Machinery Lubrication

India November-December 2016 machinerylubricationindia.com

INSIDE

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Why Hydraulic Oil Changes Color

15 Lube Tips to Help You Achieve Lubrication Excellence

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Contents»

12 COVER STORY

15 Tips to Help You Achieve Lubrication Excellence

Machinery Lubrication India magazine presents 15 of the best lubrication tips that have been offered through the years.

Machinery» Lubrication India

November-December 2016

3 LUBRICATION BASICS

Why You Should Maintain Precise Oil Levels in Sumps and Reservoirs

Checking an oil level indicator might seem like a small task, but it can be critically important for the reliability of your machinery. Learn why maintaining a precise oil level in certain sumps and reservoirs is important due to the influence the oil level has on internal components.

6 AS I SEE IT

Will ISO 55000 Change the Definition of Lubrication Excellence?

The recent standard published by the International Organization for Standardization (ISO) could be a game-changer for machinery asset management and the field of reliability.

19 FROM THE FIELD

Understanding the Economics of Maintenance and Reliability

Successful maintenance and reliability managers understand the investments of time, money and energy, including how the three are related and can be substituted for one another. Learn the expected returns and strategies that can be employed to yield better results.

21 HYDRAULICS

Why Hydraulic Oil Changes Color

Find out when an oil color change indicates your system is suffering from lost lubricating properties or gross contamination and when it is simply a normal aging characteristic that should be dismissed.

23 LESSONS IN LUBRICATION

Selecting the Right Oil Analysis Lab

Often the steps involved in selecting an oil analysis laboratory are guided by the wrong motivations. Discover which factors you should consider and why your end goal can provide the answers to these important decisions.

28 LUBE-TIPS

Our readers offer advice on a host of lubrication-related issues, including tips on storing grease guns, using synthetic oils, changing oil in small pumps, checking lubricant compatibility and employing a magnet for routine oil inspections.

More Editorial Features

29 GET TO KNOW
31 INDUSTRY NEWS
32 ASK THE EXPERTS
34 TRAINING
35 TEST YOUR KNOWLEDGE
36 BASE OIL REPORT

Publisher's Note

The slower growth of China has given India an opportunity to become the bright prospect on the horizon, creating potential for rapid growth in lubricant consumption also Indian govt is tightening the screws on controlling the air pollution which has also thrown a huge opportunity for the industry by increased use of modified / synthetic lubricants and fuels. However despite these positive factors, the first three quarters of fiscal year 2015-2016, India's lubricant market appears to have fallen short of expectations. While giving scant credence to government statistics signalling a steep drop in demand volumes through the first nine months of the year, industry insiders agree that demand volumes saw little to no growth. With the 'Make in India' campaign started by Honourable Prime Minister, Indian lube manufacturing enterprises have got a huge scope as the current scenario is already showing India to be the third largest lubricants market in world behind America and China. Around 60% of the same is contributed by the automotive segments in different space and around 40% is used in Industrial Applications. In the lubricant segment in India, Indian Oil Corporation commands the highest share, followed by other majors like Hindustan Petroleum and Bharat Petroleum based on reports data. While these big three PSU players covers nearly 50% of the market share, the rest consists of the public and private players such as Balmer Lawrie, Gulf Oil, Castrol, ExxonMobil, Shell ,Valvoline, Tide water Oil etc.

The Sept-Oct 2016 issue which was a "Special Oil Analysis Issue" got great reviews from the readers. Based on your feedback, we shall have more articles on Oil Analysis, Interpretation and their impact on machine reliability.

This issue of Machinery Lubrication India has a cover story that brings you the best lubrication tips which when applied can prove to be fruitful and prevent frequent and untimely breakdowns. Implementing these lube tips can increase machine efficiency as well. Another article on Hydraulic Oil gives clears the misnomer about the color of hydraulic oil.

We look forward to your continued feedback which helps us to improve the quality of this publication.

We wish our readers, advertisers a Happy Merry Christmas and a prosperous 2017.

Warm regards,

Udey Dhir

GARRETT BAPP | NORIA CORPORATION

Why You Should Maintain PRECISE OIL LEVELS in SUMPS and RESERVOIRS

Are you one of those people who checks your car's oil level before departing on a long road trip? Have you ever asked yourself why it is so critical to maintain the oil level within the hash marks on that dipstick? Of course, the primary reason is to prevent engine failure, but what happens when the engine is low one or two quarts of oil? Can the engine continue to operate in this state without damaging the components and the oil?

This principle of maintaining precise oil levels applies to all types of equipment. I've seen instances where the correct oil level was critical. For example, I was once responsible for maintaining two 1,100-horsepower gearboxes. When these gearboxes arrived onsite, I noticed immediately that the upper and lower oil level limits were within one-half inch of each other on the dipstick. Both gearboxes were on a circulating system. This was a simple system that contained a pump, filter, oil cooler and oil piping to the gears inside the box. At first I didn't understand why the oil level had to be so precise on a force-fed system. Later, when looking at the blueprint of the gearbox, I discovered why it was so important. These gearboxes had input bearings that didn't receive oil from the circulating system. The only oil introduced to these bearings was the oil that was maintained in the sump. Letting the oil level drop below the specified mark on the dipstick would allow the oil to fall below the input bearing housing and cause the bearings to run dry.

Automobiles

Most people jump into their cars every day and commute to work, school or other locations. It has become a convenience to schedule an appointment to have a local dealership, mechanic or service station maintain your vehicle for you. They tell you when your next oil change should be, make necessary repairs and even keep service records for you.

Why are these inspections so important for lubricated components? In addition to changing your automobile's fluids at specified mileage intervals, technicians are also looking for leaks that could cause different components to fail due to a lack of lubrication. A car has many components that require some sort of lubricant. The expensive ones are the drivetrain, engine, transmission and differential. If one of these fails, you're looking at major repair bills.

Take the engine, for example. The manufacturer specifies how much oil the engine should hold. For instance, my car takes 6.5 quarts. While this may seem like a lot, the engine oil performs different functions besides just lubricating the crank, cam and other components. One of its jobs is to cool

Checking a level indicator might seem like a small task, but it is **critically important** for the **reliability of your machinery.**

the frictional surfaces and give the oil time to cool down before being reintroduced to the delivery system. Another is dispersing contaminants within the sump.

A high oil level in the crankcase can lead to oil churning. Depending on the severity, this increased agitation can result in foaming problems. Churned motor oil produces increased oil temperatures, which causes oil oxidation and lower oil pressures. Aerated oils become spongy and harder to pump, which can lead to starvation within the engine.

A low oil level in the crankcase can also result in lubricant starvation if it is low enough. However, just being one quart of oil low can make a difference in the life of the engine and the oil. With less oil in the sump, the same oil must now make more passes through the system without a cooldown and release period. The frictional zones within the engine that generate heat are exposed to higher temperature oil, which will start to oxidize faster. Also, being low a quart of oil changes the amount of additives in the system and how they are depleted. While being one quart low won't lead to an immediate failure, it has a huge impact on engine longevity.

Gearboxes

When discussing gearbox oil delivery systems, there are two primary types: circulating systems and splash- or bath-lubricated systems. Circulating systems deliver oil to the bearings and gears inside the housing by use of a pump. These systems usually consist of a pump, filter, oil cooler and piping to supply fresh oil to internal components. With splash- or bath-lubricated systems, the internal components of the gearbox are partially submerged, allowing the lubricant to be picked up to create a lubricating film. Although each of these systems operates using different principles, they have the same goal: supply lubricant to the internal components to reduce friction.

When maintaining circulating systems, being low on oil generally isn't as devastating to the internal components as it is to the lubricant. You just don't want too high or too low of an oil level. I have found that when running an oil cooler in line with the flow of fluid, you can get away with a lower oil level without damaging the equipment and the oil. However, if the oil level gets too low in the system, the pump may start to suck air and decrease the amount of oil delivered to the internal components.

In splash- and bath-lubricated systems, a precise oil level is very important. If the level is too high, the oil can aerate and may not deliver a substantial oil film. Frequently, foaming issues result if the oil level is too high in a splash-/bath-lubricated gearbox. If the oil level is too low, lubricant is starved from component surfaces and rapid wear is generated, causing machine failure. This is probably one of the costliest failures due to metal-on-metal friction, which can lead to shaft, housing and other machine damage. It's crucial when installing or maintaining splash- or bath-lubricated gearboxes to set the oil level correctly. Failure to do so can be the difference between getting one hour or 10 years of operation.

Pumps

Maintaining a correct oil level is also critical to the operation of oil-lubricated pumps. I've been in many plants that employ constant-level oilers. When asked why they use this type of device, the response is usually because it came with the pump or to check the oil level. However, constant-level oilers should not be used to determine the oil level. Think of it like a dog's water bowl with a 2-liter bottle for a reserve. The constant-level oiler supplies oil when the level decreases in the sump, just like the reserve of water refills the bowl when your dog takes a drink. While the water level in the dog's bowl doesn't matter as long as there's some water in the bowl, the oil level in your pump does matter.

The majority of pumps set the oil level halfway up the lowest roller on the bearing. This supplies adequate lubricant film to the bearings while reducing energy consumption and oil churning.

Damages

Not only does the machine suffer if there is an inaccurate oil level, but so

does the lubricant. When oil levels are too low, rapid machine damage occurs. There may be an increase in friction due to boundary conditions from a shortage of lubricant film or viscosity changes created by increased oil temperatures. This metal-to-metal contact is adhesive wear that leads to smearing (material transfer), spalling, pitting and seizing. If oil levels are low for long periods of time, higher equipment rebuild costs may result.

High oil levels usually affect the lubricant properties. Some machine damage may also take place if the level is not corrected. When the oil level is high for long periods of time, the equipment can aerate the oil, which changes the viscosity, speeds up oxidation and uses up additives. If the machine is run in these conditions, the lubricant film strength weakens, boundary conditions form and machine damage may occur.

Causes of Incorrect Oil Levels

Leakage is probably the No. 1 cause of a low oil level. Many points on equipment can suddenly or gradually fail. Seals may pressurize and allow oil to leak. Gaskets can fail due to age or excessive heat. Remember, everyone has leaks of some sort with their equipment. It's how you deal with these leaks and move forward that will determine if machine damage will occur.

When leaks are discovered, they should be categorized by priority, tagged and entered into the maintenance system for repair or monitoring. Typically, employees will notice a small leak and ignore it or top off the oil to the correct level and go about their day. Of course, small leaks turn into bigger leaks that can be more difficult to remedy. Even if a leak remains small, over time there will be increased lubricant consumption, disposal and labor.

39%

of lubrication professionals do not maintain precise oil levels in the sumps and reservoirs at their plant, according to a recent survey at MachineryLubrication.com

Another cause of an incorrect oil level is misunderstanding the recommendations from the original equipment manufacturer (OEM). Sometimes it's not clear where the level should be and may depend on how you look at it from different positions and angles. The OEM manual should have diagrams and instructions on where to set the oil level in your equipment. If you are still confused as to where the level should be, call the manufacturer and ask. It is crucial to get it right. If you fail to maintain the correct oil level from implementation, internal damage can happen immediately and shorten the life of the equipment.

The oil level should also be clearly marked for field inspection. I've often seen oil level indicators with no markings to specify where the level should be maintained. This is especially important with column-level indicators where the oil level can range 6 to 15 inches depending on the length of the indicator.

Remedies

A number of things can be done to ensure the right oil level is maintained in your equipment. As mentioned previously, the oil level should be determined before the equipment is turned on for the first time. The best time to decide on the appropriate oil level is when the equipment first arrives at your facility. This is when all the decisions are made on how to retrofit the equipment for your reliability goals.

Once the correct oil level is identified, it must be clearly marked in the field. This can be achieved with upper and lower limits on the column indicator. Use a material that is durable enough for the environment. Also, record the lubricant volume and other relevant notes in a database.

Develop procedures for everyone to follow, including what to do if a low or high oil level is discovered. Reporting a problem at this phase can help with troubleshooting later for a root cause analysis. Not all problems show up right away within your equipment. It may take months or years before a small defect becomes a big issue.

In addition, address when the oil level should be read. When machinery is operational, the oil level usually reads less. This can lead to false readings and added work. I've seen situations when an oil level was topped up to the upper limit while the machine was running. When the equipment was shut down, the oil level was past the upper limit.

Don't forget to record all top-up volumes. What might be a small leak today could turn into a large leak tomorrow. All leaks should be reported and prioritized.

Finally, train your personnel. Checking a level indicator might seem like a small task, but it is critically important for the reliability of your machinery.

While not every piece of equipment will self-destruct because the oil level is higher or lower than it should be, there are machines that can be expected to fail based on the oil level. In my view, every machine should be treated with the same expectations of controlling the oil level and making sure it is well-maintained. ■

About the Author

Garrett Bapp is a technical consultant with Noria Corporation, focusing on machinery lubrication and maintenance in support of Noria's Lubrication Program Development (LPD). He is a certified lubrication specialist through the Society of Tribologists and Lubrication Engineers (STLE) and holds a Machine Lubrication Technician (MLT) Level II certification through the International Council for Machinery Lubrication (ICML). Contact Garrett at gbapp@noria.com.

Jim Fitch | Noria Corporation

Will ISO 55000 Change the Definition of LUBRICATION EXCELLENCE?

This past year I've been spending a lot of time studying the possibilities of ISO 55000, especially its long-term impact on the lubrication field. I was a bit skeptical at first. Now I view it as a game-changer to machinery asset management and the field of reliability in general. If you haven't heard of ISO 55000, this might be a great time to get acquainted — very acquainted.

ISO 55000 is an international standard published by the International Organization for Standardization (ISO), created and approved by representatives from 10 countries, 50 organizations and 15 different industries. The foundational elements of ISO 55000 originate from the British Standards Institution (BSI) standard PAS 55. It provides an overarching framework for using modern principles of asset management to achieve a wide range of precisely defined organizational objectives.

An asset, by definition, is anything that has future value. Plant machinery and

ISO 55000 IN SIX ESSENTIAL STEPS

STEP	STEP ELEMENT	ELEMENT DESCRIBED IN THE CONTEXT OF AN ASSET MANAGEMENT SYSTEM	ELEMENT DESCRIBED IN THE CONTEXT OF MACHINERY LUBRICATION	ISO 55001 CHAPTERS
1	The Larger Organizational Objectives	Organizational objectives in the use of all assets: safety, financial, social, regulatory, environmental, readiness	Organizational objectives in the use of machinery assets: safety, financial, social, regulatory, environmental, readiness	4
2	Asset Management Objectives (policies) that Support Organizational Objectives	High-level management commitment statement related to the optimum use and management of assets to achieve organizational objectives (within the constraints of the organization)	High-level management commitment statement related to the optimum use and management of machinery assets to achieve organizational objectives (within the constraints of the organization)	5
3	Asset Management Transformation Plan	Development of a specific, optimum and documented asset management plan needed to achieve organizational objectives	Definition of the lubrication optimum reference state (ORS) and transformational steps needed to achieve the machinery asset management objectives. ORS elements include skills and training, lubricant selection, lubrication procedures, machine readiness, oil analysis processes, key performance indicators (KPIs), etc.	6
4	Implementation of Asset Management Transformation Plan	Execution of transformation steps needed to close gaps between the current asset management state and the planned optimum state	Execution of the transformational steps needed to close gaps between the current state of lubrication and the planned optimum state for all machinery assets utilizing lubricants	7, 8
5	Performance Assessment	Using an independent auditor, assess (by verification or measurement) the alignment of the current transformed state of asset management with the optimum planned state	Using an independent auditor, assess (by verification or measurement) the alignment of the current transformed state of machinery asset lubrication with the planned optimum reference state	9
6	Performance Improvement & Governance	Closure/remediation of remaining gaps by continual improvement	Closure/remediation of remaining gaps by continual improvement	10

equipment are most commonly referred to as assets. However, people are assets too, as is software, intellectual property (e.g., patents and trademarks), knowledge/skills, goodwill and so much more. In a nutshell, asset management can probably be best summed up by the following sentences excerpted from ISO 55000. Certain words are underlined to emphasize concepts and themes that I will further develop in this and future columns.

"Asset management involves the balancing of costs, opportunities and risks against the desired performance of assets, to achieve the organizational objectives."

"An asset management system provides a structured approach for the development, coordination and control of activities undertaken on assets by the organization over different life cycle stages, and for aligning these activities with its organizational objectives."

ISO 55000 has many similarities to ISO 9000, which focuses on quality management and assurance. More than 1 million organizations are now certified by ISO 9000 worldwide. Conversely, ISO 55000 is written in the context of asset management and its many familiar subcategories. These subcategories include reliability, reliability-centered maintenance (RCM), total productive maintenance (TPM), preventive maintenance, predictive maintenance, proactive maintenance, oil analysis, lubrication, etc.

There are three parts to this standard, which are listed below. For simplicity, my reference to ISO 55000 in this column includes the three parts collectively:

1. ISO 55000: Asset Management – Overview, Principles and Terminology
2. ISO 55001: Asset Management — Management Systems — Requirements
3. ISO 55002: Asset Management — Management Systems — Guidelines for the Application of ISO 55001

The adoption of ISO 55000 (all three parts) "enables an organization to achieve its objectives through the effective and efficient management of its assets ... consistently and sustainably over time." This process can be distilled down to six key actionable elements. These are shown in the table below and flow like a sequence of steps. Although the steps suggest a beginning and an end, asset management is a living, continuous journey with no ultimate finality.

The fourth column in the table is my effort to restate each step element in the context of machinery lubrication. To the far right are the individual chapters (from ISO 55001) corresponding to the elements. A copy of this standard can be obtained via the ISO website (www.iso.org).

Using ISO 55000 to Write an Engineering Specification for Lubrication Excellence

Think of ISO 55000 as a detailed framework, like a template or programmatic checklist, for writing an engineering specification for lubrication excellence. The foundation for the framework is rooted in well-tested organizational principles such as management of change, management science, process control, quality assurance and many others.

ISO 55000 doesn't advise you on needed lubrication improvements in your plant. In fact, I was unable to find the words lubricant or lubrication anywhere in this document (nearly 80 pages). Yet, for machinery-intensive organizations, reliability is intensely related to lubrication. Reliability and machinery asset management require enablers. There is no better enabler than lubrication excellence.

The concept of optimum and balance is a fundamental principle to achieving lubrication excellence and compliance to ISO 55000. However, this standard doesn't define optimum but rather guides you, or your organization, in seeking and defining optimum based on many factors and constraints that surround each decision. These are unique to your plant, work environment and individual machines. They generally include overall machine criticality (likelihood and consequence of failure), failure mode ranking by likelihood and severity (FMEA), the range of available options

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BENEFITS KEY

- ■ = Machine Reliability Benefit
- ◆ = Maintenance Labor and Material Cost Savings
- 💧 = Lubricant Consumption/ Cost Savings
- ▲ = Filter Consumption/ Cost Savings
- ⬢ = Enhanced Safety
- ● = Environmental Benefit

ORS PERFORMANCE ATTRIBUTES		OPTIMUM REFERENCE STATE (ORS) TACTICS THAT ENHANCE AND HELP THE ENVIRONMENT: LUBRICANT SELECTION	LUBRICANT HEALTH	CONTAMINATION CONTROL
Lubricant Attributes	Optimum lubricant products and supplier selection	■ ◆ 💧 ●	■ ◆ 💧 ●	■ ◆ ▲ 💧
	Lubricant reception, labeling, packaging, storing and handling	■ ◆ 💧 ●		■ 💧
Lubrication Attributes	Optimum selection of oil change and regrease intervals		■ ◆ 💧	
	Optimum selection, documentation and use of lubrication and oil analysis PMs, tasks and procedures		■ ◆ 💧	■ ◆ ▲ 💧
Machine Attributes	Proper selection and location of filters		■ 💧	■ ▲ 💧
	Correct selection and location of oil level gauges and inspection sight glasses		■ 💧	■
	Correct selection and location of sampling valves			■
	Optimum selection of breathers and headspace management devices		■	■
	Correct machine relubrication and flushing hardware and tools		■	■
	Optimum selection and use of seals and leakage control devices			
	Optimum selection and use of seals to control contaminant ingression		■	■ ▲ 💧
Oil Analysis Attributes	Oil analysis program design and execution	■ ◆	■ ◆ 💧	■ ◆ ▲ 💧
People & Program Management Attributes	Awareness training, skills training, competency testing	■ ◆	■ ◆ 💧	■ ◆ ▲ 💧
	Optimum use of lubrication program metrics and KPIs	■ ◆	■ ◆ 💧	■ ▲ 💧
	Optimum program management, data management and work management systems		■ 💧	■ 💧
Other	Proper lubricant waste and disposal hardware and practices			

Figure 1. Attributes are actions taken by plants and organizations. Most attributes support multiple tactics. Tactics produce benefits.

(to each decision), the ability to successfully implement/execute the options, and budget/resource constraints.

Each decision is an attribute in support of a larger optimum state, a concept required for ISO 55000 compliance. Noria refers to this using the term the optimum reference state (ORS) for machinery asset management and lubrication excellence (see the ORS sidebar). In the left column of the table above, ORS performance attributes are listed by category. To the right are the tactics that drive the benefits coming from an optimum state. The benefits are color-/shape-coded and are defined in the key in the upper left corner. They include reliability (downtime), labor and material, lubricant consumption, filter consumption, safety and environment.

The good news is that most of these attributes can be deployed and controlled entirely by asset owners/users. The table on page 6 shows the same list of ORS attributes keyed to those who have the greatest control in driving transformation to an optimum state. As can be seen, users command

69%

of lubrication professionals say their plant has not achieved lubrication excellence, based on a recent poll at MachineryLubrication.com

RELIABILITY, REDUCE COSTS, INCREASE SAFETY		
LUBRICANT LEVEL/ SUPPLY	ROOT CAUSE AND FAULT DETECTION	SAFETY, WASTE AND ENVIRONMENT
■ ◆	■ ◆	⬢ ●
		⬢ ●
■ ◆		● 💧
■ ◆	■ ◆	⬢ ●
		●
■ ◆		
	■	
■ ◆		⬢
■		💧 ⬢ ●
	■ ◆	●
■ ◆	■ ◆	⬢ ●
		⬢
■ ◆	■ ◆	⬢ ●
		⬢ ●

Getting lubrication to an optimum state of excellence requires complete organizational alignment. ISO 55000 was precisely constructed to enable this alignment.

The Optimum Reference State

The lubricant optimum reference state (ORS) is a critical concept in the journey to world-class lubrication and enhanced machine reliability. In short, it is the prescribed state of machine configuration, operating conditions and maintenance activities required to achieve and sustain specific reliability objectives. Lubrication excellence is achieved when the current state of lubrication approaches that of the optimum reference state.

There are many different critical attributes of the ORS. These attributes relate to people preparedness, machine preparedness, precision lubricants, precision lubrication and oil analysis. Achieving the ORS almost always involves change or modifications. Each attribute must be:

1. Precise and definable (e.g., a specific lubricant sump level),
2. Measurable (e.g., a specific viscosity) or verifiable (e.g., a sample port location),
3. Controllable (by modification) and sustainable (by program continuity),
4. Able to achieve the desired reliability objectives related to the financial benefit, safety and machine readiness.

primary control of 10 of the 16 attributes listed.

This works best when users believe that optimized lubrication: 1) is considerably different from the current state of lubrication in many critical areas, 2) will bring real value to users' organizations and to maintenance workers individually (financially and in career development), 3) can be deployed with manageable risk and cost, and 4) is sustainable. There is no better way to achieve this than through training, which is effective in building knowledge, skills and an improved maintenance culture.

Viewing ISO 55000 from the Top

Getting lubrication to an optimum state of excellence requires complete organizational alignment. ISO 55000 was precisely constructed to enable this alignment, a goal that should be sought by senior leaders of any organization. Naturally, this must start by defining the highest-level organizational objectives. Next, the asset management policy and plan should be constructed to conform and deliver on these objectives. The subsequent execution of this plan should stay true to this alignment, which is ultimately confirmed by independent assessment and certification.

When done well, the organization gets the most of what it wants and the least of what it doesn't from its assets. After all, don't all organizations want the most for the least? The least is a short list and includes cost and risk. The most is a longer list and frequently includes reliability, environmental responsibility, Current State (A) → Straight Line → (B) Optimum Reference State

■ = Primary
● = Retroactively
▲ = Somewhat

ORS PERFORMANCE ATTRIBUTES		CONTROLLABLE BY				
		USER ORGANIZATION	OEM	LUBE SUPPLIER	OIL ANALYSIS LAB	RESEARCHERS
Lubricant Attributes	Optimum lubricant products and supplier selection	■	▲	▲		▲
	Lubricant reception, labeling, packaging, storing and handling	■		▲		
Lubrication Attributes	Optimum selection of oil change and regrease intervals	■	▲		▲	
	Optimum selection, documentation and use of lubrication and oil analysis PMs, tasks and procedures	■	▲			
Machine Attributes	Proper selection and location of filters	●	■			
	Correct selection and location of oil level gauges and inspection sight glasses	●	■			
	Correct selection and location of sampling valves	●	■			
	Optimum selection of breathers and headspace management devices	●	■			
	Correct machine relubrication and flushing hardware and tools	■				
	Optimum selection and use of seals and leakage control devices	●	■			
	Optimum selection and use of seals to control contaminant ingression	●	■			
Oil Analysis Attributes	Oil analysis program design and execution	■		▲	▲	▲
People & Program Management Attributes	Awareness training, skills training, competency testing	■				
	Optimum use of lubrication program metrics and KPIs	■			▲	
	Optimum program management, data management and work management systems	■				
Other	Proper lubricant waste and disposal hardware and practices	■		▲		

Figure 2. The pursuit of lubrication excellence is largely accomplished by plants and organizations (users) that take actions consistent with ORS attributes.

safety, quality, satisfied customers, satisfied employees, profitability and high shareholder return.

Integration of lubrication concepts with the broader field of asset management and ISO 55000 is a seismic shift that's rich with benefits and rewards. Its tenets of process and execution are rock solid. For asset owners and users, this greatly controls risk, cost and guesswork in the pursuit of lubrication excellence. You'll hear much more about ISO 55000 in future issues of *Machinery Lubrication* and from Noria in the coming months and years. We'll break it down into the many subcategories of lubrication and oil analysis where it is best applied. Folks, it's a whole new ballgame. Finally, it's time to achieve the optimum. ■

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 courses 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 the director and a 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.

Tips to Help You Achieve Lubrication Excellence

Machinery Lubrication India presents 15 of the best lubrication tips that have been offered through the years.

1. Test New Lubricant Deliveries

F or certain machines, deviations in lubricant quality can lead to disastrous consequences. This punctuates the need to confirm the quality of new lubricant deliveries, especially when the need for reliability is particularly important. Likewise, a quality-minded lubricant supplier will appreciate receiving feedback, both good and bad, from users who run such tests.

Another important benefit for testing new lubricants is to establish a baseline for routine used-lubricant analysis. Even when new lubricants are well within acceptable quality limits, there may be considerable variations in physical and chemical properties (batch to batch). For instance, viscosity can vary plus or minus 10 percent from the ISO viscosity grade (VG) midpoint and still be "in grade." Cautionary limits are sometimes set at plus or minus 5 percent from new lubricant viscosity. Hence, the specific new lubricant viscosity must be known.

By taking an active role in testing new lubricants and giving constructive feedback to your supplier, incremental improvements in lubricant quality are bound to result. Lubrication excellence is a collaborative process. Lubricant quality is a measurable property. If it's important, measure it.

2. Avoid Overgreasing

Overgreasing can have many of the same negative side effects as undergreasing, plus the added cost of high lubricant consumption. Greasing can be thought of as a purging or filtering of contaminants from the bearing, but you should not exceed a calculated amount of grease when performing greasing activities.

The calculated quantity of grease for a bearing is based on its geometry and dimensions, which provide the ideal amount for relubrication. The misconception is to apply more grease than needed to purge out contaminants. The right approach is to apply a fraction of the calculated quantity at a shorter time interval. This helps eliminate overgreasing at a given interval but still supplies the benefit of purging contaminants out of the bearing, just like automatic grease systems.

One of the most common ways to overgrease is to use an automatic grease system without proper calibration, maintenance and interval calculations. The premise and benefits of automatic grease systems are to provide a small amount of grease very often to promote a more continuous grease application. In order for this to work and be beneficial, the technician must know how much grease to add at the right time and calibrate the automatic grease system accordingly. If it is not calibrated correctly, it is likely that too much grease will be supplied too often, which can result in a bearing failure and high grease-consumption costs.

3. Achieve and Sustain Dry Oil

You don't have to remove what you don't allow in. Indeed, it's hard to question the logic of controlling water ingression. But because moisture is everywhere, achieving bone-dry through exclusion alone may not be practical or even necessary. Lubricating oils have different degrees of hygroscopicity (water-loving tendencies), making the control of all dissolved water an almost futile exercise. However, for many applications, it's the free and emulsified water that is the most destructive and, hence, the central target for control.

Exclusion relates to the process of preventing (excluding) the ingress of water from environmental, machine and process sources. Common points of water ingression include:

- Water from makeup oil (some supply tanks can collect inches of water below the oil level)
- Turbine gland steam seals (improper pressure regulation)
- Defective vapor extraction system (too high can suck in steam while too low can fail to keep up with ingress)
- Process water in-leakage from pulp and paper production, water treatment plants, sewage treatment plants, etc.
- Oil cooler leaks
- In-leakage of water past seals from washdown sprays, rain and flooding conditions
- Reservoir and sump headspace vent/breather ingress

The top-line priority is to squelch ingression points through tight and well-managed ingression control. Deferring maintenance of worn seals, defective breathers and coolant leaks creates more expensive maintenance events in the future, including the possible cost of premature oil changes, flushing, oil dehydration and replacement of water-damaged parts. Monitoring and promptly closing off ingression sites are by far the wiser use of maintenance resources.

There are many factors that influence the decision of when to change oil. And in many cases, the oil may never need to be changed. With increasing pressure to drive down operating costs in order to boost operating profits, there is a real need to define an optimum approach.

4. Consider a Condition-based Oil Change Strategy

In the past, many organizations have exclusively used interval-based oil change criteria. The interval was based on an assortment of considerations, such as the calendar, operating hours (meter), fuel consumed, miles/kilometers driven or production/work performed. In many cases, an approaching outage and shutdown have a driving influence on the decision, coming from the desire to avoid unscheduled downtime later or the need to change lubricants "on the run." In addition, new equipment still under warranty may have OEM-specified lube change-out intervals, which can make the matter far less subjective (and optimized).

The condition-based oil change strategy is indeed important in reducing oil consumption and associated costs. However, there are many situations with certain machines when maintenance and reliability are not "optimized" when the strategy is applied. In order to perform a condition-based oil change, there is added cost to monitoring the conditions, namely oil analysis. There may also be added risk from running the oil too close to its end of life, which could lead to such challenges as the following:

- a sudden and inconvenient need to change the oil,
- wear and damage to the machine, and
- the need to perform an expensive system flush prior to introducing new lubricants (resulting from oxidation of the belatedly changed oil).

5. Inhibit Rust and Corrosion

Regardless, for most companies and machinery applications, the benefits of the condition-based oil change far outweigh the risk and cost.

Corrosion costs companies billions of dollars each year. Much of this loss is due to the corrosion of iron and steel. When exposed to moisture and oxygen, iron and steel will react, forming an oxide. This oxide does not firmly adhere to the surface of the metal and will flake off, causing pitting. Extensive pitting eventually results in weakness and disintegration of the metal, leading to failure.

The best way to stop rust and corrosion is not to allow the metal to come in contact with water, oxygen or acid. In essence, this is exactly what rust and corrosion inhibitors do. These additives are typically compounds that have a high polar attraction toward metal surfaces. They chemically bond to the metal surface, forming a protective film over the underlying metal. This film acts as a barrier that does not physically allow the metal to come in contact with anything that could promote corrosion. Some popular compounds being used are amine succinates and alkaline earth sulfanates.

If rust formation cannot be prevented, the rust particles can flake off and contribute to abrasive wear. The iron oxide is much harder than the steel surfaces it comes in contact with, so massive amounts of three-body abrasion occur.

Rust and corrosion are detrimental to your reliability program. Remember to always fight it at its root causes. Eliminate the root causes of a failure and you will reduce the likelihood of that failure's occurrence.

6. Search for the Root Cause of Failures

Knowing when a piece of equipment is going to fail (predictive maintenance) is much more difficult than making it last long (proactive maintenance). Even more complex is root cause analysis (RCA), which is performed post-mortem, like an autopsy. Still, reliability professionals are increasingly stressing the importance of performing RCAs following all failures of critical machinery. As odd as it sounds, it is more productive to study failures than successes. After all,

an apparent success may actually be a failure in disguise, more like a problem waiting to happen. Studying failures teaches insightful lessons in developing predictive and proactive maintenance strategy.

Root cause failure analysis is a process of working backward through a sequence of events or steps that led to functional failure of the machine. This process is often referred to as "asking the repetitive why" or "the five whys." The first "why" is intended to reveal the obvious and more immediate cause, sometimes referred to as the direct cause. This is the suspect that first, and most often, bears the blame. However, by continuing the series of questions, one can often expose hidden causes that include contributing causes (partners in crime) and intermediate causal agents. With a little luck, your interrogation will lead you to the root cause. Keep in mind there may be multiple root causes.

7. Learn to Interpret Oil Analysis Reports

Interpreting an oil analysis report can be overwhelming to the untrained eye. Oil analysis isn't cheap, and neither is the equipment on which it reveals information. Every year, industrial plants pay millions of dollars for commercial laboratories to perform analysis on used and new oil samples. Unfortunately, a majority of the plant personnel who receive these lab reports do not understand the basics of how to interpret them.

Typically, an oil analysis report comes with a written summary section that attempts to put the results and recommendations in layman's terms. However, since the laboratory has never seen the machine or know its full history, these recommended actions are mostly generic and not precisely tailored to your individual circumstances. Therefore, it is the responsibility of the plant personnel who receive the lab report to take the proper action based on all known facts about the machine, the environment and recent lubrication tasks performed.

8. Change Filters on Time

Changing a filter too late puts the oil and machine in jeopardy. Changing a filter too soon wastes valuable resources. It has been reported that in many cases, the cost of a common oil change can exceed 10 times the apparent cost of the oil and associated labor to change the oil. This multiplier may hold equally true for the cost of a filter change. In addition to the cost of the filter, there are additional costs for labor, inventory, scheduling, used filter disposal, waste oil disposal and oil top-off costs (you always lose a little oil when you change filters).

There are many available technologies to help improve the timing of a filter change. These include pressure-rise profile monitoring, Delta-P indicators, bypass indicators, online particle counting and time-out alerts. Multiple methods used together may be the wise choice in certain cases. Nonetheless, changing filters on condition should be the primary objective in the quest for filter economy.

We all know that filters are consumable machine components. They have two primary jobs to do: remove particles at the same rate that they arrive into the oil and protect sensitive machine components from contaminant invasion. Conventional wisdom tells us to focus on the value proposition presented by better filtration, not on the cost of filtration. However, the astute maintenance professional may choose to have his cake and eat it too.

9. Employ Sealable, Reusable Oil Containers for Top-ups

Particles and moisture enter lubricants from a variety of sources and entry points. Many of these contaminants arrive in stages through the chain of custody as lubricants are handled and transported from the blend plant to the ultimate point of use. For small machines, a surprisingly large amount of contamination is introduced at the last stage, between intermediate storage (e.g., drum or tote) and the machine. This is where the sealable and reusable (S&R) container plays a vital role in controlling contaminant ingression during routine oil changes and top-ups (the introduction of makeup oil).

Oil cans with narrow openings are hard to clean. Conversely, wide-mouth S&R containers offer welcomed convenience when it comes to routine cleaning typically done in a parts cleaning station or industrial washing machine. Most importantly, they present little opportunity for invasion of contamination and, hence, there is less need for such periodic cleaning.

Unlike teapot-type oil cans, S&R containers are also tightly sealed to control air exchange and contaminant ingression. The air vent, nozzle and other openings are all snug tight when not in use. You don't have to filter or clean what doesn't become dirty.

Yes, air does need to enter during oil dispensing, but S&R containers restrict the exchange of ambient air when not in use. Traditional oil cans, on the other hand, act more like dirt magnets by constantly collecting dust on the oil-wet internal surfaces.

10. Don't Forget to Perform Preventive Maintenance

Lubrication requires constant attention. Vigilance is perhaps a better word. It's easy to forget the things we are not motivated to do, yet rarely do we forget those activities we are passionate about and desire to do. We are all driven by animal instincts to seek out the things that we enjoy or give us a gratifying reward.

Because it's hard to find happiness in performing most routine maintenance tasks, it's not uncommon for many of them to become periodically forgotten or perpetually postponed. Much of this is actually "conscious forgetfulness," similar to procrastinating. Why does this happen? It is most likely due to a lack of rigor, which is due to a lack of structure, measurement and incentive.

Delinquent PMs can become habit-forming, leading to even more delinquency and a general cavalier attitude among maintenance workers toward punctuality and work quality. This "mañana mentality" or constant procrastination can lead to a destructive downward spiral. Common symptoms relating to lubrication include:

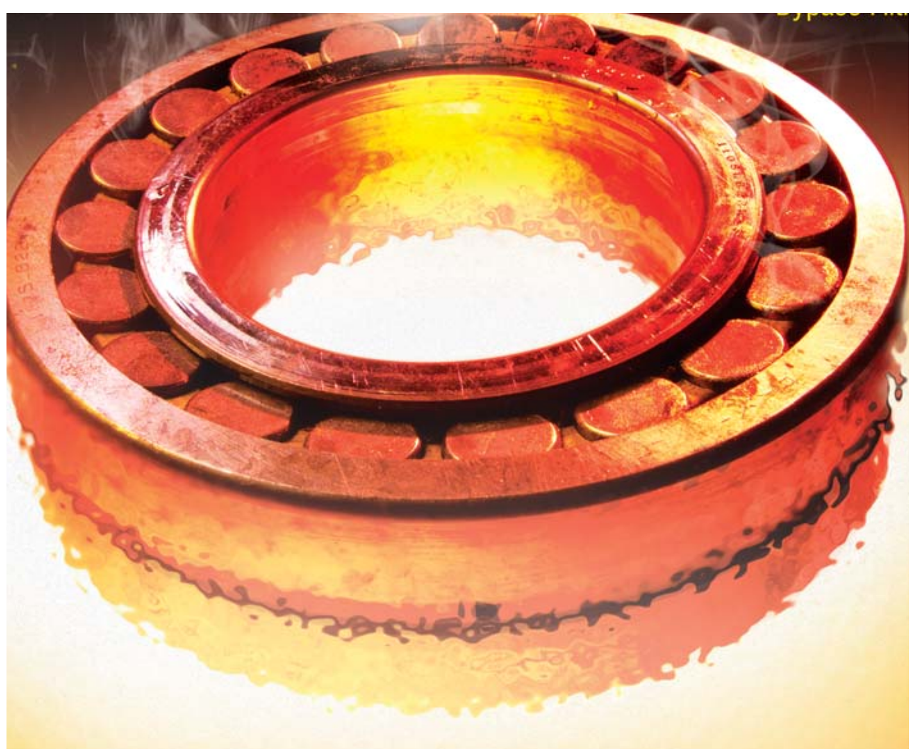
- Widely fluctuating oil levels
- Inspections that don't get performed or reported
- Filters and breathers that don't get changed on time
- Oil samples that never get taken or are collected improperly
- Oil that is not changed on time
- Bearings that don't get a timely shot of fresh grease

Periodically forgetting to perform "the rights of lubrication" is equivalent to periodically accepting preventable failures. We can and should do better.

11. Prevent Lubricant Starvation

Although most everyone knows about lubricant starvation in principle and realizes the common sense of adequate lubricant supply, it is frequently ignored because many typical forms are largely hidden from view. For instance, who notices the quasi-dry friction that accelerates wear each time you start an automobile engine? This is a form of lubricant starvation. It's not a sudden-death failure, but it is a precipitous wear event nonetheless. Each time controllable wear goes uncontrolled, an opportunity is lost to prolong service life and increase reliability.

Machines don't just need some lubricant or any lubricant. Rather, they need a sustained and adequate supply of the right lubricant. Adequate doesn't just mean dampness or the nearby presence of lubricant. What's defined as adequate varies somewhat from machine to machine but is critical nonetheless. High-speed equipment running at full hydrodynamic film has



the greatest lubricant appetite and is also the most punished when starved. Machines running at low speeds and loads are more forgiving when lube supply is restricted. Even these machines can fail suddenly when severe starvation occurs.

Lubricant starvation is an almost silent destroyer. While there are telltale signs, they generally aren't recognized or understood. Of course, there are varying degrees of starvation. Complete starvation is sudden and blatant. However, more moderate partial starvation is what tends to go unnoticed until failure. Then, other suspect causes (the bearing, lubricant, operator, etc.) may be falsely blamed.

12. Utilize Lube Identification Tags

Stickers or lube identification tags have been employed for years to guarantee the right lubricant is put in the right place. However, few organizations utilize lube tags to their full potential, while some fail to use them at all. These simple devices not only can help ensure the proper lube is being used, but if managed correctly, they can also improve machine reliability.

A good tagging system is frequently overlooked as a key part of a world-class lubrication program. There are many solutions on the market for color-coding devices that are commonly used in a lubrication program. Some of these include top-up containers, filter carts, grease guns, totes, pumps and other similar products. Although color-coding is a great practice, simply using a color for a single lubricant is often ineffective. With most facilities having more than 10 different lubricants, it can become difficult to distinguish between subtle differences in color, and more clarification is needed.

Some organizations have taken the additional step of utilizing a symbol along with a color to specify a particular lubricant for an application. By adding a second identifier, such as a shape scheme, you can exponentially expand the number of unique color and shape combinations to suit the amount of lubricants in your facility. For example, if you were to only use yellow to identify a particular gear fluid, you are limiting the color yellow to a single application. If you were to use yellow and a shape, such as a square, you can then employ yellow for other applications, provided that you utilize a different shape combination.

13. Use Primary and Secondary Oil Sampling Points

Choosing the correct oil sample location can be challenging. When installing a sample port, look for a single spot where you can gather as much useful data about the entire system. This is called the primary sampling location. At this location, the goal is to be able to draw a single sample that acts as a snapshot of the entire system. In most circulating systems, this will be on the main return line before the reservoir. By sampling from this one spot, you can check the wear debris from the rest of the system as well as the particle count to get an idea of the total contaminants in the system.

Although the primary sampling location is a great place to start, it often leaves behind a lot of valuable data. This is why secondary sampling locations should be installed on most systems. The goal of a secondary location is to be able to pinpoint the cause of any fault seen on an oil analysis report. Unlike the primary port, which provides an overall look at the entire machine, secondary ports enable you to focus on individual components inside the system.

Most circulating and hydraulic systems should have both a primary and secondary sampling location to ensure that any identified failure mechanism can be tracked back to the component causing the problem. Not only can a secondary port be used to help determine the source of wear debris or particles, but by installing sampling ports behind filters, you can monitor how well the filter is removing particles. So while the primary port may get the most use, the secondary port is invaluable once a fault has been detected.

14. Consolidate Your Lubricants

In the interest of reducing purchasing costs and streamlining storage and handling, many organizations have substantially slashed the number of lubricant stock keeping units (SKUs) they use. They have also re-engineered the precision of their lubricant specification. There are many real and a couple of somewhat imaginary benefits to these consolidation initiatives. Let's start with the real benefits.

These include:

- Reducing stale inventory by directing more turnover (usage) across fewer lubricant products
- Purging discontinued or hard-to-find lubricants from lubricant storerooms
- Sole-sourcing lubricants to a single distributor and perhaps brand to simplify the purchasing function and leverage volume buying
- Enhancing usage convenience and lowering the risk of accidental cross-contamination (fewer drum pumps, transfer systems, filter carts, top-up containers, etc.)
- Re-engineering and enhancing lubricant selection especially for machines utilizing lubricants that have drifted out of spec (perhaps as a result of several past consolidation attempts)

The imaginary relates to the false reality that limiting lubricant SKUs to the catalog products of a single major brand can optimize the selection and number of lubricants in typical process industry plants and factories. For instance, some chemical plants have reported as many as 80,000 lube points, all requiring periodic relubrication. Many of these same companies have bloated inventories of lubricants from as many as 25 brands of more than 200 unique products. These are the companies that stand to benefit the most from consolidation.

Of course, along with the potential for benefits and savings, there are also many real risks and concerns. Most of these are associated with cutting corners and failing to do proper lubrication engineering. This can be avoided by making technically sound decisions with the support and advice of qualified lubrication advisors. Some lubricant suppliers have these capabilities, but others do not. After all, one or two harsh machine failures from placing the wrong lubricant in a high-value machine can wipe out all the potential savings and benefits that might have otherwise been realized.

15. Develop Effective Lubrication Procedures

What is an effective lubrication procedure? It is a step-by-step guideline that directs the user through a specific lubrication task. Of course, there are many types of tasks, including manual bearing lubrication, gearbox filling, gearbox checking, kidney-loop filtration, sample collection, etc. Each of these tasks will have some degree of uniqueness as well as a lot of overlap with other similar lubrication tasks.

When preparing a lubrication procedure, consider the following:

Strategy — How does the procedure support the broader maintenance strategy?

Purpose — What needs to be accomplished?

Procedure — How is the task accomplished, including the many details that determine safety, efficiency and effectiveness?

While there is no single approach to defining the individual tasks for a procedure, certain specifics must be incorporated to remove ambiguity and assure compliance. At a minimum, the purpose should include the name of the item to be addressed, the objective of the work, the identification of the individual to perform the task, the operational and safety conditions, and the amount of time allocated to the task. The details should identify what is to be done, where it is to be done, who will do the work, tools and materials needed, and special issues surrounding the work (safety, operational, etc.).

In the process of devising and writing procedures, expect to find major similarities between like components grouped by maintenance strategy. A template can be created with a significant amount of generic information or structure to facilitate the process without diluting the results.

JEREMY WRIGHT

UNDERSTANDING the ECONOMICS of Maintenance and Reliability

To get something for nothing in this life is extremely rare. There is almost always some form of investment to gain a return. The investment can come in many forms, but the most popular are money, time and energy. Along with this investment, there is also some potential risk that must be weighed against the prospective gain.

In terms of maintenance and reliability, these investments are becoming mandatory for top companies. Many organizations have come to realize that without investments in future reliability and production cost reductions, the competitive future will be rough.

> At the beginning of any undertaking, it should be mandatory to take a step back and evaluate your specific resources (time, money and energy).

How can you be certain that you are maximizing the return on your investment? Are there strategies that can be employed to ensure success? Success can hinge on resources, and it's no secret that those with the most resources often win.

In a program implementation, several avenues can be used to reach the end result. There is certainly a finite amount of resources. Money, for example, merely changes hands during day-to-day transactions. In theory, it is held constant and can't be generated from thin air (unless you are the government, and that is a topic for a whole series of debates). Energy can be transferred from one form to another, but it also is held constant, neither being able to be created or destroyed (according to the law of conservation of energy). Time is similar. You can't magically create more time from thin air. Something else these resources have in common is that they all can be managed.

Money

Money is the easiest of the three to manage. In developing a world-class program, it is possible to funnel enough money into the program that there is seemingly no choice but for it to be successful. Hiring the best consultants in the world is one way to use money in exchange for the time and energy of your own resources. In this case, you are trading one for the other. This can be both good and bad. On one hand, hiring consultants provides experts who likely have experience and understand all the nuances. They should know what works and what does not, as well as offer a host of other advantages. On the other hand, if there is no buy-in from the onsite team when the consultants turn over the project at its completion, the likelihood of sustained success decreases. This often occurs when the only thing invested is money. There is no program champion, no one invested in the project left behind by the consulting firm.

Time

While travelling the globe assessing lubrication, maintenance and reliability programs, not once have I heard, "I have nothing left for my guys to do." Out of all the plants I've visited, I have never seen guys just sitting around with nothing to do. It seems there is always firefighting and reactive maintenance happening all the while inspections are being performed to gradually move the needle closer to predictive maintenance and ultimately to proactive maintenance. So where will the extra time it takes to assess, design and implement a world-class program come from? I've rarely seen a resource dedicated solely to proactive or predictive tasks. Only the best companies understand the value in spending time wisely on the front end (proactive maintenance) as opposed to the much costlier back end (reactive maintenance). Sometimes organizations may even fully understand the value and yet still make poor decisions and actions.

Energy

Energy is defined as the strength and vitality required for sustained physical or mental activity. You can exert energy toward your goal in many different ways. Knowing the type of energy and passion your team has will be important in understanding the path to a successful program. Are your workers enthusiastic about making changes for the better? If so, you need to give them direction. They must know what success looks like. Otherwise, they will waste energy chasing their tail and searching for success when all they needed was a clear path.

Are your team members more reserved and methodical? These types of personalities must understand the "whys" and have a thorough education before they take on a project. In this environment, if you start down a path that is incorrect, the course correction will be agonizing.

At the beginning of any undertaking, it should be mandatory to take a step back and evaluate your specific resources (time, money and energy). Once these are fully understood, a precise plan can be formulated that will maximize the return on the investment you are about to make. Start looking at these investments as what they are: finite resources. If they are spent unwisely, you usually can't get them back.

About the Author

Jeremy Wright is the vice president of technical services for Noria Corporation. He serves as a senior technical consultant for Lubrication Program Development projects and as a senior instructor for Noria's Machinery Lubrication I and II training courses. He is a certified maintenance reliability professional through the Society for Maintenance and Reliability Professionals, and holds Machine Lubricant Analyst Level III and Machine Lubrication Technician Level II certifications through the International Council for Machinery Lubrication. Contact Jeremy at jwright@noria.com to learn how Noria can help you maximize the return on your investment in a lubrication, maintenance or reliability program.

JEREMY WRIGHT

Why Hydraulic Oil Changes Color

By Jack Weeks, GPM Hydraulic Consulting

When hydraulic oil turns from that golden honey color of new oil to a dark brown, does that mean it must be changed immediately? Is the system suffering from lost lubricating properties or gross contamination when this occurs, or is this a normal aging characteristic to be dismissed so long as the oil analysis results are within acceptable parameters?

These types of questions are often asked whenever hydraulic fluid maintenance is discussed. Many people compare the oil in their industrial hydraulic systems to that of their automobile, assuming if the oil has turned to a dark brown that it must be changed as soon as possible regardless of how long it has been in service.

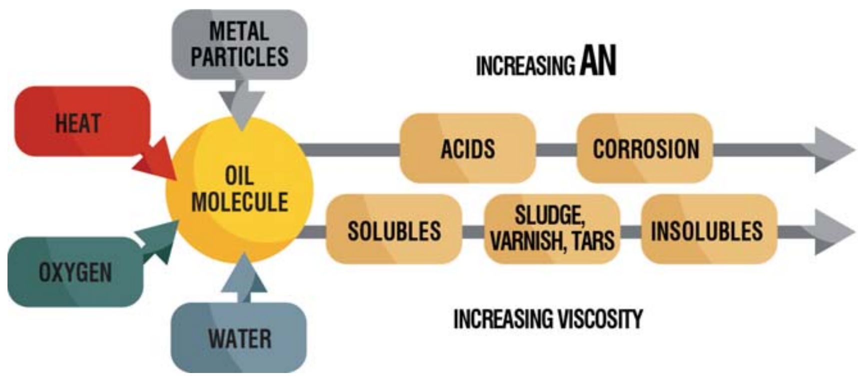
It's easy to forget that the oil in an industrial hydraulic system is kept in a much different environment than the oil in an internal combustion engine. A color change in hydraulic oil is a good reason to be alert but not a good reason to go running for the oil skid to replace it right away. You first need to determine why the oil has changed color.

The two most common causes of oil darkening are thermal stress and oxidation, neither of which will necessarily require that the oil be replaced. The first step is to take a representative sample of the oil and have it analyzed. I have seen hydraulic oil that has darkened considerably but was still perfectly good to remain in service. I have also seen hydraulic oil that has retained its original color but could not meet the parameters necessary to provide adequate system protection. In short, a change in oil color alone tells you nothing about the serviceability of the oil.

However, darkening of the oil can direct you to potential problems that may need to be addressed. Perhaps a system has one or more "hot spots" where the oil is heated up significantly in a localized area, but the temperature is brought down again once it reaches the relatively cool reservoir.

I once found a valve that had failed, forcing oil through a small orifice with a significant pressure drop. This generated a relatively large amount of heat, but it was localized in only a very small amount of the system oil. The only symptom was a darkening of the oil.

When a sample of the oil was analyzed, it was determined that the acid number and viscosity had not changed, eliminating the likelihood of oil oxidation and suggesting that the change in color was the result of thermal degradation. Inspection with an infrared camera located the overheating valve in very short order. The valve was replaced, and significant varnish was noted at the point where the heat was generated. Oil analysis showed that the oil was perfectly suitable for continued service, but since there was no discernible change in system operation, the valve failure may very well have gone unnoticed until it became a system outage had there been no color change in the oil.



While oxidation, the chemical union of oil and oxygen, is a common reason that hydraulic oil stability is reduced, the amount of color change is not a good indication of the level of oxidation. Antioxidants will react as they do their job, frequently producing colors ranging from brilliant yellow to inky black. There are a number of factors that include formulation, operating conditions and contaminants, any of which can cause a considerable color change without significant oil degradation. Although the color change can be alarming, the oil can still retain good antioxidant potential, since a series of these reactions can occur before becoming truly exhausted. Again, the only way to be certain of the oxidation level is by oil analysis. Look for an increase in the oil's viscosity and acid number as an indication of oxidation.

The presence of metal catalyst particles, heat, oxygen and water all contribute to oil oxidation. As the acid level increases, corrosion of components will become more likely. Viscosity will increase as soluble contaminants mix with the oil. This will leave sludge, varnish and tar deposits as a thin, insoluble film throughout the system's internal surfaces. The degradation process accelerates with continued exposure to these elements.

A change in oil color alone tells you nothing about the serviceability of the oil.

Oxidation can be kept to a minimum by normal fluid maintenance practices. The rate of all chemical reactions, including oxidation, will approximately double for every increase in temperature of 10 degrees C (18 degrees F). For most mineral-oil-based hydraulic systems, the maximum recommended temperature is 140 degrees F (60 degrees C). For every 15 degrees F (5 degrees C) above this temperature, the oil's life span will be cut in half.

System pressure can make a difference, too. As pressure increases, so does fluid viscosity, which causes an increase in friction and heat generation. Also, increased pressure results in an increase of entrained air (and therefore oxygen). The additional oxygen will accelerate the oxidation reaction of the oil. It is recommended that system pressure be kept as low as possible for maximum system efficiency and longevity of the oil and system components.

Contaminants are another factor that can affect oxidation. A 1-percent sludge concentration in hydraulic fluid will double the rate of oxidation as compared to fluid with no sludge at all. Certain metals, most notably copper, act as catalysts for oxidation reactions, particularly in the presence of water. The presence of water and copper is a common occurrence when a heat exchanger ruptures.

When you find that your hydraulic oil has darkened in color, don't assume that it needs to be replaced. It is quite likely that there are years of service remaining in your fluid. Get a good representative sample and have it analyzed. The most representative sample will be taken immediately downstream of the pump. The second best location is from the exact center of the reservoir, obtained either while the system is running or immediately after shutdown.

If you are just beginning a fluid sampling program, a good starting point is every 13 weeks. Adjust the frequency of sampling based on the analysis results. Keep at least a full year of analyses on file for comparison and spotting trends. Only then will you truly know the condition and serviceability of your hydraulic fluid.

BENNETT FITCH | NORIA CORPORATION

Selecting the RIGHT OIL ANALYSIS LAB

When you go in for a blood test, do you want to be told what your red and white blood counts are, what your platelet or hemoglobin levels are, or what the mean corpuscular volume is? Unless you're a medical doctor, probably not. You rely on a reputable doctor to analyze the blood count report and tell you if you're healthy. If he spots concerns, does he say, "You're unhealthy," and that's it? No. You expect him to act with urgency to figure out why you're not healthy and what can be done to make you better. You expect him to ask a battery of questions to help pinpoint the root causes and explain the problem at hand. That's why we have doctors and not just blood counts or healthy/unhealthy alarm limits. We need a true diagnostic methodology to help us stay healthy.

A laboratory should share your end goal of aiding in the optimization of plant-wide reliability by proactively monitoring various indicators within the oil of individual machines.

Just like blood analysis, oil analysis is undoubtedly complicated. First, someone is tasked with ensuring samples are collected in just the right way to minimize human interference in the results. This requires training. Then, laboratory technicians are rushed to process the sample through a gambit of instruments. They must use precise and consistent methods to avoid the potential interference from such things as previously run samples or variations in sample agitation technique. This calls for a lot of training.

Once the lab tests are completed, the job isn't finished. You should expect a skilled diagnostician (just like a doctor) to analyze the results, uncover the clues behind the raw data and produce clear recommendations to address any concerns. This last step is probably the most important reason why oil analysis is performed. It also is arguably the most difficult and often the most overlooked part of it all. This article will offer selection principles necessary to ensure your oil analysis laboratory is giving you what you need to keep your machines healthy.

The End Goal of Oil Analysis

When several end users were asked about the ultimate goal of oil analysis, the most common responses included determining if or when machines were going to fail, detecting incipient machine failures earlier, knowing when to perform an oil change on time, understanding contamination levels and optimizing machine reliability at the lowest possible cost.

While the actual responses varied, a unified answer to the question can be surmised. That is, the end goal of oil analysis is to aid in the optimization of plant-wide reliability by proactively monitoring various indicators within the oil of individual machines. This should be what motivates each plant to design its oil analysis program effectively. This same motivation will also be the deciding factor when evaluating each aspect in selecting and working with a laboratory.

Selection Principles

A laboratory likely will not excel in every aspect of oil analysis as you might hope. In order for it to be competitive, the lab may concentrate its efforts on those areas most valued in the market. The problem is many people are often too focused on price and may unknowingly fall short of their end goal by overlooking some of the most important oil analysis principles.

1. Preparation

- Sample shipping time/distance to the laboratory
- Provide certified-clean bottles and labels
- Support with sampling methods
- Test slate availability and selection assistance

To capture the scope for evaluating an oil analysis laboratory, selection principles can be grouped into five categories: preparation, regulation, interpretation, communication and evaluation.

Preparation includes all things leading up to the laboratory obtaining the oil sample. Choosing a lab that is located close enough to where samples can be delivered within 24 hours or as soon as possible from when the sample was drawn is a must.

The laboratory should supply certified-clean bottles that are selected based on cleanliness targets and the type of oil to be collected. Lab personnel should be knowledgeable about bottle types and when it is appropriate to select one over another.

Along with the bottles, sample labels should be provided requiring the collection of relevant data for the machine, lubricant, environment and maintenance practices. Without this information, the laboratory will not be able to fully interpret the results. The lab may also furnish special packaging materials to facilitate safe and effective shipping of the oil.

If you are new to oil sampling, your laboratory should offer support on the best practices. This will include how often to sample, where to draw a sample and what type of extraction tools should be utilized.

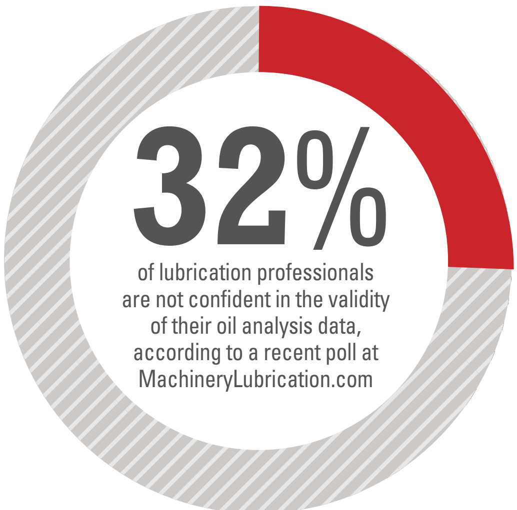
One of the first steps in developing an oil analysis program is understanding which tests should be performed for each equipment class based on the criticality of each machine. This will involve routine testing (potentially performed in-house) and exception testing (for when results come back questionable or abnormal). Your lab should be able to provide the required tests and assistance for optimizing test slates. The more you measure, the more you can analyze and the more potential opportunities ultimately arise.

Most oil analysis test methods are not straightforward but will necessitate having regulations to carefully follow. The regulations may come from standards provided by ASTM, ISO or other comparable standardization organizations. These test standards define the generally accepted procedure, the proper application of the test, the method's repeatability or reproducibility, calibration requirements and other pertinent data. The laboratory may even choose to follow a modified version of a test standard based on the lab's preferences. It is critical to understand which standard the lab will use for the required tests as well as the measures taken to ensure the operating technicians are conforming to those standards. There should also be minimum requirements regarding the operating technician's certifications to perform all necessary tasks within the lab (though outside of the actual test standards).

2. Regulation

- Instrument testing standards validation
- Operating technician certification
- Sample handling process (e.g., agitation)

The lab's sample handling processes before and even after the tests are performed will be crucial. Find out how quickly samples are processed for



analysis, the sequence of tests and how the remaining sample is stored for potential exception testing. At times, laboratories must take additional steps outside the scope of the testing standards to improve the accuracy of the results, such as the method to effectively agitate the sample prior to analysis or a quick physical inspection of the oil as the initial indicator of a potential concern.

Additionally, each laboratory may decide (and is expected) to go through an extensive self-assessment based on generally accepted standards for maintaining and managing a lubricant testing laboratory. In recent years, ASTM D7776-12 (Self-Assessment of Quality System Practices in Petroleum Products and Lubricant Testing Laboratories) has been developed to better outline the specific criteria that should be reviewed. If possible, end users should request any documents that can provide the results of laboratory self-assessments and the methodology and criteria that were employed.

3. Interpretation

- Three categories of oil analysis
- Statistical trends and calculations
- Multiple data point correlations
- Maintenance history considerations

If only raw data from the oil analysis tests is presented in the final report, it can be quite confusing and overwhelming for end users who have little to no interpretation experience. To achieve the end goal of oil analysis, there must be a comprehensive interpretation of the data. The interpretation stage can be challenging to summarize, as each oil analysis test provides different forms of data. Nevertheless, some general guidelines should be followed during the interpretation of routine oil analysis.

First, the overall results should focus on verifying or identifying the three oil analysis categories: fluid properties, contamination and wear debris. Second, tests performed on a single sample will not be sufficient to obtain quality results. Developing statistical trends of specific data points and calculations across multiple data points will likely be required to determine if there are any concerns. Perhaps the most important comparison will be against the baseline sample results (new oil test results from the same batch of the used oil result).

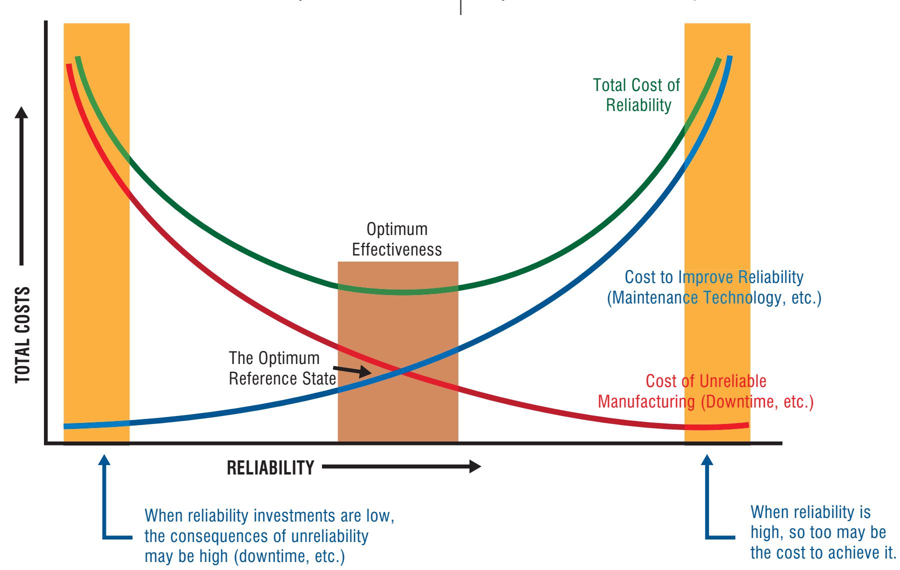
The various trends developed for each sample point along with the collected maintenance history and understanding of the machine's criticality will allow cautionary and critical alarm limits to be set. The lab should offer assistance in establishing these limits, but they must be in agreement with the plant's overall reliability objectives.

Another thing you must consider is whether your laboratory's interpreters are familiar with the types of machines from which the oil samples were obtained. If they are not, make sure a specialist is involved to give you the diagnostic skills your machines require. Remember, providing oil analysis data and providing a good explanation of the data are two different things.

After the interpretation has been performed, you should expect your lab to effectively and quickly communicate the results in a quality, user-friendly report. You should see supporting graphs, highlighted concerns, pictures and written interpretations in addition to the complete raw data. In recent years, it's common for all reports to be routed through a cloud-based software to allow you to easily scan multiple reports and modify charts and trend graphs to suit your needs. The last thing you want is the important details to get lost in the jumble of data or to spend too much time trying to make complex interpretations yourself. While it's always wise to make your own

4. Communication

- Quality, user-friendly report presentation
- Software integration
- Urgent notification of critical results



interpretations (since you are most familiar with your machinery's history), you don't want to have to spend an unreasonable amount of time doing so.

Every minute matters when your machines are in distress. Your laboratory should be prepared to immediately contact you if there are any critical concerns. This may be via call, text, email or whatever method works best for you. When it comes to these critical notifications, do not rely on the standard delivery methods for your oil analysis results, as you may overlook their urgency. For example, if you normally receive all oil analysis results by email, you may not perceive the urgency of an email about a critical concern because it might be seen as a typical report in your inbox, likely delaying its review.

5. Evaluation

- Exception test recommendations
- Root cause investigation
- Assess other condition monitoring results
- Customer-focused support

After critical alarms are triggered and urgent notifications are sent, subsequent communication from the lab should help you evaluate the problem at hand and make quick decisions. The laboratory should assist you in determining exception tests that could provide more information about any concern identified by a routine test. This further analysis should include techniques like microscopic analysis, which can be obtained from any remaining oil from the original sample. More oil may also need to be drawn from the machine. These exception tests are intended to confirm, deny or provide more details in order to find the root cause of the issue. With this data and more in-depth examination into the recent events of the machine's operating conditions, investigation reports and other condition monitoring technologies, remediation recommendations can be formulated.

In many cases, the laboratory may be able to provide the investigative assistance you need to get to the root cause of a potential failure. Know your lab's full capabilities and set your expectations accordingly. The laboratory should be passionate about detecting and solving problems, and share your end goal of aiding in the optimization of plant-wide reliability by proactively monitoring various indicators within the oil of individual machines.

At What Cost?

Each of these oil analysis selection principles can be refined by considering the optimum reference state (ORS) of each machine or, more importantly, your plant's overall reliability objectives. If price was not a concern, you would simply choose a lab that could deliver on all of these principles. Unfortunately, price eventually must be a concern.

So when does the price of oil analysis outweigh its returns? First, you must consider the impact of a potential failure for any of your machines, including the resulting cost of parts, labor and lost revenue from a production interruption. Then, depending on the magnitude of this impact, you must decide how much you would be willing to spend to avoid the average incident, regardless of whether there is a history of failure. In almost every circumstance, a single catch that avoids the average failure would more than justify the typical cost of an oil analysis program for an entire plant.

Oil analysis services are generally competitively priced in the market. Nevertheless, beware of the potential shortcomings of very low-cost or even free oil analysis programs, such as those provided by a lube supplier. Even if the oil analysis is free, it still costs you time and money to collect samples and manage results. If the oil analysis program isn't created with your end goal as the focus, you may not be giving yourself any sort of advantage. You may be better off spending a few extra dollars to guarantee you get the value you're trying to achieve. Asking the questions specified by the selection principles will help ensure this. As the optimum reference state suggests, there is an optimum effectiveness zone that is a balance between the cost of an investment (like oil analysis) and the cost of unreliable operation. The total cost of reliability will be the lowest at this optimum effectiveness zone.

So while price must be taken into consideration, it should not be your top priority. Consider price only after you can verify your satisfaction with the level of service and quality the lab offers in each of the selection principles as it relates to your end goal. Like most things, it is often a tradeoff between price, service and quality, where two of the three are achievable at a desired level. Do not sacrifice the necessary levels of service and quality for price. The attainment of your end goal is depending on it.

Lube-Tips™

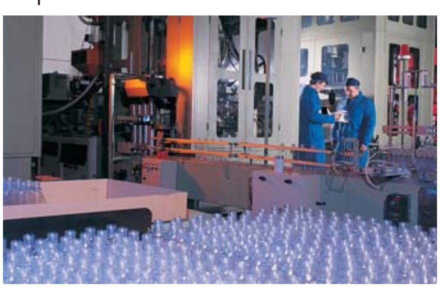
THE "LUBE-TIPS" SECTION OF *MACHINERY LUBRICATION* MAGAZINE FEATURES INNOVATIVE ideas submitted by our readers. Additional tips can be found in our Lube-Tips email newsletter. If you have a tip to share, email it to editor@machinerylubricationindia.com

An Oil Analysis Metric to Track Serious Wear Debris

To better track the threat of serious wear debris in machine components, consider trending the percentage of large particles (PLP) as part of your direct reading (DR) ferrography analysis. PLP will indicate the relative fraction of the total ferrous debris that is indicative of serious wear problems. Simply subtract the reported small particle concentration from the large and divide by the total. A shift from normal results should prompt further evaluation.

Storing and Handling Food-grade Lubricants

If you use food-grade grease, the grease gun should be stored separately from other grease guns and it should be marked "food grade only." This will help avoid cross-contamination. Never use a food-grade grease gun with other lubricants. The storage area for food-grade grease and oil should also be away from other lubricants and hazardous materials such as cleaning supplies, parts washer fluid, antifreeze, etc.



Where Synthetic Oil Works Best

The advantages offered by synthetic oils are most notable at either very low or very high temperatures. Good oxidation stability, higher viscosity index and a lower coefficient of friction (with some synthetics) allow operation at higher temperatures. The higher viscosity index and lower pour points permit operation at lower temperatures.

What to Check When Changing Lubricant Brands

When changing lubricant brands or types, be certain that the new lubricant is chemically compatible with the old. Although you may be adding the new lubricant to an empty and clean reservoir, residual old lubricant will be in the lubrication system piping and metering devices.

Consider Lubricant Storage Life Limits

Most lubricants have supplier-recommended shelf lives based largely upon the lubricant's additive package. For example, lubricants containing rust inhibitors may lose performance after as little as six months in storage. Conversely, some turbine fluids with a light additive dose may be shelved for up to three years. Shelf life information is typically available from your lubricant supplier and/or manufacturer.

Advice for Small Pump Oil Changes

Changing oil in small pumps can be challenging due to the design of the pump housing. There is a cavity in the bottom of the housing that traps water and contaminants. Use a small handheld vacuum pump to completely remove the water and/or old oil from this cavity. This will result in much cleaner oil with each change-out. You can get 10 additional ounces or more out of the pump using this method, as opposed to only opening the drain plug.

Use a Magnet for Routine Oil Inspections

Filtering oil with a filter cart can be useful for maintaining target ISO contaminant cleanliness codes. Placing a magnet in the filter cart near the inlet and before the pump is also beneficial for removing wear debris and for routine inspections. Put the magnet in a location where it can't interrupt oil flow and ensure the magnet is strong enough to remain in place.

Magnet inspections should be compared to oil samples because oil analysis results may be better due to the magnet capturing metal. If multiple pumps or bearings feed into one lube unit, use a magnet for each return line to determine which one may be wearing out. Be sure to wear leather gloves to protect your hands from sharp metal fragments when cleaning.

Stop Grease Gun Disasters

Slowly pump grease into bearings over a period of three to five seconds per normal shot of grease (0.1 ounce or 2.8 grams). Increase or decrease the time to adjust for larger or smaller volume output per shot. Using a quick lever action could blow out seals and may not allow the grease to distribute correctly within the bearing. If the application is high risk, consider installing shut-off-type grease fittings that prevent overpressurization during greasing.

GARRETT BAPP | NORIA CORPORATION

Salem Manages World-class Lube Program for Kimberly-Clark

After working at a tissue-converting plant in Beirut, Lebanon, Jad Salem came to the United States and began his career at Kimberly-Clark's tissue mill in Fullerton, California. He soon transitioned into his new role as a mechanical lead engineer on the rejuvenate and improve (R&I) team. As an R&I engineer working on capital projects, Salem received a request from the reliability team to build a centralized lubrication room for the mill and to improve the overall lubrication process from the time new oil enters the mill to the time it exits the facility. He is currently finishing the last part of this new lube room project, which will result in the organization of tools and materials into labeled and color-coded storage locations as well as kits that contain just what is needed to perform a task.

Name
Jad Salem
Age
32
Job Title
Mechanical Project Engineer
Company
Kimberly-Clark Corp.
Location
Fullerton, California
Length of Service
4 years

Q: What types of training have you taken to get to your current position?

A: I have taken a Kepner-Tregoe workshop and several online classes that have helped me better communicate and manage the team. To improve my technical skills, I have completed Noria's machinery lubrication training, a bearing failure analysis course and a

Be Featured in the Next 'Get to Know' Section

WOULD YOU LIKE TO BE FEATURED IN THE NEXT "GET TO KNOW" section or know someone who should be profiled in an upcoming issue of *Machinery Lubrication* magazine? Nominate yourself or fellow lubrication professionals by emailing a photo and contact information to editor@noria.com.

pump system design course. I am also certified in the Festo Pneumatic System. In addition, I have participated in several kaizen workshops at Kimberly-Clark.

Q: Are you planning to obtain additional training or achieve higher certifications?

A: I am currently scheduled to attend the project management training offered by Kimberly-Clark. I will continue working and interacting with our well-skilled master technicians to sharpen my skills.

Q: What's a normal work day like for you?

A: Normally my responsibilities are mixed between leading and/or supporting capital projects at different Kimberly-Clark mills. I also support the reliability team, focusing on managing a world-class lubrication program here at the mill.

Q: What is the amount and range of equipment that you help service through lubrication/oil analysis tasks?

A: We estimate having more than 3,750 pieces of equipment for oil analysis, ranging from oil tanks and pumps to high-viscosity gearboxes. We also have a variety of electric motors that we need to lubricate.

Q: What have been some of the biggest project successes in which you've played a part?

A: I provided engineering support for the rebuild at the mill in Chester, Pennsylvania. This project reduced the safety risks associated with several operator tasks, increased machine reliability and stability, improved production quality, and eliminated injuries.

I have also investigated and submitted several cause failure reports at the mill and led the implementation of countermeasures.

I am currently supporting a steam optimization project, which will save the Fullerton mill $310,000 annually through reduced natural gas consumption, carbon-dioxide emissions and downtime associated with steam-related issues.

Q: How does your company view machinery lubrication in terms of importance and overall business strategy?

A: Kimberly-Clark's Fullerton mill has come a long way in the past few years, and it didn't happen by itself. Our maintenance team saw the importance of machinery lubrication, especially after they went through the training provided by Noria. The mill's technicians are working continuously to sharpen their skills.

Q: What do you see as some of the more important trends taking place in the lubrication and oil analysis field?

A: I believe a good oil analysis program is key. Last year we were able to predict a bearing failure a week before it happened. Oil analysis showed metal shavings in the 900-gallon oil tank. This find allowed us to better plan for bearing replacement.

Q: What has made your company decide to put more emphasis on machinery lubrication?

A: Seeing improvement in overall machine operation has been the main drive behind the emphasis on machinery lubrication. These efforts resulted in a 0.06-percent water reduction in 2013 and a 35.6-gallon reduction in oil consumption between 2012 and 2013.■

ExxonMobil

ExxonMobil Introduces Industrial Lubricants Digital Knowledge Center via New Website

- Extensive catalog of equipment maintenance best practice tips and industry insights on the newly redesigned mobil.com/industrial
- ExxonMobil lubrication experts provide insights to help equipment owners across a wide range of industries stay on top of current trends and improve equipment performance
- Website's improved search and filter functionality helps visitors more intuitively find product, application and service information with streamlined navigation and menus

To help industrial operators more easily find the information they need to properly protect their equipment, ExxonMobil has introduced a new digital knowledge center full of educational content on its redesigned Industrial Lubricants website, mobil.com/industrial.

Available via the website's Technical Resources section, visitors have access to best practice maintenance tips and key insights on industry trends that are impacting a wide range of industrial sectors, such as general manufacturing, mining, oil and gas, power generation and food and beverage.

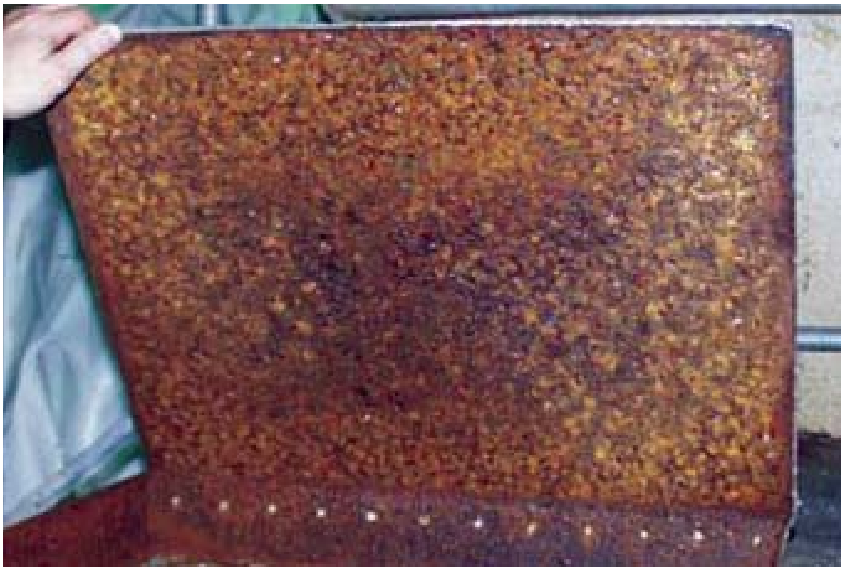
This content includes:

- **Expert Answers** – Taken from ExxonMobil's Mobil SHC™ Club industrial lubricants community, these short articles answer a range of lubrication-specific questions sourced from real customers
- **Industrial Application Expertise and Tips** – A mix of in-depth articles and quick tips authored by ExxonMobil field and technical experts providing best practice guidance on critical lubrication topics, such as safety, used oil analysis and lubricant selection
- **Industry Insight** – Also authored by ExxonMobil experts, these industry trend articles outline "big picture" considerations that can help industrial operators enhance productivity and profitability
- **Success Stories** – Real-world case histories showing how customers across a range of industries captured substantial benefits with Mobil-branded lubricants and ExxonMobil's field engineering support

This new content is part of a wider range of enhancements to the new Industrial Lubricants website. For example, the site offers improved search functionality where visitors can simply search for equipment builders, lubrication specifications, and topics, to find the product and service information they need. The site also includes responsive design to optimize the viewing experience on any device. ■

"Is there a recommended test to determine the vapor-phase corrosion-inhibiting properties of lubricants?"

The standard test method for measuring vapor-phase corrosion inhibition is ASTM D-5534. In this test, a steel specimen is attached to the top of an ASTM D-3603 test apparatus that contains the fluid to be tested at 60 degrees C (140 degrees F). The specimen is then exposed to water and oil vapors for a period of six hours. At the end of the test, the specimen is examined for evidence of corrosion. If corrosion is present, the lubricant is scored as a fail. Obviously, if there is no sign of corrosion, the lubricant is given a pass.



While it is important to have a lubricant that can protect against water ingression and the eventual humidity created by the water and hot machine oil, what is more important is taking a proactive approach to reduce water ingression in the first place. There are many viable solutions, which tend to be application-dependent, including desiccant breathers, headspace purging, expansion chambers, etc. One of the easiest, cheapest and most fundamental ways to reduce ingression is to simply seal the system as best you can. This would include not leaving tank hatches open, not relying on OEM breathers to stop moisture and not running water across the top of a sump to cool it.

If water does enter the system, you must be able to recognize its presence, analyze its state and concentration, and remove it as quickly as possible. Water can exist in oil in three states or phases. The first state, known as dissolved water, is characterized by individual water molecules dispersed throughout the oil. Most industrial oils such as hydraulic fluids, turbine oils, etc., can hold as much as 200 to 600 parts per million of water (0.02 to 0.06 percent) in the dissolved state, depending on the oil's temperature and age, with aged oils capable of holding three to four times more water in the dissolved state than new oil.

Once the amount of water has exceeded the maximum level for it to remain dissolved, the oil is saturated. At this point, the water is suspended in the oil in microscopic droplets known as an emulsion. In a lubricating oil, this condition is often referred to as haze, with the oil said to be cloudy or hazy.

The addition of more water to an emulsified oil/water mixture will lead to a separation of the two phases, producing a layer of free water as well as free and/or emulsified oil. For mineral oils and polyalphaolefin (PAO) synthetics with a specific gravity of less than 1.0, this free water layer is found on the bottom of tanks and sumps.

Recognizing the states and analyzing the concentration can help you make a decision on how to best remove the water, but as stated earlier, stopping the ingression in the first place should be the ultimate goal.

"What percentage of total life-cycle costs do lubricants account for in a pump, motor, conveyor or blower/fan?"

When estimating the life-cycle costs of machinery, you must take into account several factors. Of course, there is the initial purchase and installation of the equipment, as well as any aftermarket accessories attached to the machine. There is also the cost of ownership, including all the maintenance procedures that are performed routinely to ensure the pump, motor, conveyor, fan, gearbox, etc. is running correctly.

Properly maintaining a piece of equipment is much easier said than done. When a simple oil change is required, several costs are incurred. Not only is there the cost of the lubricant but also an expense for the labor associated with changing the oil. In larger-capacity reservoirs, it may take hours if not days to complete the oil change. This is referred to as the "hidden cost of an oil change." If you are using premium formulated oils, especially synthetic fluids, the cost of the lubricant alone can be more than $50 dollars per gallon.

Perhaps the best way to answer this question is to explain the benefits of properly lubricating and maintaining equipment. An equipment failure can occur for a variety of reasons, yet in a recent study it was determined that as much as 43 percent of equipment failures are directly attributed to the incorrect choice and usage of lubricants.

A common mistake that can lead to premature failure is the selection of the wrong viscosity based upon the operating conditions (load, speed, surface roughness, etc.), which can greatly increase the amount of wear a machine experiences. While the cost of a lubricant can be very low, the benefit of using it correctly can be very high.

Aside from using the incorrect viscosity, the cleanliness of the lubricant makes a big difference in how well and how long a machine can operate. By keeping the lubricant clean, you can extend the life of the machine in which it is operating. A study by Ernest Rabinowicz has shown that 70 percent of machines lose their usefulness due to surface degradation of internal parts. Proper lubricant conditioning can lessen this occurrence and thus extend machine life.

So while it is difficult to put a dollars and cents value on the cost of a lubricant throughout the life cycle of a piece of equipment, the effects the lubricant has on the machine are limitless. In order to get the most from your machines and cut down on the mean time between failures (MTBF), you must properly maintain the lubricant. ■

If you have a question for one of Noria's experts, email it to editor@noria.com

Lubrication INSTITUTE.COM

Lubrication Institute, an associate of VAS Tribology Solutions organised five trainng programmes on Machinery Lubrication and oil analysis at Dhaka, Kolkata, Mumbai & Colombo.

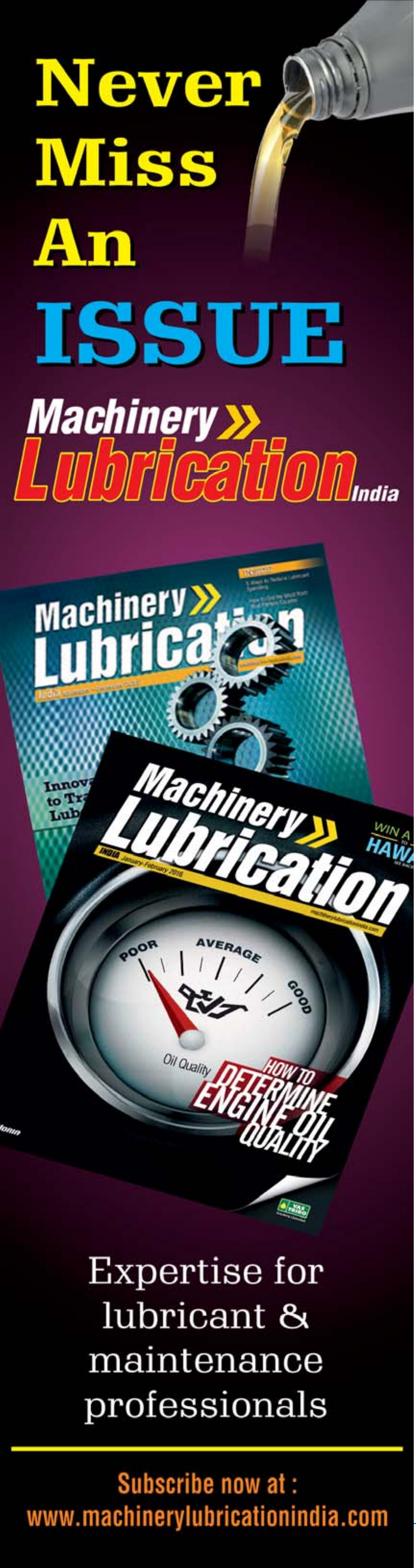
Dhaka (Bangladesh) 14-16 November, 2016. Essentials of Machinery Lubrication.

Kolkata 17-19 November, 2016 Practical Oil Analysis

Mumbai 21-23 November, 2016 Advanced Machniery Lubrication

Mumbai 24-26 November, 2016 Advanced Oil Analysis

Colombo (Sri Lanka) 28-30 November, 2016 Essential of Machniery Lubrication



TEST your KNOWLEDGE

This month, *Machinery Lubrication India* continues its "Test Your Knowledge" section in which we focus on a group of questions from Noria's Practice Exam for Level I Machine Lubrication Technician and Machine Lubricant Analyst. The answers are located at the bottom of this page. The complete 126-question practice test with expanded answers is available at store.noria.com.

1. Condition-based maintenance:

A) Is based on the condition of the equipment and the early detection of faults

B) Is based on regular time-based overhauls

C) Is based on run to failure

D) Is based on the condition of the oil and other root causes

E) Answers A and D

2. The oil film thickness (or dynamic operating clearance) in operating bearings:

A) Cannot be determined

B) Is about 10 microns for journal bearings (although can vary considerably)

C) Is about a micron for rolling bearings

D) Is not measurable

E) Answers B and C

3. Oil degradation due to contamination can result in:

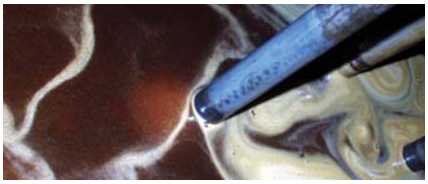
A) Viscosity change

B) Additive depletion

C) Oxidation

D) All of the above

E) Only A and B



Answers

1. E

Condition-based maintenance is often referred to as predictive maintenance (PdM), where the ultimate goal is to perform maintenance activity based on early detection of problems using periodic or continuous monitoring. Obviously, "E" is the correct answer, while "B" and "C" represent preventive and reactive maintenance, respectively.

2. E

Generally, the film thickness in a journal bearing is approximately 10 microns, while in a rolling-element bearing it is about 1 micron. This is why rolling-element bearings are more sensitive to contaminants.

3. D

Oil degradation due to contamination can result in a viscosity change (decrease/increase) based on the contaminant; additive depletion due to decomposition, adsorption and separation; and oxidation where contaminants such as water work as catalysts to expedite the oxidation reaction.

DHIREN SHAH

BASE OIL REPORT

India's crude oil imports rose 17.7% to 4.5 MMbpd (million barrels per day) in September 2016 compared to the same period in 2015. September imports were at their highest level since April 2009. A rise in domestic demand led to the rise in crude oil imports. India's oil ministry expects India's crude oil demand to rise 11% in 2016 compared to 2015. This would be driven by better economic growth and favorable monsoon rains. Crude oil consumption in India will rise by 400,000 barrels per day in 2016 and 2017.

The IEA (International Energy Agency) projects that India's crude oil demand growth rate will be the highest by 2040. The IEA estimates that India is the fourth-largest country in terms of global refining capacity. Indian government data show that India's refining capacity has grown from 62 million tons per year in 1999 to 215 million tons per year in 2015. India's refining capacity is expected to increase more due to various expansion projects, which could support crude oil imports.

The U.S. Energy Information Administration reported that India plans to build three SPRs (strategic petroleum reserves) in 2016. The expected capacity of the SPRs is 39.1 MMbbls (million barrels) of crude oil. Most of these facilities will be completed by the end of 2016. India is also planning a second phase of SPR capacity of 91 MMbbls by 2020. This could also add to its demand for crude oil. India's crude oil production was at 900,000 bpd in 2015, much less compared to its refinery capacity at 4.4 MMbpd (million barrels per day).

MONTH WISE IMPORT BASE OIL IN INDIA

Month	Imported Base Oil
January 2016	193786 MT
February 2016	208150 MT
March 2016	229985 MT
April 2016	257118 MT
May 2016	197892 MT
June 2016	290324 MT
July 2016	277855 MT
August 2016	215886 MT
September 2016	131183 MT

Base Oil Group I & Group II CFR India prices:-

Month	Group I - SN 150 Iran Origin Base Oil CFR India Prices	N-70 Korean Origin Base Oil CFR India Prices	J- 500 Singapore Origin Base Oil CFR India Prices	Bright Stock-150
July 2016	USD 515 – 520 PMT	USD 555 - 575 PMT	USD 605 - 615 PMT	USD 980 - 990 PMT
August 2016	USD 545 – 550 PMT	USD 585 - 605 PMT	USD 635 - 645 PMT	USD 1010 - 1020 PMT
September 2016	USD 515 – 520 PMT	USD 575 - 585 PMT	USD 610 - 625 PMT	USD 985 - 995 PMT
October 2016	USD 505 – 510 PMT	USD 560 - 565 PMT	USD 600 - 615 PMT	USD 975 - 985 PMT
November 2016	USD 490 – 495 PMT	USD 545 - 550 PMT	USD 585 - 600 PMT	USD 960 - 970 PMT
	Since July 2016, prices have gone down by USD 25 PMT (5%) in November 2016.	Since July 2016, prices have fall down by USD 15 PMT (3%) in November 2016.	Since July 2016, prices have decreased by USD 15 PMT (2%) in November 2016.	Since July 2016, prices have dipped down by USD 20 PMT (2%) in November 2016.

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Essentials of Machinery Lubrication

DHAKA (BD)
20-22nd November
Practical Oil Analysis

KOLKATA
23-25th November
Essentials of Machinery Lubrication

MUMBAI
27-29th November
Advanced Machinery Lubrication

MUMBAI
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- Possess High Viscosity Index and FZG load carrying ability to protect hydraulic systems
- Outstanding oxidation and thermal stability ensuring long service life

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