software tool that converts PCs into a fully functioning Fast Fourier Transform (FFT) analyzer. The 4.0 features new analytics and reporting capabilities that improve the diagnostic process. Functions include the ability to customize graphs and save parameters, customized backgrounds for easier printing, and annotations for easy-to-pick anomalies.

UE Systems Inc.
www.uesystems.com
800-223-1325

Turbine Oil Products

To address increasing performance demands on modern turbines and provide a proactive solution to new cleanliness and varnish concerns, ConocoPhillips enhanced its baseline Turbine Oil to offer a TOST (Turbine Oil Stability Test – ASTM D943) rating of 15,000 hours as opposed to the previous 7,500 hours. The company also introduced Ultra-Clean Turbine Oil featuring a guaranteed cleanliness level of ISO 18/16/13 and a TOST rating of 15,000 hours.

ConocoPhillips
www.conocophillips.com
281-293-1000

Ultrasonic Detection Software

UE Systems, developer of the Ultraprobe 10,000 digital ultrasound inspection system, introduced the improved Spectralyzer 4.0, a diagnostic software tool that converts PCs into a fully functioning Fast Fourier Transform (FFT) analyzer. The 4.0 features new analytics and reporting capabilities that improve the diagnostic process. Functions include the ability to customize graphs and save parameters, customized backgrounds for easier printing, and annotations for easy-to-pick anomalies.
**Food-Grade Lubricants**

Summit Industrial Products recently introduced a food-grade version of its popular Syngear PG Series lubricants. The polyglycol-based Syngear PG-F series is recommended for enclosed gears, bearings and compressors operating in areas where incidental food contact is possible. It is an NSF H1 and ISO 21469 certified food-grade lubricant which comes in ISO grades 150, 220, 320, 460 and 680. These lubricants provide better wear protection when compared to traditional petroleum-based lubricants.

Summit Industrial Products
www.klsummit.com
903-534-8021

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**Machinery Health Transmitter**

Emerson extended the monitoring capabilities of its CSI 9210 Machinery Health Transmitter. The CSI 9210, which monitors vibration, temperature and speed on machine trains, can now be applied more extensively to plant and mill rotating machinery, including motors, fans, cooling tower fans, pumps and compressors. A component of PlantWeb digital plant architecture, the smart transmitter analyzes the health of mechanical equipment through predictive diagnostics to improve availability and performance.

Emerson Process Management
www.emersonprocess.com
800-833-8314

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**Cinch-Action Drum Holder**

The MORcinch drum holder from Morse features a unique “cinching action” that adjusts to the vast majority of drum diameters, holding drums more securely than other designs. MORcinch embraces nearly the entire girth of drums, evenly distributing the weight to maximize security of the grip and minimize stress points that can cause drum sidewall damage. The product works with a variety of Morse drum handlers, from floor and high-lift models to lift-truck attachments and below-hook products.

Morse Manufacturing Company Inc.
www.MORSEmfgco.com
315-437-8475

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**Oil Purifier, Water Remover**

The Compact Oil Purification System (COPS) from ARGO-HYTOS removes large quantities of free water from oil quickly and economically. COPS heats the oil, which is then channeled into a vacuum chamber, where the water is removed. The oil is then passed through a 5-micron filter, ensuring that clean, dry oil is returned to the hydraulic system. Water content is constantly monitored with the LubCos H2O water sensor. COPS removes 900 milliliters of water per hour at a flow rate of 10 liters per minute.

ARGO-HYTOS Inc.
www.aro-hytos.com
419-353-6070

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**Oil Condition Monitor System**

IntelliStick is a patented, real-time intrusion detection and oil condition monitoring system that continuously reports vital information in mission-critical engine parts. It continuously scans for water, fuel and coolant intrusion, reports and graphs oil condition, and triggers alarms based on customer specifications, for increased uptime and productivity. IntelliStick/TS is available for condition-based oil monitoring in engines, gearboxes, turbines and compressors in remote locations as well as local sites.

IntelliStick Inc.
www.intellistick.com
888-812-5988

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**Infrared Thermometers**

The Omega OSS30LE-W9 series of handheld infrared thermometers provides performance at an affordable price. This product line’s built-in wireless measurement makes it the first of its kind. With a combination of powerful features, this portable and rugged series offers solutions for many temperature measurement applications. The built-in laser sighting is switchable between laser dot and circle patterns. It measures temperature ranges from -23 to 871 degrees Celsius (-10 to 1,600 Fahrenheit).

Omega Engineering Inc.
www.omega.com
888-826-6342
The need for hose replacement is a fairly common occurrence on hydraulic machines. Hydraulic hose fabrication is a big business with plenty of competition and more than a few cowboys running around. So if you own or are responsible for hydraulic equipment, where you source replacement hoses from, and how they’re made, cleaned and stored – prior to installation on your machine, warrants your attention.

The hose fabrication process – or more specifically, the hose cutting process – introduces contamination in the form of metal particles from the hose’s wire reinforcement and the cutting blade itself, and polymer dust from the hose’s outer cover and inner tube.

The amount of contamination which enters the hose during cutting can be reduced by employing techniques such as using a wet cutting blade instead of a dry one, blowing clean air through the hose as it is being cut and/or using a vacuum extraction device. The latter two aren’t very practical when cutting long lengths of hose from a roll or in a mobile hose-van situation.

Therefore, the main focus must be on effectively removing this cutting residue – and any other contamination which might be present in the hose – prior to installation. The most efficient and, therefore, most popular way of doing this is by blowing a foam cleaning projectile through the hose using a special attachment connected to compressed air. If you are not familiar with this equipment, do a search on Google for “hydraulic hose projectile”.

The manufacturers of these cleaning systems claim that hose cleanliness levels as good as ISO 4406 13/10 are achievable. But like most everything else, the results achieved depend on a number of variables, which include using a projectile of the correct diameter for the hose being cleaned, whether the projectile is used dry or wetted with solvent, and the number of shots fired. Generally, the higher the number of shots, the cleaner the hose assembly. Furthermore, if it is a new hose that’s being cleaned, the projectile cleaning should be done before the ends are crimped on.

Hose Horror Stories

Almost all hydraulic hose fabricators these days have and use hose cleaning projectiles; but how meticulous they are when doing it is another matter entirely. This means if you want to ensure you take delivery of hose assemblies to a certain standard of cleanliness, it’s something you must specify and insist upon, as the
following account from a heavy equipment mechanic demonstrates:

"I was changing some hoses on a Komatsu 300 HD for a customer, and he noticed me washing out a hose before I put it on. So, he asked: 'They clean 'em when they make 'em, don't they?' I said, 'Sure, but I like to check.' I took the caps off a new hose and washed it with solvent and emptied the contents into some paper towel as he watched. His response was 'holy (expletive).'

And it’s not just the standard of the cleaning which must be insisted upon. A few years back, I was at a client's premises when its hose supplier arrived to deliver a big supply of hose assemblies. When the pallet came off the truck, it was obvious to anyone with eyes that none of the hoses were capped to prevent contaminant ingestion. And, the customer accepted them. Nuts. As soon as I saw what was going on, I advised my client to require all hoses be delivered with caps installed and not to accept them otherwise.

**Abrasion and Bending**

This sort of penny foolishness should not be tolerated from any hose fabricator. And, it's definitely not something to be laissez-faire about, either!

When it is time to install a replacement hose, other than ensuring it's clean, pay careful attention to routing, ensure all clamps are secure and tight, and if necessary, apply inexpensive polyethylene spiral wrap to protect the hose from abrasion.

Hydraulic hose manufacturers estimate that 80 percent of hose failures are attributable to external physical damage through pulling, kinking, crushing or abrasion of the hose. Abrasion caused by hoses rubbing against each other or surrounding surfaces is the most common type of damage.

Another cause of premature hose failure to be on the lookout for when replacing a hose is multi-plane bending. Bending a hydraulic hose in more than one plane results in twisting of its wire reinforcement. A twist of 5 degrees can reduce the service life of a high-pressure hydraulic hose by as much as 70 percent, and a 7 degree twist can result in a 90 percent reduction in service life.

Multi-plane bending is usually the result of poor hose-assembly selection and/or routing, but also can occur as a result of inadequate or insecure clamping where the hose is subjected to machine or actuator movement.

Paying attention to these often-overlooked details will not only ensure replacement hoses aren’t responsible for contaminant ingestion and possible collateral damage to the hydraulic system they become part of, they’ll last the way they should, too!

**About the Author**

Brendan Casey has more than 20 years experience in the maintenance, repair and overhaul of mobile and industrial hydraulic equipment. For more information on reducing the operating cost and increasing the uptime of your hydraulic equipment, visit his Web site, [www.InsiderSecretsToHydraulics.com](http://www.InsiderSecretsToHydraulics.com).
How do you know if you’re using the right hydraulic oil?

For most lubricated machines, there are plenty of options when it comes to lubricant selection. Just because a machine will run with a particular product doesn’t mean that product is optimal for the application. Most lubricant mis-specifications don’t lead to sudden and catastrophic failure, but rather they shorten the average life of the lubricated components and, thus, go unnoticed.

With hydraulics, there are two primary considerations – the viscosity grade and the hydraulic oil type. These specifications are typically determined by the type of hydraulic pump employed in the system, operating temperature and the system’s operating pressure. But it doesn’t stop there. Other items for consideration are: base oil type, overall lubricant quality and performance properties.

A system’s requirements for these items can vary dramatically based on the operating environment, the type of machine for which the unit is employed and many other variables.

Selecting the best product for your system requires that you collect and utilize all available information.

Pumps and Viscosity Requirements

Let me start by outlining the No. 1 lubricant selection criteria: pump design types and their required viscosity grades. There are three major design types of pumps used in hydraulic systems: vane, piston and gear (internal and external). Each of these pump designs are deployed for a certain performance task and operation. Each pump type must be treated on a case-by-case basis for lubricant selection.

Vane: The design of a vane pump is exactly what its name depicts. Inside the pump, there are rotors with slots mounted to a shaft that is spinning eccentrically to a cam ring. As the rotors and vanes spin within the cam ring, the vanes become worn due to the internal contact between the two contacting surfaces. For this reason, these pumps are typically more expensive to maintain, but they are very good at maintaining steady flow. Vane pumps typically require a viscosity range of 14 to 160 cSt at operating temperatures.

Piston: Piston pumps are your typical, middle-of-the-road hydraulic pump, and are more durable in design and operation than a vane pump. They can produce much higher operating pressures – up to 6,000 psi. The typical viscosity range for piston pumps is 10 to 160 cSt at operating temperatures.

Gear: Gear pumps are typically the most inefficient of the three pump types, but are more agreeable with larger amounts of contamination. Gear pumps operate by pressurizing the fluid between the meshing teeth of a gear set and then expelling that fluid. The two main types of gear pumps are internal and external.

• Internal gear pumps offer a wide range of viscosity choices, the highest of which can be up to 2,200 cSt. This pump type offers good efficiency and quiet operation, and can produce pressures from 3,000 to 3,500 psi.

• External gear pumps are less efficient than their counterpart, but have some advantages. They offer ease of maintenance, steady flow, and are less expensive to buy and repair. As with the internal gear pump, these pumps can produce pressures ranging from 3,000 to 3,500 psi, but their viscosity range is limited to 300 cSt.

Fluid’s Roles and Makeup

Hydraulic fluid has many roles in the smooth operation of a well-balanced and designed system. These roles range from a heat transfer medium, power transfer medium and a lubrication medium. The chemical makeup of a hydraulic fluid can take many forms when selecting it for specific applications. It can range from full synthetic (to handle drastic temperature and pressure swings and reduce the rate of oxidation) to water-based fluids used in applications where there is a risk of fire and are desired for their high water content.

• A full synthetic fluid is a man-made chain of molecules that are precisely arranged to provide excellent fluid stability, lubricity and other performance-enhancing characteristics. These fluids are great choices where high or low temperatures are present and/or high pressures are required. There are some disadvantages to these fluids, including: high cost, toxicity and potential incompatibility with certain seal materials.

• A petroleum fluid is a more common fluid, and is made by refining crude to a desired level to achieve better lubricant performance with the addition of additives, which range from anti-wear (AW), rust and oxidation inhibitors (RO), and viscosity index (VI) improvers. These fluids offer a lower cost alternative to synthetics and can be very comparable in performance when certain additive packages are included.
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*Average of Shell and customer reported evaluations. Actual energy savings may vary depending on application, current oil used, maintenance procedures, condition of equipment, operating conditions and intensity of hydraulic power usage.

www.shell.com
• Water-based fluids are the least common of the fluid types. These fluids are typically needed where there is a high probability of fire. They are more expensive than petroleum but less expensive than synthetics. While they offer good fire protection, they do lack wear-protection abilities.

Application-Based Selection

Application should be the most critical attribute when selecting a hydraulic fluid in order to ensure the system’s ability to function properly and attain long life. When selecting a hydraulic fluid, it is very critical to determine the system’s needs: viscosity, additives, operation, etc.

For example, take a large dump truck that is constantly in the rain, encounters high particle contamination from road debris and leaks 10 percent of its sump volume in two days. There is no need to buy or use the most expensive fluid with the best additive package simply because of the associated cost of replenishment and the inherent lack of maintenance. On the other hand, you have a very clean, critical and highly loaded system that is maintained properly and used to its full potential. You may want to use a more premium product, such as a highly refined petroleum-based fluid with an AW or RO additive package or even a full synthetic fluid.

As far as the viscosity of the fluid is concerned, this should be determined by the pump type as previously discussed. Not having the correct viscosity for the application will dramatically reduce the average life of the pump and system, thereby directly reducing its reliability and production. When selecting the appropriate viscosity grade, look for the optimum viscosity required by the pump. This can be determined by collecting data from the pump OEM, actual operating temperature of the pump, and the lubricant properties referenced to the ISO grading system at 40 and 100 degrees Celsius.

Check the operating temperature of the pump and see if it falls between the temperature ranges of the lubricant in question. If not, you may need to increase or decrease the viscosity of the lubricant to achieve the desired, optimum viscosity.

As you can see, selecting the proper hydraulic fluid for the application is not a hard task, but it does require time to research the application, determine the resulting cost and decide which fluid type is best.

You can spend more or less money than is needed simply by not educating yourself on proper lubricant selection techniques. To practice good lubricant selection is to practice great machine performance! ML

About the Author

Stephen Sumerlin is a technical consultant with Noria Reliability Solutions, working on Lubrication Process Design Phase II projects for Noria clients. He is a mechanical engineer and a certified Level I Machine Lubrication Technician (MLT) through the International Council for Machinery Lubrication.
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More than 1,000 industrial professionals attended RELIABLE PLANT 2009, Noria Corporation’s annual conference and exhibition, held August 31-September 3 at the Greater Columbus Convention Center in Columbus, Ohio. Attendees represented companies from 42 states and 17 countries. This year’s event included five co-located trade shows:

• Lubrication Excellence
• Reliability World
• Lean Manufacturing
• Plant Energy/Sustainability
• Plant Safety

RELIABLE PLANT 2009 marked the ninth year of Lubrication Excellence, the fifth year of Reliability World and the fourth year of Lean Manufacturing, as well as the first installment of Plant Energy/Sustainability and Plant Safety.

“Many attendees commented that this was Noria’s biggest and best conference ever from a content perspective,” said Paul V. Arnold, the editor-in-chief of Noria Publishing. “The lineup of speakers provided game plans for the real-world issues that industrial pros are facing today.”

During the three main days of the conference, September 1-3, nearly 90 case studies, industry reports and training sessions were presented. Mike DaPrile, who recently retired from his longtime position of vice president of manufacturing at Toyota Motor Manufacturing North America and who has spent 47 years in the global automotive industry, provided the opening keynote address.

Lubrication Excellence presentations were delivered by leaders from: Noria, Eli Lilly, Covance, Albemarle, Kittiwake, Timken Reliability Solutions, Donaldson, Fluitec International, Reliable Process Solutions and Dave Wooton Consulting.


Lean track presentations were given by leaders from: Novelis, Kennametal, Plexus, Wausau Paper, AbitibiBowater, NSK, Johnson Screens - Weatherford International, ABB, Grainger, Auburn University, The Lean Leadership Academy, WCM Associates, Dynamic Business Solutions and Smarter Solutions.


Plant Safety presentations were given by leaders from: Texas Instruments, Worthington Industries, Ross Controls, the Occupational Safety and Health Administration, Brady Corporation, the University of Tennessee Reliability and Maintenance Center, IRISS, New Pig Corporation, Combustion Safety, AVEVA, Grainger, HR and Safety Resources, and Predictive Service.

At the expansive exhibition hall, more than 125 suppliers featured new products and industry solutions.

Workshops from Richard Palmer and Associates as well as Fuss & O’Neill Manufacturing Solutions were held on August 31. SMRP held...
testing for its Certified Maintenance and Reliability Professional certification on August 31. ICML held testing for its Machine Lubricant Analyst (MLA), Machine Lubrication Technician (MLT) and Laboratory Lubricant Analyst (LLA) certifications on August 31 and September 2.

RELIABLE PLANT 2009 was sponsored by CITGO Lubricants, COT-Puritech, Des-Case Corporation, Donaldson Company, Herguth Laboratories, HYDAC, Hy-Pro Filtration, INTERNORMEN Technology, Lubrication Engineers, MP Filtri, Schroeder Industries, Shell, SKF, Snap-on Industrial, Trico and W.W. Grainger. It was endorsed by the International Council for Machinery Lubrication (ICML), the National Lubricating Grease Institute (NLGI), the Society for Maintenance and Reliability Professionals (SMRP), the Society of Tribologists and Lubrication Engineers (STLE), and the Vibration Institute.

Noria’s 2010 conference and exhibition will be held August 31-September 2 in Nashville, Tenn. To learn more about this event as well as additional education and training events, visit www.noria.com.
Reliability is increased and equipment life is extended through practice and a continuous pursuit of best practices. That is the mind-set of Shikoku Electric Power Company. And, it is the credo of four maintenance professionals who are leading meaningful change at the company’s Ikata nuclear power plant.

The team’s work is shown in this article through its efforts to transform the Ikata plant’s lubrication storage room as well as the site’s overall maintenance strategy.

Land of Rising Uptime
Shikoku is the smallest (140 miles long and between 30 and 95 miles wide) and least populous (4.14 million residents) of the four main islands of Japan. It is located south of Honshu and east of the island of Kyushu. The Shikoku region, comprising Shikoku and surrounding islets, covers more than 7,250 square miles and consists of four prefectures (sub-national jurisdictions): Ehime, Kagawa, Kochi and Tokushima.

These prefectures depend on Shikoku Electric. Forty percent of this area’s power needs are supplied by the Ikata nuclear station. The site encompasses 9.26 million square feet and generates 2,022 megawatts (MW) of power.

With such an importance placed on this power plant, uptime and reliability must be the norm; breakdowns and chaos are unacceptable.

Storage, Filtration & Transfer
This past March, the team completed a project to revamp the plant’s lubrication storage room. It maximized space in the 861-square-foot layout by installing a multi-level rack system (from IFH Group) that houses cube-shaped storage containers. These units are tagged and identified with a color code based on content and plant application. See-through gauges allow maintenance personnel to examine oil condition and the amount of oil remaining in the container. Desiccant breathers and a unique dispensing port under the rack were also installed.

Also implemented were Des-Case “drum topper” units that act as a portable filtration station, ensuring higher levels of oil cleanliness when used in daily operations, including filtering new oil directly from the drum, filling small totes and acting as an offline filter for critical equipment. Particulate and water contamination can corrupt new fluid during processing, mixing or handling. This contamination can be prevented or removed with the installed system. The Ikata plant has now instituted policies that require filtration to target cleanliness levels.

The team addressed lubrication transfer and filling tasks by scrapping conventional oil jugs and standardizing on new LubeRite models that keep contamination out and feature colored identification bands that coincide with the colors on drum units. That way, the threat of using the wrong lubricant for a given application is greatly reduced.
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The Push to be Proactive

The Ikata plant’s first reactor system went on line September 30, 1977. At the time of its installation, durable service life years for critical plant equipment was estimated at 30 years, meaning such assets are currently well into the mature phase. In order to avoid degradation and/or failure of equipment, the plant turned to condition-based maintenance in recent years. The thought was that, if done right, CBM could help equipment achieve life cycles nearly twice that of the previous prognostications.

Utilizing vibration analysis, oil analysis, thermography and other predictive technologies, CBM can assure system integrity or pick up on symptoms of degradation and unreliability. Early detection can then allow maintenance and operations personnel to address potential issues on a planned and proactive basis, thus minimizing downtime and impact on power generation.

Shikoku’s history with CBM is fairly brief. Ikata started down this path in March 2005 when Taguchi expanded the usage and viability of vibration analysis, and team leader Hirose began to explore the full possibilities of oil analysis. Hirose traveled to North America and documented a host of best practices on oil analysis from nuclear power generation facilities in the United States. Upon returning to Japan, he supplied the information to Yano and appointed him the diagnostic oil analyst. This turned into an all-consuming project and passion for Yano. Starting from scratch, he worked to identify all lubrication points for rotary machines, as well as document oil types and inventory throughout the plant.

The interpretation and usage of CBM expanded as Ikata moved forward. In the eyes of the maintenance team, “predictive” was not enough. The drive needed to be more aggressive and advanced. Picking up on the early signs of failure was still an indication of failure. The team wanted to address the factors that could lead to potential early stage issues.

“Find the symptom of machine failure in advance and then take the correct prescribed action,” says Hirose. “Proactive maintenance – that’s that we were after.”

Hirose and Yano attended a Noria Machinery Lubrication Level I seminar in Tokyo in August 2006 and came to the conclusion that proactive maintenance would come with a greater utilization of oil analysis. Shortly after the seminar, the team purchased Fourier Transform Infrared Spectroscopy testing equipment and a particle counter, as well as a filter cart. They began to analyze samples taken from lube points on critical equipment.

Additional work targeted oil supply and purchasing practices. Yano’s investigation determined that 38 types of lubricants were used in rotary equipment inside the plant. Many of these lubricants performed the same functions and had identical properties, but had different names or were supplied by different companies. Different oils were going into the same machines. So, he revised the lubrication plan, rationalizing and standardizing based on application and needs. The 38 lubricant types were whittled down to 22.

A Never-Ending Pursuit

After a great deal of samples and analyses, Taguchi and Yano came to the conclusion that oil analysis was uncovering the symptoms of machinery degradation faster than even vibration analysis. Proactive maintenance – from lubricant reception and storage to lubricant transfer and filling to lubricant application and performance – was in place and functioning at a high level.

Success does not mean that this project is completed. Policies, procedures and tools are continually revised and improved. Goals become more stringent, which is a must in any industry, but particularly in one such as nuclear energy.

Practice and best practices will continue to raise performance and expectations at Shikoku Electric’s Ikata plant. The CBM team will be at the forefront of those efforts.
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Earl Edens, the subject of this issue’s “Get to Know ...” section, is more than deserving of a moment in the spotlight. Earl is a lubrication technician at Eastman Chemical’s plant in Kingsport, Tenn. He has worked the past 35 years at Eastman, starting off as a maintenance mechanic apprentice before holding roles in the power generation, wastewater treatment and incinerator areas over the next 23 years. His first assignment in predictive maintenance came in the late 1990s, spending eight years as a vibration analyst and then two years as a reliability contact. In 2007, he began his present assignment as the Kingsport plant’s lubrication technician. Let’s find out more about Earl Edens.

When did you get your start in machinery lubrication, and how did it happen?: I began my journey into the lubrication side of predictive maintenance in early 2007 when I was selected to replace the previous technician due to his planned retirement.

What types of training have you taken to get you to your current job?: In addition to the many years of experience I gained in maintenance and reliability, I attended evening college classes to complete the requirements for Eastman’s technician certification.

Do you hold any professional certifications?: I have Level I, II and III certifications in vibration analysis through Technical Associates of Charlotte, and Machine Lubrication Technician Level I and Machine Lubricant Analyst Level I certifications through the International Council for Machinery Lubrication.

What’s a normal work day like for you?: There is no “normal” day! I can honestly say that this is the most interesting job I’ve ever held. I had no idea there could be so much to learn in the world of oils and greases.

I am the administrator and analyst for our oil sampling/analysis program, so the first thing I try to do each day is look at any oil analysis reports that have been flagged as abnormal. We average around 600 oil samples monthly, so this is a continuous effort. There are two full-time samplers charged with obtaining quality samples, keeping schedules up to date and tracking shipments. We use an external analysis lab that provides us with same-day results electronically. Recommendations I make for actions to be taken are forwarded to the lubrication and maintenance groups.

In addition to oil analysis, I’m responsible for referencing the correct lubricants for all new equipment and for any changes needed on any in-service equipment. Again, this is a constant task.

35-Year Eastman Vet Calls Lube Work ‘Most Interesting Job I’ve Ever Held’

Working closely with our lubrication services and maintenance personnel is very important in my job. Examining equipment in the field in order to make recommendations for improvements to the lube systems is a daily occurrence.

We use two major lubricant suppliers at our site, and I serve as the point of contact when technical support is needed in regard to their products. In this job, it’s very important to have a really good working relationship and to feel confident about the products and vendors we use.

What is the amount and range of equipment that you service at your plant?: Due to the size of our plant, we are all over the board with industrial equipment. We have everything from turbo-generators, turbine-driven compressors, coal pulverizers, reciprocating compressors, centrifuges, multi-stage high-pressure pumps, refrigeration units, cooling towers, and on and on.

What lubrication-related projects are you currently working on?: Early on in my involvement in lubrication, I saw the need for readily available options for improving/upgrading lube systems on our machinery. I have evaluated various oil system accessories such as breathers, filters, oil sampling ports, sight glasses, etc., to use in the varied operating conditions at our plant. I am in the process of having these items stocked on site for easy accessibility.
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Another project being evaluated involves standardizing the oil viscosity/type on ANSI pumps across our plant using a lower-viscosity synthetic oil. Data is being taken to determine any electrical energy savings that may be realized by this change.

**What have been some of the biggest lubrication project successes for which you have played a part?:** One of the first projects I worked on is still one of my favorites. High operating temperatures and heavy loads were causing premature failures on several gearboxes on a critical process line. Several changes were implemented to improve the reliability of these units. Some improvements were:

- a change from mineral to synthetic oil;
- a change in oil viscosity (lower);
- installation of breather and drain port fittings that included quick-connect fittings for portable filter cart and Pitot tube oil sample valves; and,
- adoption of a portable filter cart dedicated for use on these units.

The improvements made to these units resulted in zero failures to date, cooler operating temperatures and easily maintained oil cleanliness levels. I use this project to show other areas what can be accomplished using world-class lubrication practices.

**How does your company view machinery lubrication and/or oil analysis in terms of importance, strategy, etc.?:** Eastman was involved with equipment reliability and predictive maintenance practices long before it became commonplace. Oil sampling/analysis was implemented 20 years ago at this site and is being constantly refined to be more efficient and effective.

On the lubrication side, our lube program is viewed as a very important part of the reliability of our machinery. An example of the significance placed on lubrication has been in going to handheld computers for handling lube routes and tasks. It was a significant investment for the company, but now all information is collected and distributed electronically.

**What do you see as some of the more important trends taking place in the lubrication field?:** On the oil sampling/analysis front, I believe that the growing awareness of the need for high-quality samples will increase the use of proper equipment and techniques in taking samples. This, in turn, will increase the effectiveness of the program by increasing equipment reliability.

Another trend that appears to be having a positive effect on lubrication (especially at our plant) is structured training for our lubrication services and maintenance personnel. World-class machinery lubrication is seen as vital to improving the reliability of the equipment.

“Get to Know ...” features a brief question-and-answer session with a Machinery Lubrication reader. These articles put the spotlight on industry professionals and detail some of the lubrication-related projects they are working on. If you know of an ML reader who deserves to be profiled, e-mail editor-in-chief Paul V. Arnold at parnold@noria.com.
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Filter Changes Can Disrupt Particle Counts

This technical tip was submitted by Brian Mann, a rotating equipment specialist at ConocoPhillips:

“Have you ever seen a sudden spike in particle count for a stable circulating oil system, where no oil has been added or lost? Check to see if the oil filter was changed just prior to the oil sample date. It is not uncommon for a spike in particle count after changing oil filters due to the ‘disturbance’ to the system. Therefore, don’t be too zealous in changing filter elements purely on a calendar basis. Take full advantage of the operating life of your elements, and only change them when they have reached their load capacity or have been in the system up to their manufacturer’s recommended service life.”

Hot Oil? Stop Collapsing Sample Bottles

This tip was supplied by Stephen French, a senior engineer at PPL Generation:

“We use five-ounce plastic bottles to collect oil samples with vacuum pumps. On hot days or when sampling hot oil, the bottles collapse under the vacuum pressure. To prevent this, I make sleeves from clear PVC pipe, with the inner diameter matching the diameter of the bottles. Before collecting the sample, I ask the technician to slide the bottle into the sleeve and then pull the vacuum. The sleeve reduces the incidence of bottle collapse by constraining the out-of-round shape change that the bottle must undergo just prior to collapse.”

Advice for Writing Lubrication PMs

This tip was submitted by Patrick Walsh, a maintenance specialist at BHP Billiton:

“When writing preventive maintenance tasks that require multiple grease guns to be taken up ladders and stairs, it is beneficial to add a stop point in the PM that states, for example, ‘Before ascending these stairs, make sure you have guns A, C and D’. This stops techs from having to carry too much equipment up flights of stairs or ladders, which is a safety positive. It also stops them from getting to the top with the incorrect guns and mixing greases in equipment, which leads to premature failures.”

Stop Turbine Oil From Cooking During Outages

This tip was submitted by Jody James, a predictive maintenance technician at Cleco:

“If you have an outage in a turbine and your lube oil pumps are locked out, be sure to turn off the tank heaters. Most heaters and RTD temperature probes are located in two different places that heat and read flowing oil. Failure to do this can result in over-cooking the oil in the non-flowing/heated area.”

Reminder

Sign up for your free weekly subscription to Machinery Lubrication’s Lube-Tips e-mail newsletter. Simply visit our Web site (www.machinerylubrication.com) and click on the “Newsletters” link found at the top of the home page.

Advice for Estimating Reservoir Capacity

This tip was submitted by Michael Lofald, a lubrication manager at Sappi Fine Paper:

“To estimate the capacity in a rectangular oil reservoir, measure the length, width and height (from the tank bottom to the oil level) in inches. Multiply these dimensions together to get the cubic inches of oil. Divide this number by 231 for gallons. Now label the tank with the capacity so you won’t have to do this math again.”
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The National Lubricating Grease Institute (NLGI) and the European Lubricating Grease Institute (ELGI) have long partnered in several joint working groups for advancement in areas such as: grease cleanliness, food-grade greases and grease shelf life. This article provides an update on these particular groups from the individual chairs, Joe Kaperick and Anuj Mistry.

Grease Cleanliness Working Group Update

The Grease Cleanliness Working Group continues to make good progress in defining a system for categorizing the cleanliness of grease as well as beginning work on developing robust methodologies for measuring this property. This group has held discussions at both the NLGI and ELGI annual meetings and, more recently, by teleconference to address these areas.

Background: The working group has agreed to the following draft definition of grease cleanliness: “A measure of the suitability of a grease to be used in such applications in which contamination by particulate matter would cause damage to the pieces in contact with the lubricant. The extent of contamination can be measured by examination of the size, number and/or hardness of the particulate matter.”

This group is assessing the feasibility of combining the results from two test methods as a measure of grease cleanliness.

- “Standard Test Method for Estimation of Deleterious Particles in Lubricating Grease” (ASTM D1404) is being evaluated as a potential indicator of abrasiveness or hardness of particulate matter. This method uses acrylic plates to quantify the number of particles that will cause scratching and, therefore, provide an indication of the potential for these particles to cause damage.

- The Hegman Gauge is being evaluated as a potential indicator of the number and size of the particles. “Standard Test Method for Fineness of Dispersion of Pigment-Vehicle Systems by Hegman-Type Gauge” (ASTM D1210) is a current method used to measure pigments in coatings. The NLGI-ELGI working group hopes to adapt this standard for use with greases.

A rating system is being considered that combines the ratings from both ASTM D1404 (abrasiveness) and the Hegman Gauge (number and size). An example of such a grid is shown in the diagram at right.

Ratings could be determined as follows:

**ASTM 1404**

Count arc-shaped scratches that appear on highly polished acrylic plates when grease is forced between two such plates and rotated.

Rating:
- 1 = less than 10 scratches
- 2 = 10 to 40 scratches
- 3 = more than 40 scratches

**Hegman Gauge - count and size**

Rating:
- A = Clean (0 particles greater than 100 microns)
- B = Moderate dirt (1-5 particles greater than 100 microns)
- C = Dirty (more than 5 particles greater than 100 microns)

Greases would have a “Cleanliness Rating” of between 1A (very few particles, small, not very hard/damaging) and 3C (many particles, larger, hard with potential for damage).

Note: The numerical ranges are merely for demonstrative purposes. Actual ranges will need to be determined after considerably more work and discussion by the group and should then reflect a range reflective of the likely amount of contamination found in commercial greases.

Recent work: A “mini-round robin” was completed last year to look at feasibility and robustness of the proposed methods. Results show a rough correlation between ratings of “clean” and spiked samples but also illustrate potential issues of repeatability and reproducibility that will need to be addressed before this methodology can be accepted for widespread use. Discussion of these issues has focused on the variations in equipment and method, as well as difficulties in determining repeatable results.
As of late, work has been to develop a series of standards spiked with incremental amounts of SAE A-4 coarse dust to be used in a more extensive round robin. At least nine companies will be involved, with the goal being to refine the methods through discussion of observations made by the individual laboratories during data generation. It is hoped that the samples will be distributed by September (this article was produced in mid-August) with a goal to complete the testing by the end of the year.

To obtain further information or participate in this working group, contact chairperson Joe Kaperick at 804-788-6393 or joe.kaperick@aftonchemical.com.

**Food-Grade Lubes and Grease Shelf Life Working Groups**

The Food-Grade Lubricants and Grease Shelf Life working groups meet twice a year at the ELGI and NLGI annual meetings in Europe and the United States.

The Food-Grade Lubricants Working Group aims to discuss and communicate effectively on topical issues that affect the use of food-grade lubricants (H1). It works collectively as suppliers and end-users for potentially effective solutions.

Major lubricant and additive suppliers as well as end-users participate at these meetings with a goal to keep up with developments within the NSF and InS Services and other developments with respect to the registration and use of food-grade lubricants as well as potential implementation and implications of ISO 21469. The overall aim of the working group is to provide a forum for collection and dissemination of suitable information for the requirements of the global grease community. The group's current focus is the ISO 21469 standard, with a view to getting a better understanding of the standard itself, the certification process and its potential implications related to its implementation within industry.

Grease shelf life is part and parcel of lubricating greases as far as suppliers and end-users are concerned and is vital within the grease industry. The aim of the Grease Shelf Life Working Group is to establish valid, recognized procedures and test methods to predict shelf life of bulk greases. Major lubricant and additive suppliers as well as end-users participate at these meetings. The group seeks to conduct a series of round robin exercises using standard NLGI reference greases as well as long-term retained grease samples to evaluate typical lubricating grease properties. The current focus is to finalize the round robin test protocol.

To obtain further information or participate in these working groups, contact chairperson Anuj Mistry via e-mail at amistry@belray.com.

**About NLGI**

NLGI is an international technical trade association that serves the lubricating grease and gear lubricant industry. Its objectives include promoting research and testing for the development of improved lubricating greases and exploring means for better lubrication engineering and methodology. For more information, visit www.nlgi.org.
When we say that we are the International Council for Machinery Lubrication, we really mean international. ICML’s certification program and its credentials, such as the Machine Lubrication Technician and Machine Lubricant Analyst designations, are synonyms with knowledgeable, skilled, pioneering lubrication and analysis professionals worldwide. In fact, more than 4,700 such professionals from over 1,000 companies in over 50 countries on every major continent have obtained ICML credentials. It is very common for lubrication program champions worldwide to be involved with and certified by ICML. And a great majority of these professionals have been certified by ICML through testing in their native languages.

ICML and Shikoku Electric

These ICML-certified lubrication and analysis professionals are employed by visionary companies worldwide and are in charge of bringing positive change to their country’s maintenance and reliability industry. Such companies know the value of education and certification for key lubrication personnel and look to ICML for independent, third-party assurance of their lubrication and analysis professionals’ skills via the council’s career path. One such company is Shikoku Electric Power Company, more specifically its Ikata nuclear power plant, which is featured in this issue of Machinery Lubrication magazine.

ICML is honored to have been entrusted with the certification of Ikata’s diagnostic oil analyst and predictive maintenance project leader – Yutaka Yano and Itsuo Hirose, respectively. Takefumi Taguchi, also ICML certified, is currently the chief engineer for vibration analysis at Ikata.

ICML offered its first exam in the Japanese language in Tokyo in January 2006. In that same year, Mr. Yano attained ICML certification both as an MLT Level I and MLA Level I, and last year received certification as an MLA Level II. Mr. Hirose also became MLT I certified in 2006, and in 2007 certified as an MLA I. Mr. Taguchi achieved his MLA I certification in 2006.

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ICML would like to say a very special thanks to Ms. Midori Teruyama, who has been a volunteer liaison for ICML in Japan and was not only instrumental in introducing ICML exams in Japan, but a great champion of ICML certification still today. We can certainly say that if it weren’t for Midori’s altruistic and tireless dedication to ICML’s cause, we could not have offered these Japanese professionals the chance to prove their skills to be on par with their ICML-certified counterparts all over the world. “Arigato gozaimasu”, Midori-san!
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Articles & White Papers

Lubrication Rules to Help Your Equipment Run its Best

Now more than ever, plant managers are looking for ways to improve equipment reliability, optimize maintenance and reduce energy consumption. Often they are doing so by challenging the status quo and experimenting with new ideas. Retraining their staff to use effective lubrication techniques is proving to be another approach to obtain needed efficiencies. Find this article in the Web Exclusives section on the Machinery Lubrication home page or type in “Cash is King” in the Search bar.

Why Oil Goes Bad

In general, all in-service lubricants will fail at some point. That being said, there are numerous ways to manage the condition of a lubricating oil and extend its life significantly. Find this article in the Archives section on the ML site or type in “Why Oil Goes Bad” in the Search bar.

Employing Oil Analysis Metrics

Ashley Mayer takes a closer look at some of the more common parameters you might use to measure machine wear. Find this article in the Past Issues section on the OA site or type in “Use-dependent Parameters” in the Search bar.

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Headspace management requires a focus on stabilizing the cleanliness and dryness of the environment inside a component’s casing. Although this seems like a simple task on the surface, it can be difficult to accomplish on many systems and in many operating environments. To effectively manage a component’s headspace, there are three areas to address:

- **Excluding** – Keeping contaminants from entering the system at all
- **Removing** – Having a system in place for removing contaminants that do enter the system or are generated from within
- **Monitoring** – Employing tools to monitor levels of contaminants in order to drive maintenance

Proper execution in these three areas will translate to big gains in machine reliability and extended component life. Though monitoring and removal are important facets of headspace management, I want to focus on exclusion for this Machinery Lubrication article.

### Expansion Chambers and Desiccant Canisters

Exclusion of all things not wanted in your system is the least expensive and most effective way to manage the headscape. Certainly, we need to be focused on excluding solid contaminants and moisture. As our systems breathe, the air transfer occurs through the headspace. Therefore, exclusion starts with either an air filter or an expansion chamber.

In my opinion, expansion chambers offer an excellent barrier to protect the system from invading contamination. However, if you are using an expansion chamber, you must also use a desiccant canister. Expansion chambers offer a “closed” system environment for your component. When sized properly, these chambers will expand when the system wants to breathe out and contract when the systems want to breathe in. No air is passed from the outside atmosphere to the inside of the system. What this means is that anything already existing in the headspace will remain trapped in the component unless a system is in place to remove it. This is an extremely important consideration for moisture.

Dry headspace translates into dry oil. Dry air above the oil will act as a desiccating blanket and pull moisture from the oil. Often, this moisture can be expelled from the system when the system exhales. When you eliminate the possibility of the system breathing to the atmosphere, you also eliminate the possible exhaustion of humid air. To ensure this humid air is removed, install a simple, non-venting desiccant canister.

### Comparing Breather Options

Modern air filters offer a gamut of features. All breathers pale in comparison to the features and functionality of the hybrid-style breather. The major disadvantage to using standard disposable desiccant breathers is that they are an always-opened fixture on the system. Regardless of the state of the system (breathing, static, cycling), these breathers are interacting with both the component headspace and the surrounding atmosphere. Because desiccating media is hygroscopic (it naturally attracts moisture), these breathers will always absorb moisture – if not from the system headspace, then from the surrounding environment. A desiccant breather installed on a machine will always absorb moisture, whether the system is operating or not. This means that depending on the level of humidity surrounding the system and the installed desiccant breather, the desiccant may not last very long at all.
normally closed. So when the system is static or not breathing, the desiccant is only exposed to the headspace of the component and not the surrounding environment. This enables the breather a comparatively longer life cycle than the disposables. This design allows for moisture stripping as the system breathes and moisture capture from the component headspace while it is not breathing.

To allow the breather to maintain a normally closed state, an expansion chamber has been incorporated into the design to allow for small changes in total volume. If the system breathes beyond the capacity of the expansion chamber, pressure and vacuum relief valves are there to pop open and allow adequate air flow.

Make Decisions Based on Knowledge and Total Cost

So, the question then leads to how you want to spend your money. Many will tend to opt for the low up-front cost and deal with the short life cycle. I have seen this happen more times than I care to remember. A client, new to desiccant breathers, decides to try out a couple on some critical systems. They decide to bring in some of the disposables because: 1) they’re about half the cost of the hybrid style, and 2) they don’t have the depth of knowledge required to make appropriate decisions about what their systems actually require in the area of air filtration.

What happens next is that the breathers (for reasons like high ambient humidity, frequent washdowns or a reservoir already full of free and emulsified water) don’t last very long. As a result, the client decides that desiccant breathers won’t work in their facility for one of the reasons previously listed.

Headspace management is one of the keys to extended equipment life and improved reliability. Like any minor modification, you should always research the options to make educated decisions on what is most effective for your systems, location, environment or process. **ML**

About the Author

As technical operations director for Noria Reliability Solutions, Jason Kopschinsky’s primary responsibilities include managing numerous and varied projects in the areas of: plant audits and gap analysis, Lubrication Process Design, oil analysis program design, lube PM rationalization and redesign, lubricant storage and handling, contamination control system design, and lubrication and mechanical failure investigations. Contact Jason at jkopschinsky@noria.com.
Rolling-element bearings used in electric motors potentially have many failure modes if an incorrect strategy is implemented. These modes include incorrect lubricant selection, contamination, loss of lubricant and overgreasing. This article will discuss several effective strategies to minimize the likelihood of these failure modes.

Most electric motors are designed with grease-lubricated, anti-friction, rolling-element bearings. Grease is the lifeblood of these bearings, providing an oil film that prevents harsh metal-to-metal contact between the rotating element and races. Bearing troubles account for 50 to 65 percent of all electric motor failures, and poor lubrication practices account for most bearing troubles. Good maintenance procedures, planning and the use of the correct lubricant can significantly increase productivity by reducing bearing issues and, likewise, the motor failures.

Get to Know the Failures

By knowing what the failure modes are, you can focus on reducing or even eliminating them. These include:

**Wrong lubricant:** It is important to use the correct grease for the application. Regreasing with the wrong grease can lead to premature bearing failure. Most oil suppliers have grease that is specifically designed for electric motors.

**Grease incompatibility:** Greases are made with different thickeners, such as lithium, calcium or polyurea. Not all greases are compatible with one another, even those with the same thicker type; therefore, it is important to use the same grease or compatible substitute throughout the life of the bearing.

**Motor casing full of grease:** If the grease cavity is overfilled and high pressure from the grease gun is applied, the excess grease can find its way between the shaft and the inner bearing cap and press its way into the inside of the motor. This allows the grease to cover the end windings of the insulation system and can cause both winding insulation and bearing failures.

**Lubricant starvation:** There are several possible causes of starvation. The first is insufficient grease being added during installation. The second is inappropriate, elongated relube intervals. The third possibility is that the oil has been removed from the thickener base by excessive heat.

**Overpressurization of the bearing housing:** Anytime there is an overpressurization of the housing, stresses are placed on parts that weren’t designed to handle the pressure. Keep in mind that the standard manual grease gun can produce pressures up to 15,000 pounds per square inch.

**Overheating due to excess grease:** Too much volume will cause the bearing elements to churn the grease, trying to push it out of the way, resulting in parasitic energy losses and high operating temperatures, which in turn increase the risk of bearing failure.

Getting Started

The first thing you need is a plan to execute. The following would be the bare minimum that would need to be discussed and implemented to get the program started.

1) Make an equipment list that includes all the assets you want to include in the program.
2) Verify the type of bearings installed in both the inboard and outboard ends of motors. This will determine if the bearings are regreasable. You also should determine a policy for the regreasing of shielded bearings, which are commonly found in motors. (Some experts recommend not greasing double-shielded bearings.)
3) Choose a grease type that will be adequate for the program. Remember that once a grease type and manufacturer are chosen, it is best not to deviate from this choice.
4) Make all necessary modifications to the electric motors. This includes adding fittings and making them accessible.
5) Establish a set of procedures for maintaining the motors.
Develop a PM System

There are many choices to make when deciding on a preventive maintenance (PM) system. In some plants, it may be beneficial to only use a spreadsheet, while others have the need for complete dedicated systems. The end goal is the same. You want to be able to track each motor as an asset and keep track of the attention that each motor receives. Some good things to include in the PM system are: date of installation, horsepower, frame size, RPM, bearing type and environmental conditions. It will take a while to set up a system like this; but once completed, it will be one of the greatest tools that you possess.

Determining Lube Type

When searching for a lubricant type and manufacturer/supplier, there are several things to consider. The following is a list of qualities associated with a good electric motor grease.
1) Good channeling characteristics
2) NLGI Grades 2-3, ISO VG 100-150
3) High dropping point, 400 degrees Fahrenheit minimum
4) Low oil bleed characteristics, per D1742 or D6184
5) Excellent resistance to high-temperature oxidation
6) Good low-temperature torque characteristics
7) Good anti-wear performance, but not extreme pressure

Polyurea grease is popular with many bearing and motor manufacturers. A good percentage of equipment manufacturers also specify some type of polyurea grease in their electric-powered machinery. A polyurea-based grease is an excellent choice for electric motors, but be warned: this thickener is incompatible with most other thickeners. Some manufacturers don’t recommend mixing one brand of polyurea with another. Instruct your motor rebuild shop on what grease to use, and make sure your grease type is specified on new motor purchase orders.

Determine Regrease Cycle

There are several methods for determining a regrease time cycle. It is very important to realize that no one method will give you a magical answer to your problems. There are multiple calculators, tables and charts that can give you a very good starting point. I like to use them all to get a good feel for how I want to set the cycles. The real fine-tuning, however, must be done by trial and error. The factors that most calculators have in common are: load, operation time, bearing type, temperature, environment and speed. This is where the database you built will be beneficial.

Grease Volume Control

Grease volume control has been a long-standing problem for industry, and simply following OEM recommendations may not be enough to solve this problem. There exists an equation that has yet to fail me. It is a very simple one that takes a very logical approach to determining the volume of grease to be added. The formula is:

\[ G = (\frac{1.144}{D} \times B) \]

Where \( G \) = the amount of grease in ounces, \( D \) = the bore diameter, and \( B \) = the bearing width.

Once the volume is found, you need to convert it into shots or pumps of the grease gun. There is only one way that I know of to get the value used to convert the number. You will need the grease gun that is going to be used and a postal scale. After finding the output per full stroke of the handle, label the gun so that it is now “calibrated”. The average value I have found is approximately 18 shots per ounce for most manual guns.

Procedure

The intent of a good maintenance program is to extend the service life of your motors. In most cases, improper lubrication procedures or the failure to follow them can have a negative impact on your program. A good base set of procedures should include some variation of the following:

1) Ensure that the grease gun contains the appropriate lubricant.
2) Clean the areas around the relief and fill fittings.
3) Remove the grease relief valve or plug.
4) Grease the bearing with the proper, calculated amount of grease. Add grease slowly to minimize excessive pressure buildup in the grease cavity.
5) Watch for grease coming out of the relief port. If you pump excessive amounts of grease into the motor and the old, used grease is not being purged, stop and check for hardened grease blocking the relief passage.
6) If regreasing is performed with the motor out of service, operate the motor until the bearing temperature rises to operating temperature in order to allow for thermal expansion of the grease. Ensure that the relief valve or drain plug is left out during this process.
7) Allow the motor to run at this temperature for a short time to expel any excess grease before installing the bottom grease relief valves.
8) After excessive grease has been purged, reinstall the drain plug and clean excessive grease from the relief port area.

Hard but Worth the Effort

This article was written as a very broad and general document to inform you of some of the thought processes that go into the creation of a lube program. It may seem like an easy task to take on; but in reality, it is very difficult. Remember to take your time, do it right the first time, and you will find the rewards are very much worth the trouble. ML

About the Author

Jeremy Wright is a certified Machinery Lubricant Analyst (MLA) Level I and Level II and Machinery Lubrication Technician (MLT) Level I by the International Council for Machinery Lubrication (ICML). In addition, he is a Certified Maintenance and Reliability Professional (CMRP) by the Society for Maintenance and Reliability Professionals (SMRP). Contact Jeremy at jwright@noria.com.
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