## Contents

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil Analysis Methods</td>
<td>p. 4</td>
</tr>
<tr>
<td>In Pursuit of Lubrication Perfection</td>
<td>p. 9</td>
</tr>
<tr>
<td>Get Your Bearings on the Facts</td>
<td>p. 13</td>
</tr>
<tr>
<td>Texas Manufacturing Plant Reduces Pump Failures and Equipment Downtime</td>
<td>p. 16</td>
</tr>
<tr>
<td>Do We Need 20 MW Gas Engines?</td>
<td>p. 20</td>
</tr>
<tr>
<td>Additional Resources</td>
<td>p. 21</td>
</tr>
</tbody>
</table>
IF CONTAMINANTS ARE HARD TO REMOVE FROM YOUR SKIN, IMAGINE HOW HARD IT IS TO GET THEM OUT OF YOUR LUBRICATION SYSTEM.

Des-Case has helped some of the world’s largest companies improve their reliability program and protect their lubricants and equipment from contamination.

615.672.8800
sales@descase.com

Download our white paper to jumpstart your lubrication program!
An oil analysis and lubrication monitoring program should address a variety of effects and should involve contamination control methods and established oil cleanliness procedures. Friction, lubrication oil, wear, and wear particles are interactive and can’t be separated.

The friction within machinery directly translates into power loss. Lubrication oil costs constitute significant parts of machinery operation costs in any plant. The wear is one of the primary characteristics defining the end of life for plant machinery and leads to costs of maintenance, replacement, and production outage. An effective oil analysis and lubrication oil monitoring program can increase efficiencies of machineries and reduce the operating costs. The value of this program can only be realized if it can be collected and analyzed in a timely and organized manner. The oil analysis can reveal important information about the condition of machinery, oils, and contaminations in the oils.

To reduce the operating costs of any plant, the focus should be on its machinery. It’s necessary to improve machinery availability and reduce the operational and maintenance costs associated with them. The reliability and availability of operating machinery depend largely on the protective properties of the lubrication oil. The machinery industry currently uses lubrication oil analysis for monitoring machinery, particularly lubrication oil performance, bearing wear, and gear system operation.

One of the purposes of lubrication oil condition monitoring is to determine whether the lubrication oil has deteriorated to such a degree that it no longer fulfills its functions. However, this is not the only purpose. Different lubrication oil condition monitoring techniques can be used to monitor lubrication oil wetted components and detect their degradation rates and possible developing damage.
Many moving components actually are lubrication oil wetted parts such as bearings, gear units, or piston/cylinder in reciprocating machines. Viscosity and dielectric constant could be used as the performance parameters to identify the degradation of lubrication oils. Particles, as the result of wear of wetted machinery components, could also be detected and classified to identify the wear rates and health situations of such components.

WATER AND IMPURITIES
The oil contamination analysis can reveal deterioration or breakdown of the oil, can identify contamination of the system with water or particulate debris, and can indicate wear of the lubricated machinery.

Water or impurities in the lubrication oil can be seen clearly at the visual inspection of samples. Water can be seen either in the form of emulsification or as a distinct water layer. The general cleanliness level of the lubrication oil also may be determined by a visual test of samples. Once filtered, the debris should be visually examined prior to microscopic examination. The presence of water within the lubrication oil can also be detected from the filter paper used for oil analysis. This is seen in the form of light circular areas on the filter paper. Water also sometimes oxidizes the ferrous material, and the presence of rust could indicate the ingress of water. Water affects the viscosity of the lubrication oil, considerably reducing the effect of the lubrication oil.

Frequently, gear units become contaminated with mineral particles such as silica, coal, and shale. These produce fine abrasive wear particles normally only observed under the microscope. The unchecked presence of mineral particles, specifically quartzite with its high hardness, should be avoided in the lubrication oil system. The mineral particles in suspension act as a grinding medium and can produce excessive bearing wear, which leads to loss of shaft location and further accelerates the wearing process.

WEAR DEBRIS ANALYSIS
Wear debris analysis is a technique for analyzing the debris, or particles, present in lubrication oil that could indicate wear, particularly mechanical wear. This method provides microscopic examination and analysis of debris/particles found in a lubrication oil. These particles consist of metallic and nonmetallic matters. The metallic particles usually indicate a wear condition that separates different sizes and shapes of metallic dust from components like bearings, gears, and generally any components that can be wetted by lubrication oil.

Nonmetallic particles may consist of dirt, sand, or corroded metallic particle. Analytical ferrography is one of the methods used in wear debris analysis; it’s among the most powerful diagnostic tools for condition monitoring.

When implemented correctly, the wear debris analysis provides very useful information on machinery under operation. It still isn’t in common use for all machineries because of its comparatively high price and a general misunderstanding of its value.

Wear debris analysis also can help with improving lubrication oil filtration efficiency and frequency for the lubrication oil cleaning and changeover. Machinery performance may be improved through proper filtration of oil. Clean oil lubrication is always more effective.

The wear debris analysis procedure in its comprehensive form is lengthy and requires the skill of trained analysts and experts. As such, there are significant costs for a comprehensive wear-debris-analysis procedure. However, most machinery experts agree that the benefits significantly outweigh the costs and elect to automatically incorporate such a method when abnormal wear is encountered.

The most important aspect of wear debris analysis is its capability to identify developing damages and malfunctions in their initial stages. This is the main reason why such an expensive and complicated condition monitoring method should be used instead of or in addition to simpler and cheaper condition monitoring tools such as online vibration monitoring technology.

An oil sample contains particles that have been produced at various times. This makes the wear debris analysis difficult. Root causes of the wear-out failures in machinery could include a combination of mechanical loads such as stresses or strains, the process environment, and the surface oil chemistry. The wear process environment could include heat, dust, and water contamination. The surface oil chemistry for oil wetted surfaces can be benign or under chemical attack, depending on the condition of the oil, presence of corrosive oil contamination, and other process details.

PARTICLE ANALYSIS METHODS
The main aspects of wear debris analysis are quantitative figures and qualitative facts. Regarding the qualitative aspects of debris, color, shape, and texture is important. As the first step, the morphology of wear particles should be examined visually by a trained expert. After that, the computer scanning and image recognition should be applied. Advances in computers and image recognition make automatic evaluation of the particle morphology possible. It may be characterized by a set of numerical features, and then appropriate classification methods can be used for wear particle identification.
COLOR AND CHARACTERISTICS OF PARTICLES
Color of particles and debris is an important feature in the wear debris analysis. If the shape and texture allow one to differentiate the wear particles according to their prehistory of formation, color may help to define debris composition or other useful data. Composition of wear particles is determined by the materials of worn surfaces, contaminants, and products of chemical reactions. In lubricated metallic contacts, steel, copper, lead, tin, chromium, and silver often can be generated as wear particles. Ferrous oxides found in the lubrication oils usually can be divided into two groups: red or black oxides. Examination of color allows one to define the source of particle generation and the severity.

White nonferrous particles, often aluminum or chromium, appear as bright white particles. They’re deposited randomly across the slide surface with larger particles getting collected against the chains of ferrous particles. The chains of ferrous particles might act as a filter, collecting contaminants, copper particles, and Babbitt particles. Copper particles usually appear as bright yellow particles, but the surface may change to verdigris after heat treatment. Babbitt particles usually consist of tin and lead; Babbitt particles appear gray, sometimes with speckling before the heat treatment. After heat treatment of the slide, these particles still appear mostly gray, but with spots of blue and red on the mottled surface of the object. Also, after heat treatment, these particles tend to decrease in size. These nonferrous particles usually appear randomly on the slide, often not in chains with ferrous particles. Contaminants usually are dirt (silica) and other particles that don’t change in appearance after heat treatment. They can appear as white crystals and are easily identified by the transmitted light source — that is, they might be somewhat transparent.

Fibers, typically from filters or outside contamination, are long strings that allow the transmitted light to shine through. Sometimes these particles can act as a filter, collecting other particles.

Increased quantities of iron are common, since many machinery parts are composed of iron (different grades of steel), while an increase in content of less common metals such as silver can often indicate precisely which component is being worn abnormally. Visual and microscopic examination of the sample is as important of a source of information as the regular testing of the debris samples. Prior to filtering the sample, examination of the sample visually can give useful information. The size and shape of wear material usually differentiate between wear mechanisms.

PARTICLE SIZE AND SHAPE
The sizing is one of the important aspects of the wear debris study. Three parameters — average particle size, maximum particle size, and the particle size distribution — are important. As a rough indication, the damage state of machinery could be proportional to the size of the particles. This is definitely true for some machinery items such as gear units. As an indication, the following size classification is presented for wear debris analysis:
- fine: less than 5 microns
- small: less than 20 microns
- medium: 20-50 microns
- large: above 50 microns.

As a rough indication, particles over 20 microns could indicate a potentially dangerous damage state for machinery. The wear particle shape could give an indication about the damage mechanism by which that particle was removed. Platelets, two-dimensional particles, are usually produced by metal-to-metal sliding. Spherical, or 3D, particles are produced by bearing fatigue or by lubrication oil failure resulting in the local overheating. Spirals or similar are most often produced by a harder surface abrading into a softer one. Chunky particles are usually produced by a fatigue mechanism.

SOA
Spectrometric oil analysis (SOA) reveals the chemical composition of metal particles suspended in the oil samples. By comparing the results to the known chemical composition of various machinery parts, abnormal wear of machinery parts can be identified, and servicing of the machinery can be initiated, thus sometimes avoiding further costly repairs or even catastrophic failure.

It’s been used for many machines, particularly aero-derivative gas turbines and small and medium critical machinery using rolling-element bearings. This method is useful to take into account the loss of wear particles with
oil usage or by the drainage and replacement of oil. These factors are of particular importance because of the high rate of lubrication oil used in aero-derivative gas turbines or others and the small particle sizes involved; this is the size to which spectrometers are most sensitive.

WEAR PARTICLES
Sliding adhesive wear particles are found in most lubrication oils. They usually are an indication of normal wear. They’re produced in large numbers when one metal surface moves across another. The particles are seen as thin asymmetrical flakes of metals with highly polished surfaces. Cutting abrasive wear produces other particle types, for instance, spiral, loops and threads. The presence of a few of these particles might not be significant, but, if there are several hundred, it could be an indication of serious cutting wear. A sudden dramatic increase in the quantity of cutting particles indicates that a breakdown could be expected.

ONLINE OIL MONITORING
The basic idea of some failure-detection lubrication oil condition-monitoring methods is the early identification of chemical aging of the lubrication oil and its additives under the influence of high dynamic loadings in the wetted components such as bearings or gears. This can use online methods and could offer extremely important benefits. The online diagnostics system measures components of the specific complex impedance of lubrication oil. For instance, broken oil molecules, forming acids or oil soaps, result in an increase of the electrical conductivity, which directly correlates with the degree of contamination of the lubrication oil. For lubrication oils with additives, the stage of degradation of additives can also be derived from changes in online measurements such as the dielectric constant. The determination of the reduction in the lubrication oil quality by contaminations and the quasi-continuous evaluation of wear and chemical aging can be combined by the holistic approach of real-time online monitoring. Another concept is the online monitoring of wear debris in lubrication oil. Online sensors can effectively control the proper operation conditions of many critical machinery parts, for instance, bearings and gears.

MULTI-METHOD MONITORING
If the rates of wear debris particles are high, it could indicate that machinery is not in good condition and might require maintenance work. On the other hand, the measurement of total wear particles could be misleading, and it may give wrong signals about a problem. Total wear debris measurement is most common, but it usually doesn’t reflect the state of operating machinery change and machinery health.

When only one method or one sensor is used, the prediction isn’t usually reliable. The key for proper lubrication oil analysis is to use different independent techniques to achieve early and reliable monitoring results. For example, when three sensors and methods are used simultaneously, then the monitoring quality is significantly improved.

Further improvements can be obtained by combining different oil and wear debris analysis methods with other condition monitoring systems. If all these methods indicate a developing malfunction in a component — for instance, a bearing — such a prediction could be reliable.

To avoid mischaracterizing data, different monitoring methods should be used. They could be factored using different key data points to allow for correct identifications of changes over time. For instance, different oil analysis methods, wear debris sensors, contaminant details in lubrication oil, and others such as vibration monitoring should be considered together, and, if all point to the same problem, such monitoring is usually accurate.

CONCLUSIONS
Machines are the heart of plants. Proactive maintenance and proper monitoring are the most important factors for increasing machinery life and avoiding machinery shutdowns or damages, which in turn increase the life and profit of the plant. Machinery performance and reliability directly depend upon the health of its moving components. Machinery performance also depends upon its lubrication oil. The oil analysis can reveal important information about the condition of machinery, oils, and contaminations in the oils. Substantial savings can be achievable through an effective oil analysis program.

Amin Almasi is a rotating equipment consultant in Australia. He is a chartered professional engineer of Engineers Australia (MIEAust CEng – Mechanical) and IMechE (CEng MIMechE), and he holds a master’s degree in mechanical engineering. Almasi also is a registered professional engineer in Queensland (RPEQ). He specializes in rotating machines including centrifugal, screw, and reciprocating compressors, gas turbines, steam turbines, engines, pumps, offshore rotating machines, LNG units, condition monitoring, and reliability. He is an active member of Engineers Australia, IMechE, ASME, and SPE and authored more than 100 papers and articles.
The Heavy-Duty, Tacky, Red Grease

That Sticks With You Under The Toughest Conditions.

This rugged, thick/tacky/adhesive, multi-purpose, extreme pressure grease can withstand higher temperatures than traditional lithium greases. The advanced, zinc free additive package provides outstanding anti-wear protection. This NLGI Number 2 density, multi-purpose grease is recommended for a wide variety of heavy-duty applications. Red in color.

**Lithium Complex** Formulation for High-Temperature Applications

**Zinc Free** Contains an Advanced, High Performance, Zinc Free Anti-Wear Additive Package.

**NLGI No. 2 Grade** Multi-Purpose For a Wide Range of Applications

**Lubriplate® Lubricants**

Newark, NJ 07105 / Toledo, OH 43605

1-800-733-4755 / E-Mail: LubeXpert@lubriplate.com

To visit us on Facebook, Twitter or LinkedIn, go to www.lubriplate.com and click on the desired icon.
IN THE BEGINNING
I’m a beer guy. Specifically, I’m the lubrication technician for a beer manufacturing facility. So I’m that beer guy. I’m also the go-to person for any lubrication process needs at our brewery—I research, approve, test and implement the products. I train people. I sell the process into other departments.

In October 2010, I began implementing a world-class lubrication process, not because I had to, but because it was the right thing to do. I knew the process we had in place wasn’t as effective as it could be. As I started to dig deeper, it became apparent that our practices and lubrication identification needed to improve. I discovered that 75% of initial oil samplings returned unwanted results; almost all samples had the wrong product or the wrong ISO viscosity. I knew we weren’t managing our equipment adequately, and, more importantly, I knew it needed to be fixed prior to investing in a robust and sustainable sampling program.

We needed 13 different colors and 11 different shapes for 70 unique profiles. Most companies didn’t offer this many colors or shapes, so three new colors and shapes, including a smiley-faced shape completely unique to our facility, had to be customized for us. We now have a completely unique solution from OilSafe for our brewery’s lubrication management, with custom colors, shapes and labels that allow us to store, transfer and apply seamlessly.

Grease guns had colored labels in shrink tube sleeves previously. But the oils or additives were showing compatibility issues and were causing the sleeves to expand and contract, diminishing their appearance and effectiveness quickly. Custom-painted colors and labels were created for all our brewery’s grease guns, including adding descriptions for secondary package requirements of the NFPA and HMIS ratings for each grease product we use.

So where am I in implementing a world-class lubrication...
process? I’ve made some great initial progress, but I see this as far from over. I’ve been working with one department at a time, setting up satellite lubrication stations with color- and icon-driven lubricant identification for secondary containers and specifically colored grease guns. I’ve been tagging all pieces of equipment with oil tags and grease caps after manufacturer documents have been reviewed to ensure the right product was used in the first place and to ensure we’re building success down the road.

We’ve purchased our first bulk storage system. I recently placed the eight-station system in a new, dedicated satellite lube room, and I’m in the process of preparing the system and room for use. This is my first complete build-out of a lube room from start to finish, with the help of engineering, of course (Figure 1). The goal is to have it completely online by June or July, allowing me to showcase our world-class lubrication system throughout the organization. In the past, up to five different lubricants would use the same transfer and recirculation pumps. This required that the pumps be purged in between, which is time-consuming and wastes product. And, even after purging, there was still a 1% contamination rate, which is unacceptable with some of our lubricants.

Now, with the new bulk system, each lubricant has its own dedicated pump. There is no need to purge. There are no contamination issues.

And another benefit is that the visual management system is completely intuitive. Color coding eliminates any guess work, and even new or inexperienced employees will know exactly how the system works. The proper lube has been spec’d out by an expert, predetermined and measurable, taking the decision out of the individual’s hands. As a result, technicians are better-focused, and our operators know exactly which lubricant goes where, eliminating the past problems of incorrectly identified lubes or cross-contamination, which made analysis difficult.

With a visual management system, lubricants are easily stored, transferred, and identified properly. With a higher level of identification, operators are more conscious and responsible to any potential issues. The addition of large 3D oil sight glasses makes visual interpretation even easier at the equipment level. With minimal training, we are experiencing a high volume of work notifications from operators who notice if oil in some of their equipment just doesn’t look right.

This is a huge step in mitigating oil and grease issues earlier on, reducing potential downtime. This would never have been noticed or reported before the system was implemented.

What I tell other departments is that 60-80% of all equipment failures are lubrication-related. If you improve the process, your equipment and your entire operation should run more efficiently. It’s all about equipment reliability and uptime.

The lubrication management process is continuous and always evolving. There are always other ways to improve and upgrade our systems, and I don’t foresee a time when every task is complete. So while we’re on this journey, my plan is to document the implementation of our world-class lubrication process and to share my experiences and learning during the transformation. My goals are to achieve increased reliability and OEE; improve uptime; create a valuable and repeatable oil sampling program; implement a lubrication process that drives down cost; show huge ROI and become the measuring standard for other manufacturing facilities; and, of course, continue to make quality beer.

**Fast Forward to March 2014**

Phase 1 training is still going well, and I’ve seen a plant-wide awareness grow regarding lubrication best practices. The numbers say it all: Only three preventable rotating equipment failures occurred in 2013 — a five-fold reduction from past years. This is a significant improvement that can be directly attributed to greater awareness of lubrication best practices. More and more work orders have been generated by operations folks simply recognizing when something just doesn’t look right in the sight glass.

With Phase 2 training kicking off recently, I’m hoping to see similar results and successes as we continue along our journey. So far, feedback on Phase 2 is good; folks really appreciate the hands-on aspect of this phase. People are especially responsive to the four-hour class that addresses the “how” and “why” of lubrication management. We go into great detail discussing why lubrication cleanliness, handling and monitoring are so important, as well as the damage that contamination can have on the entire business operation.

I’ve been following up with crews after...
training to gauge the effectiveness of the class, and it’s apparent they aren’t only more aware and prepared to perform the activities, but they also understand the reasons for and the importance of each process. Our sample size of those who have completed Phase 2 training is relatively small, but it’s apparent how much more effective our training is now compared to even just a few years ago. Looking back, it’s scary to realize just how far off we were and how much we were at risk of equipment failures. Essentially, we were asking inadequately trained folks to perform lubrication tasks using improper equipment, and that was obviously putting us at major risk for failures.

The hands-on Phase 2 training will be beneficial for both skilled and inexperienced individuals, helping them to acquire the skills and know-how needed to perform all lubrication management tasks. With these improvements, we’ll experience fewer equipment failures. And standardization of our lubrication process and equipment are keys to long-term success.

With Phase 2 training underway, my new focus is on auditing different departments to determine levels of improvement in our lubrication management process. I am asking the necessary questions to get the honest answers. Are we getting better? Is equipment cleaner and better maintained than before? Are better practices on display with sight glass conditions and low oil levels? Are approved lubrication containers in place in all areas?

To most accurately answer these questions, I pulled the work notifications from the previous year, where I wrote 244 notifications, 136 of those for low oil — some for the same machines over and over again. In the first two months of this year, I’ve only written 21 notifications, many of which are repeats from late last year. This is a 50% reduction already. And only six of the 21 notifications pertain to new conditions, so it’s apparent our efforts are working.

As I audit various departments, I notice that, in those areas where employees have already received training, the lubrication containers, grease guns, and jugs are cleaner, are better stored, and appear to be used properly. This drastic difference also makes it very easy to identify those departments that have not yet undergone the training. In departments where training has not yet occurred, I still see dirty sight glasses, low oil, improperly cared-for containers, and even some open caps on jugs sitting out on the floor. It’s no coincidence that these departments also have the most breakdowns and work orders for equipment. The good news is that area managers are now aware of the training, have tasked their staffs with getting up to par, and have approved implementing new lubrication equipment. The great news is this means we’re coming close to having a completely standardized lubrication management process.

These audits help us to identify and address some critical issues, and I feel we are well-poised for the future, even with the inevitable hiccup every now and again. The most pressing question I’ll have to answer now is what will be my new gauge of success as our failures continue to decrease and our process continues to improve.

AND INTO THE FUTURE

So, what’s next for us during this process? Once all our folks complete Phase 1 and Phase 2 training, we’ll implement Phase 3 training. In Phase 3, operators will be tested on all the necessary skills they’ve acquired in phases 1 and 2, ensuring we have an efficient and standardized process. I will continue to audit all departments and measure our progress, making sure we continue to improve and see a dramatic decrease in the number of work notifications and equipment failures.

As we continue on our journey toward lubrication perfection, I often reflect back to where we started. We’ve come a long way. One of the things I’m most pleased to see is OilSafe equipment utilized in most departments, with the correct tags and caps in their proper places on this new equipment. And I’m expecting to see brand-new color-coded grease guns, containers, and labels popping up in even more departments that didn’t previously have this equipment.

People are becoming more self-sufficient and knowledgeable in lubrication management, knowing what to get, how to read the master lube list, how to coordinate the colors and symbols to the right product, and how to get the proper containers on their own. It’s not perfect all the time. However, I am asked less often to answer general questions. This gives me more time to focus on specific equipment needs and follow up on critical items.

I’m sure you’re wondering if we accomplished what we set out to do with this new process. We are well on our way; we have made great progress while implementing this world-class lubrication system. And these successes have made believers out of everyone, even those who initially doubted or resisted the change in our lubrication management process. We’ve seen an overall decrease in work notifications with reduced equipment failures and reduced instances of contamination, which has resulted in increased reliability and uptime. Our lubrication process is cleaner, more organized, and, most importantly, standardized, which has resulted in repeatable, measurable lubrication management.

As I’ve said before, the lubrication management process is continuous, and I still don’t see a time where every task will be complete. I believe that ongoing improvement is the key to success, and I’m excited to see how much better we can get in the future.

Thanks again for joining us on this journey. I hope that coming along with us as we implemented our new lubrication process has provided you with some useful information you can apply in your own facility or program. Cheers.

Richard David is a condition-based monitoring technician, with almost 20 years of industry experience, including the past five years as predictive maintenance analyst and CBM technician (MLA-II, Vibe CAT II, Thermography I, Ultrasound I).
SUPERIOR LUBRICATION MINIMIZES DOWNTIME INCREASES PROFIT

UPGRADE TO SYNFILM - OUR MOST VERSATILE LUBRICANT

- Reduces bearing vibrations
- High film strength protects bearings
- Saves energy with a low coefficient of friction

One of the primary factors that determines the reliability of rotating equipment is the quality of the lubricants. Royal Purple Industrial Lubricants gain their performance advantages over competing mineral and synthetic oils through the superior blend of synthetic base oils plus Royal Purple’s proprietary Synerlec additive technology. This unique additive technology is proven to make equipment run smoother, cooler, quieter as well as more reliably and efficiently. Royal Purple produces a complete range of high performance lubricants for nearly every industrial application.

To learn more, visit RoyalPurpleIndustrial.com or call 888.382.6300
A recent reliability conference dealt with machinery reliability improvement. After one of the presenters invited attendees to ask questions, two reliability engineers in attendance explained how their plant had repeatedly experienced bearing failures on large electric motors. The average bearing life of these European-built 13.2 kV/3,585 rpm induction motors was reported as 12 months, which, of course, is unacceptably low. When asked about the grease path and bearing styles — single shielded, double shielded or open — they had no details. Regarding grease application mode, such as cross-flow, same-side reservoir, plug removed, or plug in place, they again could offer no data.

At the same conference, an attendee from an oil refinery explained that, at his facility, the electrical department was in charge of motor lubrication. He spoke of moves underway to revert from continuous oil-mist lubrication at present to grease lubrication in the future. The refinery's maintenance crews would then, in the future, periodically replenish the grease on hundreds of electric motors.

Because two maintenance technicians and a part-time trainer would probably have to be added to this refinery's staff to do all the regreasing, reverting to grease lubrication should be seen as a step backward. Backward steps very often center on gaps in knowledge and a lack of learning. We can confidently make that statement because there are, even as we speak, thousands of electric motors which, with properly configured bearings, well laid-out grease paths, and soundly determined lube-replenishing intervals, give many years of continuous and satisfactory service. Even more dependable are about 26,000 electric motors that are lubricated by pure oil mist. Some of them were installed in 1978 and have yet to have their bearings replaced. Savings in maintenance with pure oil mist at one forward-looking petrochemical plant were estimated to exceed $200,000 per 1,000 electric motors, even before the prorated cost of an avoided fire was added to the estimate. Good cost justification calculations take into account that a $4 million fire is likely per 1,000 failures. Therefore, each avoided motor failure would be worth $4,000, according to the 4th edition of "Pump User's Handbook: Life Extension,” which I co-wrote with A.R. Budris.

Of course, it would be impossible to purchase a motor without specifying its speed, voltage, and power. Because many different combinations of bearing types and lube methods exist, these, too, should be specified by the buyer or disclosed by the vendor (Figure 1). Although some combinations of bearing styles and lube practices may prove troublesome, a large number of plants still purchase from the lowest bidder and leave lubrication to trial-and-error or chance.

To be counted among the reliability leaders, a user company must understand and successfully implement modern lubrication methods. The managers and staffers who advocate going back to maintenance procedures that were discontinued in the early 1960s are entirely on the wrong track. A safe plant is a reliable plant, and vice versa. Tangible steps to achieving both safety and reliability do not come out of nothing: they are rooted in learning. This learning cannot be sporadic or superficial; it must be highly structured and must embrace both theory and practice. True learning culminates in the acquisition of in-depth knowledge which, when applied, is called wisdom. Wisdom comes after years of being mentored, doing much reading, observing, and applying a considerable amount of common sense over the span of one's career.

Do not let opinion get in the way of facts. Wisely practicing motor lubrication is granted to those who understand the difference between opinion and facts. Only a mature person will act on facts consistently. And only a highly principled manager will consider it a priority to groom, nurture, and reward mature professionals. Because mature professionals explain facts even in the face of unfounded opinion-based opposition, they are not universally loved by all. They may even be viewed as non-players in a herd of team players.

Not being advised by mature professionals is a serious problem for many managers. Only an informed manager can make good decisions, and he must be careful not to surround himself with the untrained or uninformed or with people who really are imposters. Good managers must make decisions on the basis of facts. When it’s all said and done, we generally find that more has been said than done. While managers don’t need an in-depth knowledge of details, they must be able to depend on
maintenance and reliability professionals who know details and will ascertain that due attention is paid to details.

While there are certainly dozens of examples that could illustrate how important lubrication details are being overlooked, we will let Figure 1 illustrate our point. Figure 1 depicts four different bearing configurations; some of these benefit from a shielded, grease-lubricated bearing. Note that the grease cavity is adjacent to one of these shields. Grease is a mixture of about 90% oil and 10% “soap.” Shields have a small annular gap, and it is through this gap that a few drops of oil are expected to migrate or “bleed” into the bearing in a full day’s time. Therefore, the design intent is for a small amount of oil to bleed from the housing’s grease cavity past the annular gap of a grease shield. If, during the regreasing process, a maintenance technician applies pressure from a grease gun without first removing the drain plug from the housing, the adjacent shield may be pushed into the rolling elements.

We refocus our attention on the costly bearing failures reported at the recent conference. If the two engineers had all the details and would act on facts, their bearings would probably live much longer.

Heinz P. Bloch, P.E., is owner of Process Machinery Consulting (www.heinzbloch.com) in Westminster, Colorado, and the author of numerous articles and books, including “Improving Machinery Reliability” and “Pump Wisdom.” His professional career commenced in 1962 and included long-term assignments as Exxon Chemical’s regional machinery specialist for the United States. He has authored more than 560 publications, among them 18 comprehensive books on practical machinery management, failure analysis, failure avoidance, compressors, steam turbines, pumps, oil-mist lubrication, and practical lubrication for industry. Bloch holds BS and MS degrees in mechanical engineering. He is an ASME Life Fellow and maintains registration as a professional engineer in New Jersey and Texas. Contact him at heinzpbloch@gmail.com.

Figure 1. Rolling element bearings with two seals (upper left), open and with grease cavity adjacent to bearing (upper right), single-shield bearing with shield shown on wrong side (lower left), open bearing with cross-flow grease path (lower right).
STOP KILLING YOUR BEARINGS!!

Use ULTRASOUND ASSISTED LUBRICATION

Cut your bearing failure rate with UE Systems Ultrasound Assisted Lubrication program. A combination of identifying bearings running dry and using an ultrasonic Grease Caddy to know when to stop lubricating, will keep your bearings running for a long time.

Learn how: View this short video »

For a complimentary Lube Guide, click here.

UE SYSTEMS INC
The ultrasound approach

PH: 800-223-1325
info@uesystems.com
www.uesystems.com
Johann Haltermann is a custom processing manufacturing plant in Houston and is a division of the four family-owned Monument Chemical Plants in operation in the United States and in Europe. Monument Chemical offers a line of specialty products and solvents, custom manufacturing services, and, through Haltermann Solution, specialty fuels. Monument Chemical manufacturing plants are located in Antwerp, Belgium; Brandenburg, Kentucky; Houston and Baytown, Texas. The Antwerp and Brandenburg plants operate as Monument Chemical. The Houston and Baytown plants operate as Johann Haltermann and Advanced Aromatics, respectively. All facilities have long histories of distillation and reaction chemistry and have easy access via water, road, and rail.

PREVENTIVE MAINTENANCE PLAN
In 2012, custom processing manufacturing plant Johann Haltermann set out to implement an aggressive plan to reduce equipment failures by 25% to meet production requirements. Rick Caines, Adam Pingel, and I led a program driven by the need to fulfill increased customer orders during a period of business growth. The plant historically had opportunities for improvements on the rotating equipment side from the nature of the operating conditions and the demanding load applied to the equipment. The Haltermann team began the process by looking for a preventive maintenance program that would address how equipment already in place could be improved with regard to reliability.
The first point of focus of the preventive program was from the lubrication standpoint. Based on experience, a pump seal only lasts as long as a bearing lasts, and a bearing lasts as long as the oil’s ability to maintain its proper lubrication properties. The team researched several different oil manufacturers and selected a high-performance synthetic-lubrication manufacturer to provide a presentation on the benefits of using its products.

A Falex test was done, using the ISO 68 oil we were currently running through most of our pumps. The test showed that Royal Purple’s Synfilm 68 film strength exceeded the lubrication qualities of the ISO 68 that Haltermann was utilizing. I was impressed by the film strength of the Synfilm 68 and its ability to maintain lubrication under extreme bearing load without any metal loss and still produce a 50% reduction in power consumption.

TRY THE INVESTMENT

The next step was determining justification of the cost. The proposed synthetic lubricants would cost twice as much as the conventional oil. Our team felt strongly that better lubrication and film strength outweighed the investment price of the oil, and, if the new product could reduce bearing failures by 10%, then the increase in cost could be justified easily.

Mid-2012, we started the transition to Royal Purple by changing more than 500 pumps to Synfilm 68 in the ANSI and API pump bearing oils, and then we complemented this with the use of Royal Purple’s FDA 34 Barrier Fluid to satisfy pharmaceutical requirements and to improve on mechanical seal lubrication. Eventually, all of the equipment was changed over to Royal Purple lubricants, including Synfilm 32 in the high-speed gearboxes, Synfilm 150 in the cooling tower right angle drives, Synfilm GT 220 in the roots blowers, Acivac 100 in the

3 LUBRICATION KPIs TO REDUCE EQUIPMENT FAILURE

GET LUBRICATION-POINT DATA FOR MORE GRANULARITY

By Kirk Williams, Albemarle, and Bill Correll, Generation Systems

For many industrial operations, lubrication remains a vexing challenge. Indeed, when machine bearings fail, there’s a better than 70% chance that faulty or insufficient lubrication practices are ultimately to blame, according Ken Bannister’s “Lubrication for Industry” (http://store.noria.com/Lubrication-for-Industry-Second-Edition-P3.aspx). Lubrication-specific key performance indicators (KPIs) can go a long way to address this costly problem. The key to making them work? Getting the right data from the outset.

Tracking KPIs that target lubrication gives maintenance professionals unique insight they can harness to reduce the frequency of machine failures. In addition, lubrication-based KPIs can help organizations to increase equipment uptime and productivity, enhance the availability, performance, and lifespan of expensive assets, improve maintenance efficiency, and reduce costs.

Some high-level lubrication KPIs provide a snapshot across entire operations. One of these is overall equipment health, a useful gauge of plant readiness. It shows the percentage of all equipment in a facility with no known issues or defects. Another is lubrication-related failure, which is often a simple calculation of the monetary cost, number of incidents, or other measures of equipment failures that can be traced to lubrication over a given period of time. More targeted lubrication KPIs cover such areas as lubrication program effectiveness, costs, lubrication cleanliness and quality, health and safety issues, and lubrication storage, among others.

While a number of lubrication KPIs can be generated using data from CMMS, EAM, and other generalized predictive and preventive maintenance management tools, some of the most valuable ones require data gathered at the level of the individual lubrication point. Three examples include lubrication task completion, lubrication tasks past due (backlogs), and lubrication consumption.

LUBRICATION TASK COMPLETION

This lubrication KPI gives reliability and maintenance managers a clear picture of the overall efficiency of lubrication practices at the task level. It’s a measure of the total number of completed lubrication tasks divided by the total number of scheduled lubrication tasks over a certain timeframe. A low figure may reveal inefficiencies in such areas as lubrication routes, workload balancing, resource allocation, or equipment access.
LUBRICATION TASKS PAST DUE
This is the mirror KPI to task completion. It reflects the total number of lubrication tasks not yet completed versus the total number scheduled. A high figure here reveals similar concerns as a low task completion score. More important, this KPI, along with task completion, tells maintenance organizations how often and to what degree lubrication goals are being met.

LUBRICATION CONSUMPTION
This KPI provides invaluable insight to help engineers and technicians rapidly spot potential problems and trends. It can be a broad measure of the amount of lubricant used over time across different facilities or a more tightly focused view of lubrication consumption within a given department or area of a plant. Irregular levels of consumption may indicate leakage, poor lubrication practices, issues with lubricant quality, or other concerns.

LUBRICATION POINT DATA IS CRITICAL
To give an accurate picture of lubrication task completion in a given facility, the KPI must contain verifiable data about how often every lubrication point has been serviced, by whom, with which lubricant, in which amount, whether any lubrication points have been missed and other vital details. The same level of lubrication-point information is necessary to create useful KPIs about consumption and a host of other KPI topics.

For organizations looking to reduce the frequency of equipment failure and take their lubrication efforts to the next level, KPIs that provide insight into lubrication consumption, failure trends, workloads, and task history can be a very powerful tool. It’s also helpful to perform KPI analysis on such topics as lubrication consumption, failure trends, workloads, and task history.

Kirk Williams is reliability technician at Albemarle (www.albemarle.com) in Orangeburg, South Carolina. Contact him at kirk.williams@albemarle.com.

Bill Correll is head of business development at Generation Systems (www.generationsystems.com). Contact him at billc@generationsystems.com.

dry vacuum pump systems, and Max-Tuff for assembly processes.

EDUCATION
The next step in our preventive maintenance and reliability program was education enrichment for employees in operations and maintenance. We used the oil manufacturer’s Extended Services Classes, provided by Reliability Manager Bob Matthews, with whom I worked to develop a course curriculum that specifically fit the needs of the Haltermann plant technicians.

As a result of the classes, technicians learned how to maintain, repair, and operate equipment properly while increasing their awareness habits and improving the day-to-day quality level. Millwrights also improved their quality performance, and the training directly triggered a change to improve the environment in which the repairs were made with the addition of a clean room to improve the level of cleanliness to help to facilitate a higher level of repair.

Operations personnel undergo an eight-hour operator-awareness class to support the drive for improved reliability through a joint effort within maintenance and operations.

THE RESULTS
Prior to 2011, the plant historically had more than 175 pump-related equipment failures annually. In 2012, the equipment failures took a significant change in the right direction. The 2012 total dropped to 156 pump failures and a loss of 464 hours of production, and the 2013 failures were below 100 with an adjusted loss of 268 hours of production, a significant improvement over 2012. These impressive results add up to a 42% reduction of downtime in one year, and a cost avoidance of more than $460,000. The MTBF for 2012 was in the 28-month range, and the MTBF for 2013 is in the 60-month range. All of these improvements happened while producing a 20% increase in production for 2013.

Jesse Lloyd is reliability coordinator at Johann Haltermann (www.monumentchemical.com) in Houston, Texas. Contact him at jhlloyd@jhaltermann.com.
New

20 Volt Lithium-Ion Grease Gun

Built-in Intelligence

LCD with real-time information:
- Grease meter
- Grease level gauge
- Battery capacity gauge

Two flow rates:
- High — 6 oz/min (170 g/min)
- Low — 4 oz/min (113 g/min)

15 grease cartridges per battery charge

www.alemite.com
800-822-4579
Do We Need 20 MW Gas Engines?

Lubrication plays a major role in Turkey’s energy production

Finnish engine manufacturer Wärtsilä (www.wartsila.com) is a pioneer of gas-engine technology and has sold more gas engines than any other original equipment manufacturer (OEM). Worldwide, it has more than 700 experts working on research and development programs that are designed to maintain its competitive edge. Wärtsilä has an extremely strong presence in Turkey, with its generating capacity in the country exceeding 3 GW. Approximately 85% of these plants run on natural gas.

In 2005 at a global gathering of all Wärtsilä operating companies, Mehmet Ufuk Berk, managing director of Wärtsilä Turkey, urged the company’s research and development teams to develop a substantially larger gas engine. He knew there were technical challenges to be overcome and it would require a great deal of innovation, but he insisted there was an emerging market need for gas engines of about 20 MW. At the time, the largest gas engine on the market was the 9-MW-rated Wärtsilä 20V34SG.

Just five years later, Wärtsilä launched the 18.3-MW-rated 18V50SG, the biggest gas engine in the world. The first units to be installed were in Turkey for a power plant on the north coast. A few months later in the southeast of the country, independent power plant operator Odaş Elektrik purchased three units; an order for four more soon followed. In less than two years, Wärtsilä Turkey had sold 18 of these units.

With an output of some 18.3 MW, the Wärtsilä 18V50SG spark-ignition gas engine is the largest gas combustion engine generating set in the world. The natural-gas-fueled engine operates at more than 48% efficiency and is based on the technology of Wärtsilä’s smaller, established engines, such as the 20V34SG, but incorporates improvements that maximize the power potential of the engine.

Wärtsilä’s role extends beyond the supply of the engines. The company has also an agreement with Odaş Elektrik under which it provides scheduled maintenance services. Odaş Elektrik does not, therefore, have to consider its maintenance requirements or employ a maintenance team. Instead, it can focus exclusively on its core business of energy production.

The Odaş Elektrik power plant supplies the electrical grid during periods of peak demand, and so gas-fired reciprocating engine technology was a perfect fit because it can be fired up rapidly. The plant often has to be on standby waiting for the order to run. Gas engines offer the ability to answer with an immediate response.

Murat Gezgin, general manager, services, and Hakan Yildiz, contract manager, Wärtsilä Turkey, are convinced of the important role that lubrication plays in the operation of their engines. See more at www.plantservices.com/wartsila.

PS: How important is the quality of the lubricant to the performance of a gas engine?

HY: It is vital. The Wärtsilä 18V50SG engine that Odaş Elektrik is using has a power output of 18.3 MW. That means the engine produces 1 MW per cylinder, and that is a big challenge. The engine is operating under extreme conditions. The technology is performing at very high peak pressures, and it is vital that the lubricant can cope with this challenge and support our engine in these conditions. The quality of a lubricating oil is one of the most crucial points for the operation of an engine. If you don’t have a proper oil, you will have a lot of problems on the machine parts, and you will have a lot of downtime, which causes a lot of trouble.

PS: What steps can be taken to ensure research and development remains vitally relevant to OEMs and power plant operators?

MG: The big issues for gas-engine operators include maintenance, as the cost of operating engines can be a key parameter, efficiency, and power output. Work closely with external companies, both OEMs and customers. We learn from them. We gain insights into how the equipment and the lubricant operate in real-world situations and about the problems they face.

PS: What trends are occurring in the gas engine market?

HY: The use of gas engines has been growing rapidly since 2000. As the availability of gas has continued to increase, so have gas engine sales. We saw a significant change in 2004. That’s when we started to sell more gas engines than heavy-fuel engines. Moreover, the growth of renewable energy increases the need for flexible power plants such as those using gas-engine technology. The future for gas engines is extremely favorable.

PS: How important is the quality of the lubricant to the performance of a gas engine?

HY: It is vital. The Wärtsilä 18V50SG engine that Odaş Elektrik is using has a power output of 18.3 MW. That means the engine produces 1 MW per cylinder, and that is a big challenge. The engine is operating under extreme conditions. The technology is performing at very high peak pressures, and it is vital that the lubricant can cope with this challenge and support our engine in these conditions. The quality of a lubricating oil is one of the most crucial points for the operation of an engine. If you don’t have a proper oil, you will have a lot of problems on the machine parts, and you will have a lot of downtime, which causes a lot of trouble.

PS: What steps can be taken to ensure research and development remains vitally relevant to OEMs and power plant operators?

MG: The big issues for gas-engine operators include maintenance, as the cost of operating engines can be a key parameter, efficiency, and power output. Work closely with external companies, both OEMs and customers. We learn from them. We gain insights into how the equipment and the lubricant operate in real-world situations and about the problems they face.

PS: What trends are occurring in the gas engine market?

HY: The use of gas engines has been growing rapidly since 2000. As the availability of gas has continued to increase, so have gas engine sales. We saw a significant change in 2004. That’s when we started to sell more gas engines than heavy-fuel engines. Moreover, the growth of renewable energy increases the need for flexible power plants such as those using gas-engine technology. The future for gas engines is extremely favorable.
Des-Case Whitepaper: Benchmarking Your Lubrication Program

Maintaining clean oil is one of the best investments a company can make, yet contamination often remains an overlooked factor behind premature machinery failure and diminished lubricant life. With increases in the cost of oil, increased desire to minimize usage and waste, and the need to prolong the life of equipment, the economic case for protection – from the time oil enters a facility until it leaves – is stronger than ever.

We manufacture and sell only the highest quality lubricants to all types of industry. Our lubricants are sold throughout the world by industrial, construction, power transmission, bearing, and automotive and marine warehouse distributors. As an ISO-9001 registered company, we are totally committed to developing, manufacturing and selling quality products that meet and exceed your expectations.

Royal Purple is the world's leading lubricant company: The Performance Oil That Outperforms®.

Our product portfolio includes a complete line of premium synthetic lubricants and performance chemicals for automotive, commercial trucking and industrial applications. With our proprietary Synerlec® technology serving as the cornerstone for most of the products, Royal Purple lubricants excel in head-to-head performance tests by outperforming the competition.

UE Systems’ Ultrasound Condition Monitoring whitepaper

Most bearing failures are lubrication-related. Relying on time-based, periodic lubrication assumes bearings need to be greased at defined time periods. By using ultrasound technology, along with standard practices such as removing old grease and replacing it with new, technicians can combine standard, time-based maintenance with condition-based, predictive maintenance, gaining in the process both a clearer picture of what's really going on and better reliability.