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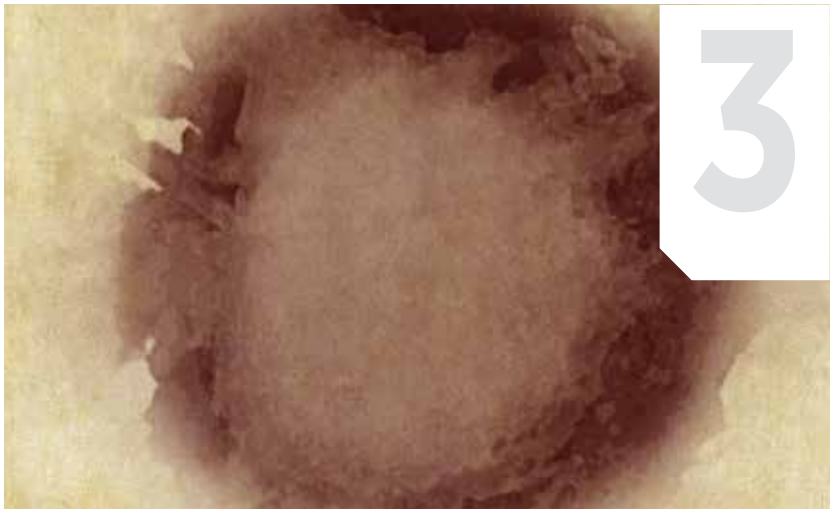
Like most condition monitoring methods, blotter spot testing can add information or data to help answer questions about machine health and lubricant condition.



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Publisher's Note

Many organizations place too much emphasis on the lubrication technicians/engineers to get the job done, while providing little or no support. The prevalent attitude seems to be that sending a technician to a training class is all they needs to change the fortune of the lubrication department. A lube tech must understand safe and best practices for lubrication tasks, sampling techniques, how machines run, how they fail, the physics and chemistry behind lubrication engineering, technology, reliability engineering principles and technology, and the important role of lubrication and reliability in the firm's economics.

A good lube tech is a specialized professional who, when properly enabled can deliver a great deal of value to the operations of a firm.

The question is who should perform lubrication tasks - dedicated lubrication technicians (centralized lubrication) or general mechanics and/or operators (decentralized)?

If we choose to centralize the activity, we can focus education and training activities on few people. Decentralizing lubrication means that numerous people must be trained and educated upfront and ongoing. This is because of turnover, which significantly increases the costs for training programs and decreases their effectiveness. In some organizations, size and scale prohibit assigning dedicated lube techs without outsourcing or assigning the activity to regional techs. In midsize to larger facilities, it is usually feasible to dedicate lubrication activities to lubrication professionals.

Decentralizing is an important activity such as machinery lubrication often results in poor performance and little innovation. Consider where your largest opportunities to improve mechanical reliability reside.

Educating the work force is a key first step in launching your lubrication program. The operators and mechanics that are directly responsible for lubrication must be suitably trained, and individuals that are indirectly involved in the lubrication program should also have at least a basic awareness of the program's goals, primary benefits, and its procedural requirements.

A best practice is to create the role of Lubrication Technician. The Lubrication Technician should be an intelligent, experienced, conscientious, highly trained member of the maintenance work force.Once trained, have your Lubrication Technicians validate their knowledge by becoming certified through a credible certification program.

We would like to thank our readers for the heartening response to our previous edition's cover story – "Supercharging Oil Analysis with AI" and other articles. Our current issue's cover story is on "Who should be your Lubrication Technician". This will help our readers to discover the benefits of having a knowledgeable and well-trained lubrication technician as well as the qualities to look for when filling this key position.

We are glad to announce that Machinery Lubrication India is about to complete 7 years with the next issue. Keep your support, feedback and encouragement pouring-in.

As always, we look forward to your valuable suggestions and feedback.

Warm regards,

Udey Dhir

Blotter Spot Testing **for Metallic and Other Solid Particles**

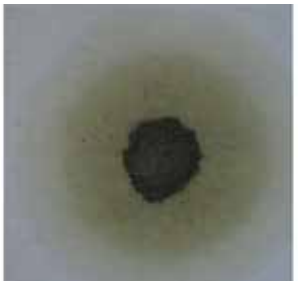
"Like most condition monitoring methods, blotter spot testing adds information or data to help answer questions about machine health and lubricant condition."

The blotter spot test has been discussed numerous times in the pages of *Machinery Lubrication* magazine. It not only is one of the oldest oil analysis tests (mid-19th century) but endures as one of the most effective at detecting and even quantifying certain lubricant abnormalities. However, the blotter spot test is not commonly known as a test for detecting and examining particles in oil such as wear debris and dirt.

As a practical matter, its ability to reveal normal and even slightly abnormal amounts of solid particles is limited, especially without the aid of a microscope. This generally is true with other applications of blotter spot testing. In other words, the lack of a visible structure (rings, starbursts, pasty center, etc.) is an indication of the absence of the target condition. Because of this, the blotter spot test is less likely to produce a false negative compared to other more advanced analytical methods.

While each method has its own unique interferences and lower sensitivity limits, the ability of blotter spot testing to provide a reliable alert to abnormal particle concentrations is undisputable. Of course, this depends on the alarm

This blotter shows rust from a lubricant contaminated with water. Oil analysis found 397 parts per million (ppm) iron. Water is not generally observable on non-engine blotters. The base oil properties looked normal.



Oil analysis reported 1,257 ppm lead. Other trace insolubles in a band around the central pattern were observed. This band could be varnish potential, dead additives or contamination.

This is an ISO VG 220 gear oil. The 870 ppm iron was mostly silt-sized wear debris and rust. The lubricant was probably heavily filtered. The base oil and other properties appeared normal.

This ISO VG 68 bearing oil had an acid number of 2.25, 1,257 ppm lead and 119 ppm copper. The oil appeared to have been previously contaminated with water. Babbitt distress from thrust bearing pads or radial plain bearings was observed.

limit. Such particles would be invisible in the oil as viewed with the unaided eye. Other methods such as patch testing, ferrography, particle counting and elemental analysis (for small particles only) could detect particles in this same range of concentration and particle type.

Particle Mobility on Blotters

Soot, oxides and other resinous (soft) insolubles in certain oils exhibit a degree of mobility (particle travel) outward in a radial direction from where the oil is introduced to the blotter paper. This can leave a recognizable structure on the blotter. Conversely, hard inorganic particles such as wear debris and dirt do not wick out into the blotter paper well, with the exception of the smallest particles (e.g., less than 3 microns). This is due to the high relative density of these particles and their larger size.

Large particles settle quickly and are entrapped by the tortuous texture of the blotter media. Small particles and those of low density can be more easily transported radially by the oil. The distance of their travel is dependent on the particles' size, density and shape, along with the viscosity and density of the oil in which they are suspended. Other influencing factors include the type of blotter paper, particle polarity, certain additives (e.g., dispersants) and temperature of the oil (when introduced), as well as whether the blotter is developed using a hot plate.

The limited mobility of particles is a good thing when their population in the oil is relatively low. This is because they will deposit in a concentrated zone, in the center of the blotter, providing more conspicuous viewing. This feature is more of a negative when particle concentrations are high, as they tend to pile on top of each other, which can obscure the view of some large particles.

Examining Blotter Spot Particle Deposits

The nature of solid particle deposits can be observed in the blotter samples shown on page 2 and below. These particles, which are basically sediment, are largely constrained in the central deposit zone and slightly at the halo region of its periphery. In most cases, the central zone is deeply colored with a dense debris field, similar to what you might see in a patch test. In a few other instances, the core region of the central zone is distinctly paler, but the color may graduate to darker tones toward the halo periphery.

The color transitions suggest some particle mobility and that most of the particles are quite small (less than 3 microns). This can occur when the larger particles are selectively stripped from the oil by sump stratification (sediment) or filtration (in circulating systems). When oil is changed infrequently, there can be a considerable buildup of small particles, often called ghost riders. For more on this subject, please refer to my article in the July-August 2018 issue of *Machinery Lubrication*.

The blotters shown on pages 2 and 4 are mostly from industrial gear and bearing oils exhibiting abnormal levels of wear metals. All blotter images are roughly the same size as when they were created, i.e., no magnification. Interpretation of these blotters is always subjective and influenced heavily by the experience of the analyst, knowledge of the machine and operating conditions/exposures, and the ability to trend from a succession of previous blotters (same machine) or from blotters from similar machines.

Note the elemental data on the oils used in the blotters shown on pages 2 and 4. Be mindful that elemental analysis is largely unable to quantify the presence of particles larger than 3 microns. Conversely, these larger particles are quite visible on the blotter, especially aided by microscopy. Other tests and inspections can also aid considerably in the interpretation, including patch testing, magnetic plugs, bottom sediment and water (BS&W), used filter inspections, ferrous density testing, secondary oil sample

Machinery Lubrication India

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Machinery Lubrication India Volume 42 - Issue 4, July-August 2019 is published bi-monthly by VAS Tribology Solutions Pvt. Ltd. Operation Office:213, Ashiana Centre, Adityapur, Jamshedpur-831013, India.

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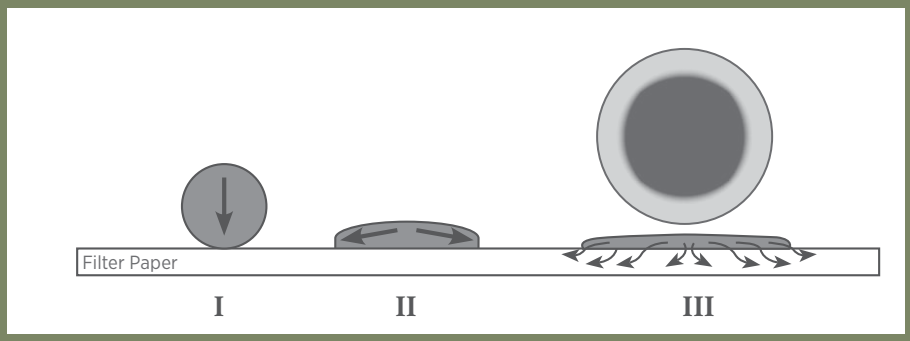
How the Blotter Spot Test Is Performed

To perform the blotter spot test, sample the oil from an active live zone of the system, similar to conventional oil analysis. Next, using a disposable laboratory syringe, place a couple drops of oil in the center of the blotter paper (see the illustration below). The oil should not be too hot, as many of the target components become insoluble at lower temperatures and only then can contribute to the blotter's structure. Room temperature is best. If trending is performed, the blotters should be developed at roughly the same temperature. When trending, the current blotter is compared to blotters from previous samples.

Allow the paper to sit in a horizontal position, such as on the rim of a beaker or drinking glass. Don't lay the card flat in direct contact with a table top or other flat surface, as this contact will interfere with the development of the structure.

Next, let the oil develop or wick radially into the paper, creating a structured blotter spread. It will absorb outward from where the oil drops were applied by capillary action. The rate of absorptive movement and total travel is influenced by many physical (e.g., viscosity) and chemical (e.g., polarity) properties, including temperature. Typically, after an hour or so, the blotter is ready to be examined. Note that some blotters will continue to move even days later. For this reason, use a standard time interval, especially if images are taken for future comparison.



inspections, vibration, acoustic emissions and thermal imaging.

Like most condition monitoring methods, blotter spot testing adds information or data to help answer questions about machine health and lubricant condition. It can provide an effective screen for numerous conditions or potential alerts. In many cases, it must be combined with other methods to enable a more complete characterization of condition and health. Despite its low-tech simplicity, it should never be ignored or underestimated in terms of importance to the field of condition monitoring and machine reliability. ***ML***

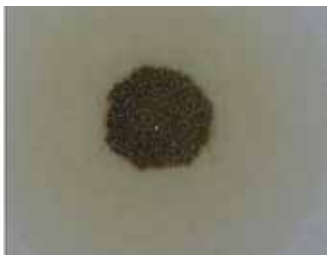
About the Author

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 also 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.

This ISO VG 460 worm gear oil had 3,619 ppm iron and 291 ppm copper. Extremely fine metallic debris was observed, both iron and copper. Iron comes from the worm, and copper from the bronze ring gear. The pale center indicates very small particles of iron and copper. No base oil degradation was observed.

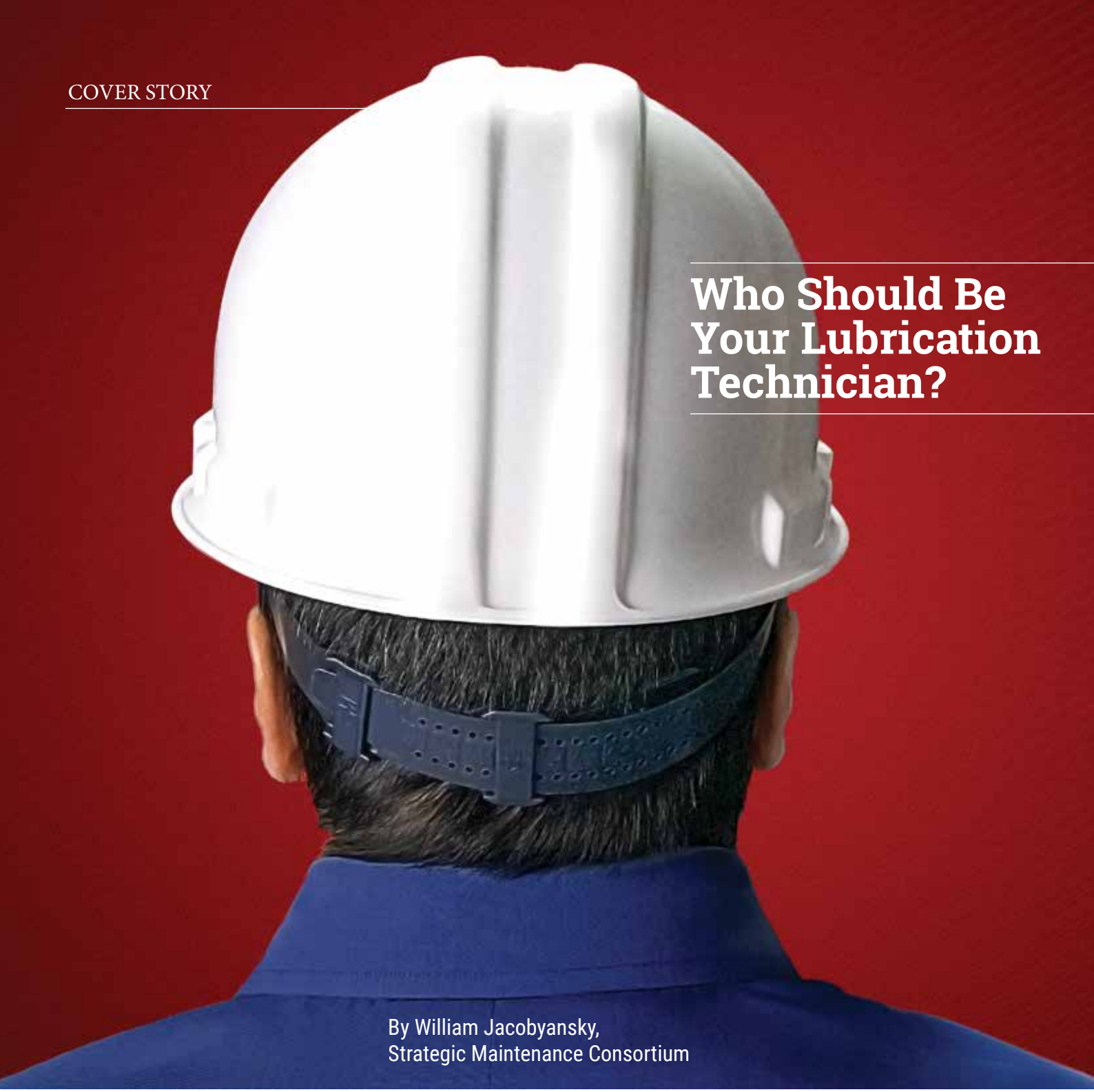
This oil had 128 ppm silicon and 185 ppm iron. Silica may not be visible in this blotter, as it usually blends into the paper's color and texture. However, it is likely a significant contributing factor to the presence of iron from abrasion and surface fatigue. No base oil distress was observed.

This is an ISO VG 680 gear oil with 273 ppm copper and 766 ppm iron. The higher viscosity of this gear oil appears to show evidence of coarse filtration and larger iron and copper particles, as indicated by the darker center zone.



This gear oil has 870 ppm iron. A high value was reported from direct-reading ferrography (ferrous density). Large, concentrated ferromagnetic particles were found by the lab. This is evident on the blotter from a small, tightly packed central zone. No particle mobility was observed.

Who Should Be Your Lubrication Technician?



By William Jacobyansky,
Strategic Maintenance Consortium

Many industrial maintenance departments put inexperienced people in the position of lubrication technician. They make the mistake of assuming that because lubrication tasks appear to be simple that being a lube tech is simple. This is supported by human resources (HR) professionals who seek gateways for maintenance personnel and to keep payrolls as low as possible. This article will discuss the benefits of having a knowledgeable and well-trained lubrication technician as well as the qualities you should look for when filling this key position.

Not a Gateway Position

The work of an industrial lubrication technician is seen by many as a simple job that doesn't require specific knowledge and therefore is not deserving of a high pay grade. Because of this, it is often used as a gateway to bring new people into maintenance. The premise is simple: get motivated but inexperienced individuals into the department where they can start to learn about machinery and maintenance skills while the company is able to get production from them as they perform simple lubrication tasks. The position is also

frequently used as a pre-retirement post to entice a seasoned technician who nobody wants to see leave but who no longer wants to endure the physical strain of maintenance work. Both of these strategies are prevalent in industrial maintenance departments. However, just because something is common doesn't mean it is the right thing to do.

Lubrication Isn't Simple

Lubrication suffers from the fallacy that it is simple. Yes, the task of injecting grease into a bearing is simple and can be taught in a few minutes. Changing oil is even easier. Untrained people do it on their cars, tractors, motorcycles and everything else all the time. I can see why HR professionals might think that a minimally experienced individual or someone on his or her farewell tour should be your lubricator – they just don't know any better. Maintenance professionals shouldn't have that excuse.

The Demand on Industrial Equipment

There's a significant difference between the demand that's put on your personal vehicle and the demand that is placed on industrial equipment. For example, a car engine that lasts for 200,000 miles is considered an achievement. Now, if this engine was averaging 10 miles per hour whenever it was turned on, then this would mean that the car ran for 20,000 hours or 2½ years of non-stop runtime. In contrast, a piece of industrial equipment is still considered new when it is 2½ years old. A car has its oil changed every 5,000 miles, which is equivalent to 21 days of runtime for industrial equipment, but you expect your plant equipment to last for 20 years or more and go six months to a year between oil changes. To achieve this long life, you must maintain your industrial equipment differently than the amateur maintains his vehicle.

Lubrication looks easy because most sites do it poorly in that they only do part of the job. Changing the oil and regreasing equipment is the final step in the process and not the only requirement. There's a lot of technology in grease and oil, and understanding it well enough to make the right decisions cannot be done in a one-hour lunch-and-learn with your local lubricant vendor.

Salaries Easily Justified

At a plant where I worked, there was a fan on a glass-tempering line that would dramatically fail at least once a year. We monitored it daily with vibration and infrared, and everything would look great, but then it would suddenly fail and destroy itself. There were design flaws in the setup of the line that were imposed by space constraints, which violated manufacturer specifications, but this could not be reversed.

Our lubrication technician, who had a Level II certification and was on his way to achieving his Level III certification, was sure it was a problem that could be solved with the correct lubricant application. We all scoffed at his idea and tried several other solutions. Fortunately for us, he was not deterred and eventually solved the problem by switching to a grease designed for high-stress applications.

This strategy wasn't on anyone else's radar and would not have been possible without his dedication to his craft. The savings from that one triumph paid for his salary for as long as the line was in operation. I don't think a young kid without any equipment knowledge or a soon-to-retire mechanic who is biding his time until retirement would have been as effective.

There were plenty of other success stories, but this incident was the most dramatic. Our lube tech took us to the point where we were starting to see incipient failures in the oil analysis results before we saw them through vibration readings or infrared inspections.

Now, I may be singing to the choir when I say it takes intelligence, time and dedication to learn how to be a good lubricator, but it also requires a lot of hard work and tenacity to build and maintain a good lubrication program. I can't see a program like this being built and maintained by someone

with little to no equipment background who is eager to move out of the position and into a better paying maintenance technician role or someone who is looking at retirement in the near future. Of course, there are people in those situations who have done the job well, but I don't think you can bank on that being the most likely result.

Lubricants Require Special Care

When I talk about oil, I call it the lifeblood of the machinery and emphasize to maintenance technicians the care that needs to be taken when receiving, storing and transferring it. Most people don't get it. You can see them transferring oil in an open can that they leave sitting on a shelf in between uses. The effect of even a soft particle like cotton is alarming when it is put under the stress of a ball in a high-speed bearing or between two gears. So, what do you think all the harder dust particles that float around in the air can do? In most industrial facilities, the inability to sample oil correctly or even to set up proper sampling ports is widespread.

Grease has its own set of complications. It faces greater temperature extremes and is often more exposed to the environment in its application. The possibility of mixing incompatible greases in the field is also a problem that frequently is not even recognized as a risk.

Training people how to manage a lubrication program can be a difficult task when they are surrounded by experienced team members who think they know what they're doing but don't. To get individuals who are at the end of their careers to buy into the premise that what they've done for 25-35 years is wrong can be an uphill struggle. Bringing inexperienced people into the department and asking them to do everything in a new way may offer a better chance of success, but if these individuals self-select out of the position shortly thereafter, it will take a long time to develop a good, sustainable program.

Qualities of a Good Lubrication Technician

A good lubrication technician should have knowledge about the equipment. You can't just know half of the equation. Understanding lubricants is great, but you also need to know what they mean to the machine's operation for a holistic view of the situation. It helps if the person is not afraid of getting dirty. This seems to be why many engineers don't go into the field as often as they get involved in vibration and infrared. It also means that someone from the maintenance crew is a perfect candidate to be moved into this position. However, you need to pull the right type of maintenance person.

I always look for someone who is eager to learn and excited by the application of new knowledge. There is a lot of bench time and computer time when you are learning the details about lubrication. The properties of additive packages, oil sample data and sampling techniques are just a few examples of the information that must be digested and understood. Someone who doesn't find any enjoyment in this, particularly those who earn their living by working with their hands, will endure some very tedious days trying to assimilate this information. It could be torturous for the wrong person, which would be detrimental to the program. Maintenance professionals are intelligent, but many of them would rather learn by doing than by studying.

Whether you are upgrading your lubrication program or starting one from scratch, you will need to change a lot of habits. Your lubrication technician will be key in this effort. For this reason, lube techs must be respected by the rest of the department. As they learn their craft, they will be implementing improvements as well as forcing changes in the activities and behaviors of team members. Change, even when it is an improvement, never comes for free. It takes effort, and the effort required is reduced considerably when there is respect for the source.

It also helps if the lubrication technicians are confident in their abilities. To me, this is one of the great benefits of getting your lube techs professionally certified. It makes them confident in their craft and credible in the eyes of plant management.

Finally, as in almost any key position, you want a self-starter. Setting up and maintaining a good lubrication program will be a long-term process that takes continuous management. It is most cost-effective if your lubrication technicians take the lead in this effort. After their initial introduction to the principles of good lubrication, they will soon learn which direction they need to go and what they need to get there. This also instills that pride of ownership, which is a powerful motivator. You want a person in the position to whom you can give free rein. It's much easier to slow someone down who is trying to go too far and too fast than to always be pushing someone down the correct path.

There are other qualities that can be beneficial, but those mentioned previously are the most important. Don't default to the common misunderstanding of this being a low-paying job or even that anyone who's good at "fixing things" can become your lubrication champion. A good lube program will save you much more than it costs in terms of longer equipment life, earlier recognition of problems and a better understanding of what is being done to your machines. Reward the job commensurately with the value it provides. Put a quality individual in the position and remember that preventing problems is much better than fixing them. **ML**

Total Lubrication Management (TLM) **A new viewpoint**

USUAL APPROACH

The lubrication responsibilities at plant were assigned to unskilled and untrained workforce or to machine operator. Anyone who needed oil or grease could order any type or amount of lubricant to complete the task at hand. The result is an excessive amount of oil and grease stashed in every corner of the plant. A few people want to change their lubrication practices but they are not able to implement it on the ground level. These people need to understand that they will need dedicated & trained team to develop and run the lubrication program. This will involve understanding issues and needs of the plant's lubrication.

Figure 1. Open contaminated galvanized container

Starting from Inventory to disposal of discarded lubricants, the reason for lubrication failure was found to be poor quality control and poor lubrication practices resulting in increased lubricant consumption, followed by unexpected equipment downstream issues.

A number of common incorrect lubrication practices (described below) are responsible for this condition.

- Use of open contaminated galvanized top up container
- Use of single container for multiple oil grades
- Use of single barrel hand pump for multiple oil grades
- Lack of written procedures for lubrication task
- Improper handling and storage

The equipment for contamination control (filter carts/breather) is in poor condition and has not been checked and changed since equipment's installation.

Figure 2.Unorganized Lube Room

As we all know that an effective lubrication program with oil analysis can provide longer equipment life, detect early signs of contamination and degradation, reduce equipment downtime and ultimately save money. In the POLARIS Laboratories OUTLOOK 2015 Benchmark Study for the Oil Analysis Industry, the following facts were determined by companies utilizing oil analysis in their preventive maintenance program:

Typical Lube problem in plant	
Under-lubrication	Over-greasing
Poor labelling system	Cross-contamination
Time/production based oil change	Lack of onsite condition monitoring
Unscheduled oil filtration	Flushing & cleaning of tanks

80%

maximized equipment uptime by using oil analysis.

- 80% maximized equipment uptime by using oil analysis.
- 69% optimized oil drain intervals up to twice that of standard drain intervals.

Beside the above fact, it has been observed that most plants do not have a lubrication program with oil analysis. Some of the plants have an onsite testing as well as third party testing facility but they are not aware of the importance of proper sampling procedure and lack of oil analysis report interpretation skills. The oil analysis reports are only used for audit purpose. In my opinion, it is just because of a limited knowledge on the subject and no standard training program & certification course available.

69%

optimized oil drain intervals up to twice that of standard drain intervals

MODERN APPROACH

The plants with Best in Class levels focus at great length on the management of their lubrication activities as they understand the importance of lubrication on equipment life. Lubrication practices within a plant have a direct effect on plant and equipment reliability. When a lubricant is working effectively in a machine with no chemical degradation and with limited contamination within it, wear will be reduced and equipment reliability will improve.

Lubrication management is not only topping up the oils into machine. This concept takes holistic approach for lubrication from cradle to grave. It starts the day the lubricant arrive onsite, and ends the day the oil is drained from the machine and disposed of safely. The industries are now focusing on the management of their lubrication activities which includes lube survey, proper storage and handling, schedule equipment inspection, oil topping up & re-greasing, onsite condition monitoring, online or offline filtration, condition based oil change and Data analysis & interpretation. In the past few years, there has been a growing trend in establishing lubrication management services, and these organizations have been reaping handsome rewards.

Figure 3. Dedicated colour-coded oil dispensing containers

IMPLEMENTATIONS

The following new implementation at plant is being done:

- Introduce a cross check of quality of lubricants received
- Focus on contaminant exclusion at every stages
- Introduce Specialized cleaning machine
- Best sampling practices
- Interpretation of Oil analysis
- Condition based oil change
- Proper segregation of waste oils
- Lubrication Training Program

Industries focus on contaminant exclusion at every state from reception to during usage as well as they have specialized filtration machine to exclude the contaminant and maintain the required cleanliness level in the machines. This helps to increase drain interval, improve system performance and lower downtime & maintenance cost. They also have the standard procedure of lubrication activities like tank cleaning, sampling, oil drain, disposal etc.

The importance of oil analysis & its interpretation has been stated. Set up an onsite laboratory at plant to get the immediate result of oil condition to take necessary action during the preventive maintenance.

Figure 4. Lube Room

BENEFITS

The lubrication team focused on each and every key area of lubrication and transformed the old practices into world class. They have overcome many lubrication challenges with a reliability focused approach and achieved 20% to 40% reduction in lubricant consumption and other improvements like reduction in spare cost, tool cost, reduction of machine downtime and improved machine availability for production service.

Figure 5. Mobile based software

IT TOOLS (LUBRICATION MANAGEMENT SOFTWARE)

Previously, the data collection, recording, segregation and reporting was done manually which could result in an error. By the introduction of mobile and web based lubrication management software, which is a great tool to collect data, manage the schedule and see the various types of trend analysis at your fingertip. The software can deliver various information such as –

- Machine criticality
- Number of lubrication points
- Lubricant being used
- Consumption trend
- Abnormality alert, Leakage Alert & stock out situation messages
- Live consumption & leakage status on display
- Schedule alarm and automatic daily report

Operational process of the software is very simple. Once you perform the lube task you need to scan the QR Code that is pasted on each machine (each lube point) with the help of mobile based application and fill & submit the task performed details. Customer having secure login ID and password can access both the application to see their lubrication activities, machine information and lubrication history of specific machine etc.

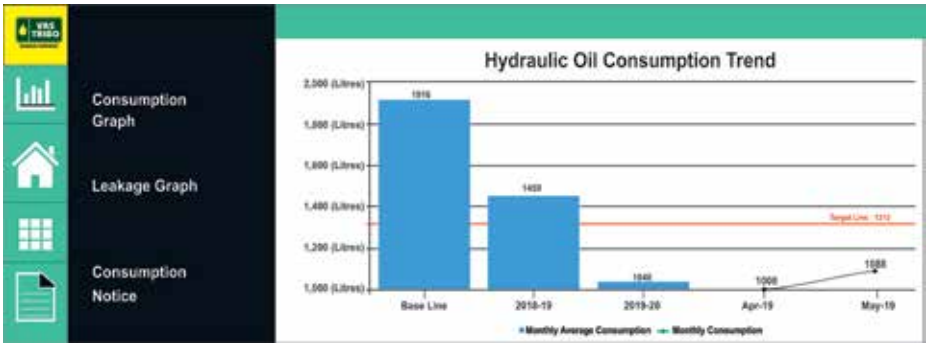


Figure 6. Web based software

About the author

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With over 25 years of experience helping businesses to find comprehensive solutions, Emami Paper Mills Ltd. enjoys the position of being the largest manufacturer of Newsprint in India, and the only manufacturer in Eastern India and manufacturer of Multi-Layer Coated Board. With over 22,000 newspapers, of which 1800 are dailies, its media market is the second largest in the world. In a discussion with Machinery Lubrication India, Mr. Ashish A Gupta – Sr. Vice President, Emami Paper Mills Ltd. tells about their journey of Lubrication Excellence.

Ashish A Gupta is a Mechanical Engineer from Bangalore University and certified as Chartered Engineer by Institute of Engineers, Calcutta. He has 30 years of experience in industrial project management, operation & maintenance of paper machines & captive power plants and multinational logistics including significant hands-on experience in Instrumentation, Electrical & Civil engineering departments in Paper/ Paperboard and Power projects. Currently, he is serving Emami Paper Mills Ltd. as Sr. Vice President- Technical and Manufacturing head.

- **What is the importance of equipment reliability in paper industry?**

Equipment reliability is the most important element that contributes towards achieving the targeted production. It becomes even more important in higher capacity machines because their down-time costs are higher. Better equipment reliability also helps in keeping your maintenance budget (spares cost and manpower cost) lower. It also helps in keeping the cost of downtime lower, which is the major component towards reducing profitability of any operation. Having recognised the importance of reliability, we have invested in a structured reliability program covering lubrication and other tools like of CBM (condition-based monitoring) e.g. on-line vibration monitoring systems on our (critical) high speed machines.

- **What percentage of equipment reliability would you earmark to poor lubrication?**

As you are aware that in Pulp & Paper Plants, the environment is very hot, humid and dusty, which could result in major challenges as far as equipment lubrication is concerned. This could result in excessive contamination like moisture, foreign particle contamination & expeditious oxidation (due to heat) of the lubricants Poor lubrication could be a result of several other factors like choice of wrong lubricants, inadequate procedures during placement of orders, poor storage and handling procedures, cross contamination during top-up activities, sampling techniques, inadequate condition monitoring, contamination control and exclusion etc.

In my view, lubrication is to an equipment what blood is to a living being – it is that important. Equipment failures on account of poor lubrication would form around 35 to 40% of all failures.

- **How have you addressed the issue of reliability connected with lubrication?**

Engineers in most Process plants do not have adequate knowledge of standards/ procedures/ best practices on lubrication procedures e.g. storage and handling of lubricants etc and our plant is no exception.

We therefore decided to engage a professional agency to conduct LPD (Lubrication Program Development) at our Balasore (Orissa) plant. Their team audited each element of lubrication from ordering stage to waste disposal of lubricants and all operations that come in-between (from cradle to grave). Their comprehensive report not only gave us a SWOT Analysis (Strength, Weakness, Opportunity & Threat) for our lubrication program, but also gave several guiding points on how to achieve "World Class Lubrication" for better equipment reliability.

- **What were the major challenges that you faced?**

  The biggest challenge that any management faces is the change of mindset of its operations and maintenance team members. Since lubrication is not given the due importance that it should get, any team would continue to give priority to production or breakdown maintenance etc. It is important that due importance is given to all aspects of lubrication including condition monitoring and other lubrication procedures. Some of these procedures can become an integral part of your predictive maintenance strategy.

- **How you trained / plan to train your team to take these challenges?**

  Having taken the first step of having appointed a professional agency to help us with Lubrication Program Development (LPD), we are considering in-house training sessions for our team of engineers and technicians to train them on various aspects of machinery lubrication, oil analysis and vibration analysis etc. Our team has already gone through an orientation program on as a part of LPD where in they have been sensitised to various aspects of lubrication best practices and how to interpret the LPD report and its implementation.

- **What do you have to say to the reliability community who are looking to transform their lubrication /reliability program?**

  It is sometimes said that the admission of ignorance is the beginning of wisdom because once you are aware that you are ignorant, you accept the fact that you don't know everything and want to change that. As I mentioned earlier, most process industries do not have adequate knowledge in lubrication and therefore as a first step it is important to accept that fact and seek professional guidance from experts such as VAS Tribology.

  Having started the process of lubrication transformation, we must keep our focus on introduction of best in class procedures as suggested by the experts. Capturing the data and analysing it to calculate the trends and benefits is also very important. The whole exercise must result in moving from human driven program to a system driven program, thus resulting in lesser errors and thus improved reliability.

Minimizing Hydraulic **Downtime with Proper Filtration**

"If one or more systems in your plant are not meeting the recommended ISO cleanliness level, **examine the system to ensure the filters are in the proper locations.**"

Contamination is the cause of approximately 90 percent of all hydraulic system failures. If the systems are maintained at the desired cleanliness level and the oil temperature is controlled, then downtime can be kept to a minimum. The ideal oil temperature for an industrial hydraulic system is 120 degrees F. If the temperature reaches 140 degrees F, oil begins to break down. The life of the hydraulic oil will be cut in half for every rise in temperature of 15 degrees F above 140 degrees F.

Mobile hydraulic systems generally are designed to operate at higher temperatures due to their smaller reservoir size, which limits the amount of heat that can be dissipated to the atmosphere through reservoir walls. A higher viscosity oil is often used in mobile systems in order to operate at higher temperatures.

Contaminant particles in hydraulic systems are measured in microns. One micron is one-millionth of a meter. The clearances inside most pumps and valves are approximately 0.0004 inch. How small is this? Consider that a grain of salt is 0.0039 inch or 100 microns. The lower visibility of the human eye is 40 microns (0.00158 inch). A red blood cell is 0.0003 inch or 8 microns. A particle much smaller than what the human eye can see is capable of causing a hydraulic system failure.

Hydraulic filters should be selected to protect the most critical component in the hydraulic system. In the "old days," a 10-micron filter was used to protect a system without servo valves, but there was no measurement for how efficient the 10-micron filter was. Did it remove all particles that were 10 microns and above, some of the particles or 25 percent?

Today, filters are assigned a beta rating to determine their efficiency. The beta rating represents the number of particles that enter the filter relative to the number of particles that are flowing out. System filters should have a beta rating of 75 or higher. For a 10-micron filter, this is expressed as B_{10}=75. This means that for every 75 solid, spherical particles

Some hydraulic units have an inexpensive breather that doubles as a fill cap.

A desiccant breather can be used to remove moisture from the air before it enters the tank.

TARGET ISO 4406 CLEANLINESS CODES		LOW/MEDIUM PRESSURE UNDER 2,000 PSI		HIGH PRESSURE 2,000 TO 3,000 PSI		VERY HIGH PRESSURE OVER 3,000 PSI	
		ISO Target Levels	Micron Ratings	ISO Target Levels	Micron Ratings	ISO Target Levels	Micron Ratings
PUMPS	Fixed Displacement Gear or Vane	20/18/15	20	19/17/14	10	18/16/13	10
	Fixed Displacement Piston	19/17/14	10	18/16/13	5	17/15/12	5
	Variable Displacement Vane	18/16/13	5	17/15/12	3	Not Applicable	Not Applicable
	Variable Displacement Piston	18/16/13	5	17/15/12	3	16/14/11	3
VALVES	Check Valve	20/18/15	20	20/18/15	20	19/17/14	10
	Directional (Solenoid)	20/18/15	20	19/17/14	10	18/16/13	5
	Flow Control	20/18/15	20	19/17/14	10	18/16/13	5
	Cartridge Valve	19/17/14	10	18/16/13	5	17/15/12	3
	Proportional Valve	17/15/12	3	17/15/12	3	16/14/11	3
	Servo Valve	16/14/11	3	16/14/11	3	15/13/10	3
ACTUATORS	Cylinders, Vane Motors & Gear Motors	20/18/15	20	19/17/14	10	18/16/13	5
	Piston Motors	19/17/14	10	18/16/13	5	17/15/12	3
OTHER	Hydrostatic Drives	16/15/12	3	16/14/11	3	15/13/10	3
	Test Stands	15/13/10	3	15/13/10	3	15/13/10	3

These target ISO 4406 codes indicate the required cleanliness levels for various system components.

entering the filter which are 10 microns and above, only one particle will exit the outlet port. Beta ratings of 200 are common for many filters in use today.

Contamination levels in hydraulic systems are measured by the ISO 4406 cleanliness code. The desired target level is dependent on the most critical hydraulic component and the pressure in the system. This is expressed in three numbers, which represent the number of contaminants that are 4, 6 and 14 microns and above in a 1-milliliter oil sample. For example, if a variable piston pump is the most critical system component and the maximum system pressure is 1,500 pounds per square inch (psi), then the target level would be 18/16/13. A 5-micron filter is necessary to achieve this target level.

If the same pump is used in a system that operates at 2,500 psi, then the target level would be 17/15/12. More metal breakdown occurs at higher system pressures. One or more 3-micron filters would be required to meet this target level.

If the oil sample for the 1,500 psi system indicates a 20/18/12 level, then the system is not being maintained to the desired standard of 18/16/13. This may be due to the filters not having the proper beta rating or the existing system filters being contaminated and allowing oil to flow through the internal bypass check valves (if used).

Once the desired cleanliness level has been identified, the next step is to determine where the filters should be located. Consider the following six system locations where contaminants can be removed.

Reservoir Breather

Whenever the oil level drops in a reservoir, atmospheric air will flow through the breather. Many hydraulic units contain an inexpensive breather that doubles as a fill cap, but oil should never be added to the system without being filtered. Not only is it important to remove solid contaminants from the air but also to keep moisture out of the tank. Air contains water vapor, which can turn into liquid moisture once it cools down inside the tank. A desiccant breather can be used to remove the moisture from the air before it enters the tank. Through the use of an adapter, this type of breather can be mounted on the same base as the

Filters often are connected in the return lines of a system's directional valves.

existing, old-style breather. The desiccant crystals will change color as the moisture is absorbed. Most desiccant breathers contain a 3-micron internal filter for removing solid particles from the air. Your selected breather should also have a visual dirt alarm to indicate the condition of the particulate filter.

Pump Suction Filter

The purpose of a suction filter is to prevent large particles from entering the pump. This filter may be in the form of a strainer located underneath the fluid level. These strainers usually have a 74- or 149-micron rating.

I recently consulted with a corrugated box manufacturer which had changed several pumps on one particular system during the past year. When the reservoir was drained and the suction strainer inspected, a large split was found down the center of the screen. When I asked how long it had been since the strainer was changed or cleaned, the maintenance mechanic said, "never in the 17 years I've been at the plant."

Suction strainers should be removed from the reservoir at least twice per year and cleaned or changed. Often there will be a suction filter access flange located where the pump suction line enters the reservoir. This permits removal of the strainer without draining all the oil from the tank.

A better method of cleaning the fluid to the pump's suction port is to mount an external filter in the line. This filter should also have a visual indicator to monitor the condition of the element.

Pressure Line Filters

As pumps operate, metal breakdown occurs. When the pressure exceeds 2,200 psi in a system with a fixed displacement pump, a pressure filter should be mounted in the pump outlet line. This will filter the metal particles prior to being directed to the system. When a variable displacement pump is used at pressures higher than 1,500 psi, a filter should be installed in the pressure line.

The best method of monitoring the element condition is through the use of a pressure switch. Once the element becomes partially contaminated and the pressure drop across the element reaches the switch setting, an electrical signal will be sent indicating the condition. The switch may be used to provide an alarm on the operator's screen that the filter is nearly contaminated. Most pressure filters contain an internal bypass check valve to allow the oil to continually flow to the system once the element is contaminated. The rating of the check valve spring is usually 7-10 psi higher than the setting of the pressure switch. The best method of filtering is to install a dual filter system where one element is active and the other is a standby. When the pressure switch indicates the online element is contaminated, the clean filter can be selected without shutting down the system.

Pressure filters are also commonly used immediately upstream of proportional valves and servo valves. This is due to the extremely tight clearances inside the valves. The majority of these filters are of the non-bypassing type. The filter should be mounted as close as possible to the valve. It is imperative to change these filters on a regular basis to prevent collapsing of the element, resulting in a catastrophic failure of the valve.

Return Line Filters

Filters are often connected in the return lines of a system's directional valves. This allows the oil that exhausts out of the cylinders and motors to be filtered before returning to the reservoir. However, this type of filtration is only effective if at least 20 percent of the system volume is ported through the element in one minute. For example, with a pump volume of 100 gallons per minute (GPM), a minimum of 20 GPM should flow through the return filter. Many systems, such as reject kickers, only operate sporadically, rendering the return line filter ineffective.

Visual indicators and pressure switches can be used to monitor the element's condition. The issue with visual indicators is that they can fail and therefore should not be relied upon. A filter maintenance schedule can be established by initially sampling the oil for several weeks or months. I once consulted with a plant in Oregon that changed the

Visual indicators can fail and should not be relied upon.

Kidney-loop system filters may be quite large.

large return filter on its press every month. After the oil was sampled monthly, it was discovered that the ISO cleanliness code was only exceeded after eight months. The plant then scheduled the element to be changed every six months.

Case Drain Filters

Any oil that bypasses a variable displacement pump or an externally drained hydraulic motor will flow through the case drain line and into the tank. The oil that bypasses will contain contaminants generated by the metal breakdown in the pump and motor. A small filter can be installed in the case drain line to remove the contaminants. Prior to installing these filters, the rating of the pump or motor shaft seal should be checked. For most variable displacement pumps, the shaft seal rating is 10-15 psi. Hydraulic motor shaft seals usually have a higher rating (approximately 50 psi). An internal or external check valve should also be used to allow the oil to bypass when the element becomes contaminated.

Kidney-loop System

A kidney-loop system consists of a separate pump and filter. Frequently, a heat exchanger is also connected in the loop. The pump constantly recirculates the oil in the reservoir through the filter and cooler. These filters can be quite large. The reservoir volume should be turned over five to seven times in one minute by the recirculating pump. For example, if the reservoir holds 3,000 gallons, to filter the oil five times (15,000 gallons) in one minute, a 250 GPM pump will be required. Gear-type pumps are recommended due to their ability to withstand contaminants better than vane or piston pumps. A visual indicator should be used to monitor the filter's condition.

There is no magic rule of thumb for the number and type of filters that should be used in a system. Can you have too many filters in a system? No, but the more that exist, the more time will be required to maintain them. Often it is assumed that the filter on a machine is working when in reality oil is flowing through the bypass check valve.

If one or more systems in your plant are not meeting the recommended ISO cleanliness level, examine the system to ensure the filters are in the proper locations. Also, verify that the filters are changed on a regularly scheduled basis. This can be established through oil analysis. By keeping the oil in your hydraulic systems clean and cool, hydraulic downtime will be kept at a minimum. ***ML***

About the Author

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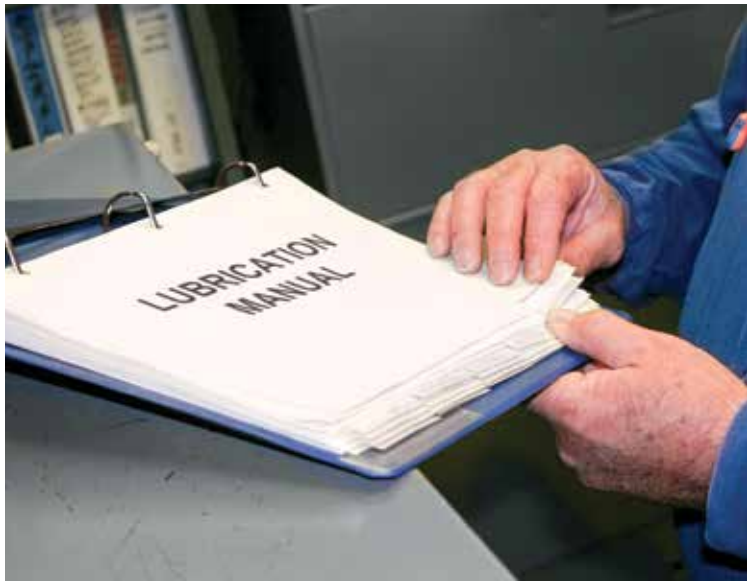
Bennett Fitch | Noria Corporation

Advantages of **Documented Procedures for Lubrication Tasks**

"When lubrication tasks are documented properly and smart management decisions are made, those who perform the tasks will be more effective and strive to become more educated in lubrication activities."

Lubrication is not what it used to be, and that's a good thing (and a bad thing). There was a time when documented procedures for lubrication tasks were treated with importance. Lubrication was front and center to both the cause and solution for a large percentage of machine failures in industrial facilities. Much has been learned since then. Improved lubricants and better engineered machines have enabled equipment life to be extended. However, over time the reduction in failures and the seemingly inconsequential effects of task performance have led to inattention in the everyday lubrication activities. Because of this, routine lubrication tasks continue to take a backseat and at times are disregarded altogether.

Even when lubrication tasks are performed, there has been an epidemic of disregarding details and overall ownership. The result is that the state of maintenance has reverted back to unnecessary lubrication failures, but this time the cause is often carelessness or human error.



Today, the most common reason for lubrication failures is not low-quality lubricants or poorly designed machines. Instead, it is because of how lubrication tasks are ineffectively managed. Following are seven reasons why documented procedures for every lubrication task can offer the solution and directly benefit the bottom line.

7 Reasons for Documented Lube Procedures

When lubrication tasks are documented properly and smart management decisions are made, those who perform the tasks will be more effective and strive to become more educated in lubrication activities. Good documentation with organized response procedures is the key to maximizing root cause detection or early signs of failure detection.

This will lead to one failure avoidance event after another. In short, less overall downtime is achieved. Those involved are also more satisfied in their job tasks and become more invested in achieving the reliability goals. Lubrication task documentation and actions with intention can be the soft solution to an increasingly hard problem.

1. Task Precision

Precision maintenance is all about the details. When careful thought is put into each of the task assignments and procedure steps, there is a better chance of achieving precision maintenance. This should be the most obvious reason. These details may include matters such as who is to perform the task, which tools will be required, in what areas of the machine will work be performed, what must be done, etc. For example, an oil sight-glass inspection task should not simply involve inspecting whether there is an accurate oil level. Instead, it should be a more comprehensive form of oil analysis. This type of inspection would include all three lubrication inspection zones: level, foam and deposits (LF&D); color and clarity (C&C) and bottom sediment and water (BS&W). The documentation should be complete with steps for analyzing the oil across all inspection zones, directions for remediation protocol and even annotated pictures, if possible.

2. Task Confidence (Job Satisfaction)

For many, it can be difficult to feel confident in your job if the tasks are unclear or undefined, particularly if you are assessed against the outcomes. This is a common challenge for new personnel who have been hired to take over the lubrication activities but may not have any experience. If they are given little instruction or are simply told to just "keep everything oiled and greased," they can become unsatisfied in their jobs. Performance will go down as they consistently question whether they are completing the tasks correctly. Even worse, if the machine experiences a lubrication-related failure mode, the root cause may be placed on this individual unjustifiably. The more this occurs, the greater the lack of confidence, and the more job performance worsens.

3. Task Consistency

Routine lubrication tasks are often assigned to one or two specific lubrication technicians (or an area of the plant). This is important in creating ownership, consistency and ease of process control. As these individuals perform their work over a long period of time, there becomes less dependence on documentation for their job tasks. This can be both good and bad. It's good because efficiencies can be developed, but bad because the technicians are more likely to deviate, simplify or overlook task requirements as they become more independent from the documentation.

Keeping documentation as a routine reference helps reinforce the validity of the work being done. Also, if the documentation is updated as deviations are proven beneficial, these efficiencies can be passed to the next individual performing the tasks. This is essential, because if the individual responsible for the lubrication activities in a specific area is suddenly unavailable (temporarily or permanently), someone else would need to step in. If there is improper documentation, a huge risk to the overall task performance will emerge.

While slight changes may not be of concern for many tasks, with others like grease relubrication or oil sampling, even the smallest deviations in the steps performed can have major consequences. For example, if an individual uses the wrong type of sample bottle or does not properly flush the oil pathway, the results could show false positives. Likewise, if the sample is taken from the wrong location, a false negative or false positive could occur. In both cases, the corrective action to prevent a potential

Ensuring Long-term Success of Your Lubrication Program

If you are considering revamping your lubrication program, there are at least two reasons why procedure documentation is vital to support the long-term success of the program. As an improved program is implemented, many of the proactive measures will result in reduced machine failures and higher overall uptime. After years of the program maturing, there likely will be changes in maintenance personnel, a shift in focus with reliability initiatives and even changes in management. All of this may lead to those involved losing sight of why certain daily lubrication tasks are necessary.

If few machines are experiencing lubrication-related failures, a perception may even arise that these tasks are irrelevant. However, if the activities are well-documented and the key metrics were tracked during and after the program's implementation, there would be evidence to show how these "irrelevant" activities are directly responsible for the reduced lubrication-related failures.

Also, if there have been changes in the personnel responsible for lubrication activities, it will be important to continue these activities with a seamless transition. Without documentation and properly scheduled assignments, a core part of the program will walk out the door with those who leave.

failure mode from progressing will depend heavily on these results, and the small details in the sample procedure will play a huge role in that.

4. Task Compliance

Proper documentation is not just about how to perform a task but also how to report that the task has been completed and what the findings or outcomes were. For grease relubrication procedures, scheduling of the next instance of relubrication will depend on when it was last performed. This requires documenting the task completion and if it was done without issue. For inspections, documentation is simply a matter of verifying that each inspection point was not overlooked. If abnormal conditions are reported, this can be trended and observed more closely or converted to a corrective action.

Proactive maintenance is one of the most effective ways to avoid unexpected downtime and extend the life of machines. Tracking task compliance with documentation is a key part in seeing the true benefits of proactive lubrication tasks. After all, what gets measured gets done.

5. Task Prioritization

It's not uncommon for lubrication technicians to get behind on their scheduled tasks and for routes to fall into a backlog, particularly if the available manpower is not adequate. For many, this seems inevitable. As a result, planning and scheduling will require prioritization across several criteria, including all task and asset types, routes and locations. Documenting these details is a prerequisite for creating these prioritizations. Furthermore, prioritization should be optimized routinely. Based on the results of predictive and proactive analysis from lubrication tasks or other condition-based maintenance, machines exhibiting early signs of a potential failure mode may move up the priority list.

6. Task Data Trending

Whether it's a specific task type on one machine or several task types across all machines in the plant, there is value in analyzing data trends. Most condition monitoring technologies such as oil analysis and vibration analysis are known for their ability to apply trend techniques to predict machine operating conditions and potential failure modes. Making these predictions and optimizing task techniques can be greatly enhanced by analyzing the documentation for task completion and feedback data.

45%

of lubrication professionals say their plant does not have written lubrication procedures, based on a recent poll at MachineryLubrication.com

7. Enforcing Proactive Maintenance

Despite the overwhelming evidence of a proactive maintenance program providing huge returns, it has a long history of being treated with diminished importance. Why? Maybe because the activities are not as urgent as rebuilding a failed pump or because there is no instant satisfaction from daily inspections or precise relubrication procedures. Whatever the reason may be, this is why all lubrication tasks should be documented. Documenting the task requirements, scheduling, prioritizing and monitoring compliance are effective ways to emphasize the magnitude of these proactive activities.

Managing Your Lube Procedures

For today's maintenance teams, a computerized maintenance management system (CMMS) is the standard for a repository where documented lubrication procedures reside. However, with the complex functionality and requirements of mainstream CMMS programs, there can be challenges integrating the specific needs of lubrication activities. Similar to what plagues many proactive lubrication requirements, a CMMS often treats lubrication tasks with lesser importance. For this reason, it is not unusual for plants to opt for separate programs for lubrication documentation, route management and other lubrication data organization.

Regardless of how you choose to manage the documentation for your lubrication procedures, the following checklist can be used to evaluate a management system:

- Is it easy to use?
- Is it easily accessible for those who need it routinely (various levels of access permissions may be required)?
- Is it easily editable for those who are training and accountable (editing should be limited and maintain consistency)?
- Is it aligned with standards provided by the corporate lubrication standards manual?
- Does it have a fixed hierarchal asset structure for organized documentation?
- Does it offer template and format control for the structure and organization of procedures (these can be driven by the corporate standards manual or internationally recognized standards)?
- Does it contain checklists or other evaluation feedback methods for inspection and quality-control tasks?
- Does it include references to additional supporting documentation (such as the corporate standards manual, training materials and internal or external subject-matter experts)?
- Do tasks specify tools, inventory items or other materials required to perform the task?
- Do tasks specify those responsible for performing the tasks (and the minimum training requirements for this role),

those responsible for editing the task, as well as any other personnel involved in the task?
- Are there built-in triggers between each possible condition reported from the condition monitoring tasks (inspections, oil analysis, etc.) with specific follow-up tasks to reconcile or monitor the concern?
- Does it have route generation and documentation features to modify, assign, review, etc., the structure of routes?
- Are there reporting options for weekly or monthly overviews and management requirements?
- Does it feature task documentation and routing mobility?
- Is there a metrics dashboard with customization options?
- Are there compliance tracking options?
- Does it have data import and export options?
- Are terminology definitions provided?
- Is there organized training on how to align functionality across departments?

Managing your lubrication task documentation is not always easy, but neither is dealing with an undocumented or poorly managed lubrication program. If your plant has just been getting by for some time without any control of how tasks are performed or documented, consider the opportunities available when upgrading your lubrication program. Coupling these improvements with other lubrication excellence initiatives is a great way to modernize and gain huge returns on your investment.

While many challenges will emerge during this process, such as changing the culture, purchasing and installing machine modification hardware, and obtaining comprehensive lubrication training, with the right action plan, these hurdles can be overcome in a short period of time. The new business as usual will then become business with the right lubrication practices. ***ML***

About the Author

Bennett Fitch is the director of product development and Lubrication Program Development (LPD) services for Noria Corporation. He is a mechanical engineer who holds a Machine Lubricant Analyst (MLA) Level III certification and a Machine Lubrication Technician (MLT) Level II certification through the International Council for Machinery Lubrication (ICML). Contact Bennett at bfitch@noria.com to learn how Noria can help you properly document the tasks for your lubrication program.

Why New Oil **Should Be Filtered**

> Until you demand that your lubricants arrive in a clean, cool and dry state, **it is unlikely to happen."**

How uncomfortable is it for your organization when off-specification product moves through your quality-assurance process and reaches your customers? I've heard of a few instances when this resulted in the termination of employees, management and even contracts. The issue here is that customers paid for a product they were unable to use. Does this sound familiar?

Likewise, when you purchase new lubricating oils, you are paying for a product that you cannot or should not put to immediate use. What mystifies me is why so many people hold their lubricant suppliers to a different standard than they themselves are being held to as a vendor. Was there something wrong with the money you paid? If not, why should there be anything wrong with the product you purchased?

Demand Cleanliness

There are numerous reasons why new lubricants are dirty or off-specification. Contaminated drums or containers, cross-contamination of bulk loads and container mislabeling are just a few. Humans are imperfect and make mistakes. Some suppliers are working diligently to improve their internal processes and minimize these issues.

Unfortunately, it is not enough, and to put it bluntly, that is your fault. Lubricant suppliers will respond to market demand. If you demand cleaner lubricants, they will provide them. Initially, the price will be higher, but as improved cleanliness becomes the norm, the price will stabilize.

It is up to you to perform a cost-benefit analysis and determine if the extra price per lubricant unit would be cheaper than the cost of filtration equipment, testing, man-hours expended to clean the oil or the cost of downtime and reduced reliability. I would venture to guess that in nearly every case it is worth the extra expense. The first step in this process is to demand cleanliness.

FINAL →	*/20/17	*/19/16	*/18/15	*/17/14	*/16/13	*/15/12	*/14/11
INITIAL ↓							
*/26/23	X 5	X 7	X 9	X>10	X>10	X>10	X>10
*/24/21	X 3	X 4	X 6	X 7	X 9	X>10	X>10
*/22/19	X 1.6	X 2	X 3	X 4	X 5	X 7	X 8
*/20/17	--	X1.3	X 1.6	X 2	X 3	X 4	X 5
*/19/16	--	--	X 1.3	X 1.6	X 2	X 3	X 4

Potential life extension of hydraulic systems when lubricant cleanliness is increased.

How Lubricants Become Contaminated

In every manufacturing process, a certain amount of debris is produced. Much of this debris is small enough to become airborne and find its way into both the machinery and the product, whether that is cement, food, metal drums or other products. Typically, the more inherently dirty the process, the laxer the cleanliness controls.

Crude oil extracted from the ground is filthy with particulate and other contaminants. As it progresses through the refining process, it becomes a "cleaner" fluid. Obviously, some filtration occurs as part of the refining process, but the question becomes how much and to what degree.

Even if the refinery was able to achieve and maintain a zero particulate ingression condition, the base oils are then loaded into railcars, tanker trucks or tanks aboard sea-going vessels, which is when things begin to go sideways. What methods are used at this time to guard against particulate contamination? Keep in mind that we have not even begun to discuss water contamination or the cross-contamination of lubricants.

When the base oils are received at the blending plant, what cleanliness controls are in place? What is the strategy for breathers on the bulk oil storage tanks? Don't overlook additive cleanliness, as it doesn't do any good to maintain clean base oils and then contaminate them with dirty additives.

Let's assume your base oils are stored in a tank at the blending plant with questionable ingression methods, and the additives are also of questionable cleanliness. Now they are mixed together in a blending vessel. How are these lubricants mixed? In small batches, this could involve something as simple as a paddle in a handheld electric drill. Was the container flushed with clean base oil? What about the mixer? Was it exposed to the environment? Is the blending vessel left open and exposed while mixing occurs?

For larger blends, how are they kept clean? Again, is there an acceptable particulate ingression strategy? Are the mixers flushed with a clean base oil? Are the vessels kept sealed to limit ingression? Some plants employ a "sparging" type of process to mix lubricants. What is the cleanliness of the air in use? Is dry instrument air utilized? What is the plant air like at your facility?

Once the lubricant is blended, is it filtered when it is put in its final packaging? What are the ingression prevention methods on the railcar, truck or tanks for the finished lubricant? For packaged lubricants, what is the cleanliness of the container? Drum manufacturing consists of grinding and welding, which not only creates metal particles but almost guarantees that particles will get into the drum or grease keg. For this reason, many companies request drums with liners.

What about plastic containers? What strategies are in place to ensure these containers are clean? Experts agree that you should filter the lubricant at every step in the process, from refining to final packaging. How can you ensure this occurs? You have little, if any, control over what happens to the lubricants before you receive them.

Hopefully, I've painted a picture of what can go wrong. I'm not implying that this is happening or that it will occur, but how can you be sure? Until you demand that your lubricants arrive in a clean, cool and dry state, it is unlikely to happen. Why would refineries and additive companies bother to keep the lubricant components clean? Just like every other industry, there is pressure to keep costs down. Why should blending plants be concerned with filtering the oil, especially if you aren't demanding it?

63%

of lubrication professionals do not filter lubricants before placing them into storage, according to a recent survey at MachineryLubrication.com

These results are from a study conducted a few years ago. Unfortunately, lubricant cleanliness has not progressed much across the board. Some companies are doing better, but there is still a long way to go.

The Benefits of Cleaner Lubricants

I can almost guarantee that the oils you receive at your plant are several cleanliness codes dirtier than what you should be putting into your machines. Cleaning your lubricants as little as one cleanliness code can provide a 35 percent increase in equipment life. How much is a 35 percent life extension worth to you and your organization? Have you lost customers due to missed deliveries? Of those, how many were the direct result of a reliability- or downtime-related issue?

Some suppliers are working to provide cleaner lubricants. Those who are have said they are doing so in response to customers demanding it. Several customers have even written their cleanliness requirements into their service agreement, which is a great idea.

Filter Before Use

I have yet to see a lubricant container from any supplier that states, "Filter before use." You are responsible for this task, with all its associated costs. I am encouraged that several of the plants I've visited are filtering their oils prior to use. Unfortunately, most of these facilities are filtering for a random amount of time.

For example, you might hear, "We hook up a cart and filter each drum for an hour before it goes into our tanks." How do you know an hour is long enough or perhaps too long? For the purposes of this article, filtering for "too long" will cost more in energy consumption and the time the technician spends babysitting the filter cart. You are unlikely to damage the oils by filtering them too long, but other activities could offer much more value. What concerns me most is when oils aren't filtered long enough, and dirty oil is put into the equipment. Without some type of particle counting, you can only guess as to how long your oils should be filtered.

Sadly, for every plant that is filtering its oils prior to use, there are untold numbers that are not. The value of this simple improvement in your lubrication program cannot be overstated. The chart on page 33 shows the potential life extension of hydraulic systems when lubricant cleanliness is increased.

With few exceptions, oils should not be put into service without filtration. The length of time oil should be filtered will vary considerably based on the lubricant's initial cleanliness level, the filter's beta ratio and the gallon-per-minute rating of the pump on the filtration unit.

Other Considerations

All of what has been described previously is related to just one aspect of the lubricant's condition – its cleanliness. However, the moisture content, the possibility of lubricant cross-contamination, mislabled lubricants and off-specification lubricants must be considered as well.

How often would you visit a restaurant that continues to mess up your order? How long are you willing to sit in a restaurant and wait for your order? How many times will you accept the answer that it's coming or that it will be right out before you get up and leave, likely never to return? Do you think your customers are any different? How often can you get away with missing delivery dates? How many of those missed

deliveries are due to equipment failure? The majority of those failures could be traced back to equipment wear and particle-induced failure.

Remember, new oil does not mean clean oil. There are countless companies out there, including your competitors. While it may sound implausible, lubricant cleanliness can in some cases be a true competive advantage. ***ML***

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Loren Green is a senior technical consultant with Noria Corporation, focusing on machinery lubrication and maintenance in support of Noria's Lubrication Program Development (LPD). He is a mechanical engineer who holds a Machine Lubrication Technician (MLT) Level II certification and a Machine Lubricant Analyst (MLA) Level III certification through the International Council for Machinery Lubrication (ICML). Contact Loren at lgreen@noria.com to learn how Noria can help you develop a program to filter new oil at your plant.

Mobil™

Cut friction with **RIGHT LUBRICANT**

Mobil Industrial Lubricants are developed by working closely with leading equipment builders. These lubricants are specially formulated to protect the equipment, ensure problem-free operation in extreme temperatures and tough conditions, and to provide longer lubrication intervals.

Be it the simple production of nuts and bolts or a complex metalworking process, friction and heat are synonymous with the operations of any shop floor. While the heavy-duty processes require machines to be both precise and efficient in their working, lubricants play a vital role in cutting the friction and boosting the machine's performance. With companies looking for ways to reduce costs and increase profitability, many players in the metalworking industry are focused on reducing wastage – and downtime – by switching to lubricants with longer shelf life and higher efficiency. Choosing the right lubricant ensures that the machine tools run smoothly with minimum friction, delivering maximum output.

THE FRICTION FACTOR

Friction is the force that opposes the relative motion of two surfaces in contact. Opposing surfaces scrape against each other producing surface wear and tear due to the friction created. Friction can be 'static or break-away', which comes into motion when a machine at restis turned on. Herein, the force applied to turn the shaft must first overcome the interactions between the two surfaces. As the shaft begins to rotate, the 'dynamic or kinetic' friction comes into play. As a result of the shaft rotation, lubricant is 'dragged' into the contact zone, which reduces surface-to-surface interactions and thus causes friction forces to drop. With increasing speed, the lubricant film in the contact zone increases and friction drops further. When surfaces are fully separated by the lubricant, friction is reduced to a minimum. If speed continues to increase, friction also increases as the lubricant film grows thin.

Smooth and precise slideway operations require special attention to the friction properties of the lubricant. Loss of frictional control can cause inaccuracies, which in a metal removal process, ultimately results in loss of machine tool productivity. Hence it is important to have the right lubrication solutions that cut friction and protect the machine to enhance efficiency and improve productivity.

STICK-SLIP EFFECT

Slideways, also referred to as linear bearings, operate along similar lubrication principles. The difference is that the two surfaces in contact are now flat and the motion is linear instead of rotational. While a plain bearing is designed to operate under hydrodynamic conditions and theoretically could do so forever, slides have to stop when the end of the way is reached, and start moving again in the opposite direction. Therefore, and because slideways typically operate in a stepwise manner, mixed lubrication plays a more important role. Most significantly, slideways are far more susceptible to a phenomenon known as stick-slip due to the large amount of time that they operate in a mixed-lubrication regime.

Stick-slip is a phenomenon caused by continuous alternating between static and dynamic friction. It can occur when static friction exceeds dynamic friction, and when there is some elasticity in the system. When a driving force is applied, high static friction prevents the slide from moving immediately. Instead, the force is loading the spring, by which the driving force exerted on the slide is gradually increased. When the force of the spring exceeds that of the static friction, the slide starts moving. Due to the change from static to dynamic friction the spring force accelerates the slide, while the spring unloads rapidly. Eventually the spring is completely unloaded and starts opposing the slide movement. The slide slows down, while friction for mixed lubrication grows rapidly, until finally the slide comes to a halt and the cycle starts all over again. This jerky movement is what is often referred to as stick-slip.

This is especially true for slideways, where stick-slip causes jerky movements of the slide and by extension, the attached work piece or tool. Such uncontrolled motion can result in inaccurate machining operations, unacceptable finished part quality and production losses. To facilitate smoother operations, special additives called friction

modifiers can be added to the lubricant to allow for better friction control. Modern slideway lubricants usually contain a synergistic mix of friction-modifying additives that enable accurate and smooth operation over a range of operating conditions.

VERSATILE NEW-AGE LUBRICANTS

Modern machine tools and slideway designs demand more of the applied lubricants. Increasing speeds and loads as well as greater expectations for machine accuracy require highly sophisticated slideway lubricants. In addition, there are an increasing number of friction material pairings, like metal-on-plastic, that have different lubrication needs. The modern slideway lubricants meet these challenges with a carefully balanced combination of base oils and additives to achieve low static friction for easy start-up, continuous transition from rest to movement and smooth movement even under heavy loads.

It is critical to choose the right slideway lubricant for machine tools that will help to improve the productivity of the equipment, protect the parts as well as prevent friction stick-slip. There are several recognized friction tests to demonstrate frictional properties of slideway lubricants such as Cincinnati Lamb Friction Test, SKC Tribometer and Darmstadt Rig Test, which enable evaluation of static and dynamic friction characteristics of a lubricant and the effect of various slideway materials.

The Mobil advantage

Mobil Industrial Lubricants are developed by working closely with leading equipment builders. Mobil engineers gain deep insights into equipment trends and lubrication requirements to guide lubricant researchers and formulators in designing highly effective lubricants. These lubricants are specially formulated toprotect the equipment; ensure problem-free operation in extreme temperatures and tough conditions, and to provide longer lubrication intervals. Available in a range of viscosity, to offer customers the right choice for their applications, Mobil industrial lubricants help cut friction, enhance performance, reduce waste and improve productivity.

Matthew Adams | Noria Corporation

Developing and Sustaining a **Reliability Culture for Lubrication**

"The development of your reliability-centered lubrication program should be continually advancing and ever-evolving."

Whether your site has an established, well-functioning lubrication program that has been in place for several years or you have just begun the journey of building your program, if long-term, recurrent success is the end goal, the challenge of developing and sustaining a reliability culture will need to be addressed. Through the years, general guidelines have emerged for this often-overlooked portion of lubrication program development. The process will involve identifying an organizational stakeholder along with a lubrication champion and a cross-departmental team, evaluating the current state of the program, constructing short-term and long-term goals, establishing a path forward with proper documentation and processes, creating awareness across the site, rewarding individuals and groups for successes, and assessing and revising the program.

Identifying the Team

The first step in developing and sustaining a sound reliability culture is to identify who should be part of the team and what their roles and responsibilities will be. These team members will be the driving force in initiating the culture change, so they should be role models who have a positive attitude and are highly engaged. It is also imperative to obtain buy-in from these individuals. Any large-scale project in the development of the program should include feedback from all team members.

This team should consist of an organizational stakeholder, a lubrication champion and a cross-departmental team. The organizational stakeholder

position should be held by someone from the site's upper management. This individual does not need to be directly involved with maintenance but must ensure that the program and the proposed changes have the support of management. If management does not show an interest in this process change, you will be set up for failure before you even get the plan off the ground.

This position is also critical from a communication standpoint, as it helps to make management aware of what is going on and how they might help address major roadblocks. Although the organizational stakeholder is not involved with the program on a day-to-day basis, he or she should regularly attend lubrication-related meetings that affect the program's development.

In addition, this individual should function as the lubrication champion's right hand to form a direct chain from the lubrication team to upper management, as well as identify issues and opportunities to all levels of plant personnel.

The lubrication champion is probably the single most important member of the team. This individual is the owner of the lubrication program. He or she should be responsible for making certain there is active participation among team members, documentation is recorded, training is being delivered, upper management is kept informed, and the program is moving in the right direction. The lubrication champion should also drive the majority of meetings and be involved with the program on a microscopic level.

The final team members are the cross-departmental lubrication team. These individuals should be the ones who perform the lubrication tasks within each department. They are responsible for completing actions in the field and delivering feedback to the lubrication champion. This team should also be included in the program's developmental side. Because much of the plant sees these individuals carrying out lubrication tasks on a daily basis, they can provide a visual representation of the cultural change in the program.

Status Evaluation

This evaluation should consider where the program has been in the past, what its current status is and what the goals are for the future. Before working toward the goals, review how the plant has been successful in the past and what the shortcomings have been in defining a cultural change in other areas. This helps to identify where additional support is needed and where it will not be necessary to "reinvent the wheel."

Each plant must contend with a varying degree of established or sustained culture. Some start at the ground level with non-interactive departments where there is a "silo" effect in which communication

is extremely lacking. Other sites have a reactive-only mindset, which makes driving a proactive reliability culture a great struggle.

Another issue is coping with the "heroes versus zeros" effect. Over time, plants can become dependent on certain individuals for specific tasks without document-driven results. A hero-type mindset is then created. This mentality is cause for concern, as it not only puts a strain on the company but can also have negative cultural effects within the department.

An often-overlooked element is the cyclical decay of the program over time. This issue can send even the best reliability cultures into decline. A plan must be put in place to ensure the program's continued success, including documented guidelines and processes that are entrenched into the plant's culture. Otherwise, the program will begin to decay over time due to turnover. This deterioration of the program through individuals leaving or taking different positions within the company can occur at any level. Once it has begun, redirecting its course can be difficult.

One final consideration in this stage of development is the benchmarking or assessment of the program against itself as well as other sites. It is critical to know where you started so you can identify and illustrate your progress throughout the journey. As you share best practices, common challenges and paths toward excellence with sister sites, the possibility of creating and sustaining a culture change becomes more optimistic.

Constructing Short-term and Long-term Goals

Like any process, changing the culture requires detailed short-term goals, broad long-term goals and non-negotiable standards (or lines in the sand) to define the scope. As goals are established, be sure they are measurable, realistic, feasibly completed within the specified timeframe and paired with an action.

Short-term goals should be defined with detailed steps on how to execute the plan. These goals should be able to be accomplished in less than a year and show continued success of the lubrication program. They should also be reviewed at every meeting to confirm that the lubrication team is working toward the overall vision.

Long-term goals should be a bit broader and can often be used as a platform from which the small-term goals derive. These long-term goals, which may vary in length from 18 months to three years, should be reviewed at least on a quarterly basis.

By creating standards or non-negotiables for your program, you can establish lines in the sand for possible future concerns. These standards may be identified from several different areas, such as within the company's overall vision or based

76%

of lubrication professionals say their organization has attempted to change its lubrication culture, based on a recent survey at MachineryLubrication.com

on best practices determined through benchmarking at other sites. A few examples of these non-negotiables might include maintaining mutual trust among all levels of personnel or sustaining a culture of continuing education within the team.

Establishing a Path Forward

Once the program's status has been reviewed and goals and standards have been developed, the next step is to establish a path forward. This is where many lubrication teams follow through on an interim basis but struggle to make continuous progress. Poor documentation of the process is often to blame. Addressing this concern will go a long way toward creating and sustaining the culture change.

Documentation can help to ensure all projects, work instructions and general lubrication tasks are performed the same way regardless of the individual, shift or department. It also leaves a footprint on the program for future team members to know where it has been in the past, what obstacles have been overcome and the planned overall direction of the program.

Among the key areas to focus on with program documentation would include identifying a criticality matrix, tying components to maintenance strategies, and enhancing the plant's maintenance planning and scheduling strategy.

A criticality matrix should determine the component's overall value to the site. It should begin as a complete asset list and include factors such as criticality to the process, cost to replace, likelihood of failure, possibility of catastrophic failure and what the associated downtime would be if the asset failed.

After the criticality matrix has been created, it is time to put it to use to decide which maintenance strategies to employ. If a piece of equipment has a low criticality score, costs very little to replace and does not have a significant impact on the plant, it might be a good candidate for reactive or breakdown maintenance in which no work is performed on the equipment until it fails. A large percentage of the plant's equipment likely will fall in the preventive maintenance realm. These pieces of equipment require attention on a set frequency. One overlooked concept behind this strategy is utilizing historical data to drive the frequencies at which the tasks are performed. Adjusting these timeframes can eliminate wasted downtime and labor as well as allow better use of the associated maintenance time.

Predictive maintenance strategies should be employed on more critical equipment where it is imperative to address failure as soon as it happens, while proactive maintenance strategies should be utilized across all areas of the plant to resolve problems and minimize the number of issues that occur. Keep in mind that an asset may have more than one maintenance strategy associated with it, and each strategy should be documented in the computerized maintenance management system (CMMS).

Planning and scheduling can also play a major role in the continued success of your lubrication program. The procurement standardization of assets and hardware, evaluation of minimum and maximum spare parts based on need and lead time, advanced dynamic scheduling of incipient asset repair, and detailed instructions for each lubrication task or work order can yield immediate results for cultural enhancement at the plant for years to come.

Creating Awareness

Creating awareness is an important aspect of any process and is especially critical when changing the lubrication culture. Having your team report new program initiatives, successes and recurring concerns will help to raise awareness. This action should be led by the entire lubrication team and vocalized at every level, from upper management to the employees on the plant floor. This is often demonstrated during town-hall meetings where a large portion of the plant is present. While this strategy for improving employee awareness is still useful today, there are other methods that can reach individuals more effectively and on a more personal level. For example, sending quarterly emails from the lubrication team is another great way to reach employees. Other options include plant-wide newsletters, bulletin-board postings in high-traffic areas throughout the plant and five-minute pre-shift discussions on lubrication development. By connecting with multiple shifts, departments and organizational levels, you will increase your chances of producing a living, breathing cultural transformation over time.

Rewarding Successes

Rewarding individuals and groups for program successes is a form of incentivizing that not only can highlight members from within the lubrication team but also those outside the established team who played a role in improving lubrication. These actions might be as small as an operator reporting known oil leaks on equipment to as large as team members installing lubricant storage and handling units. When implementing a rewards program, base gifts on statistics and not on a manager's or team's fondness for an individual or group.

Assess and Revise

The final phase in developing and sustaining an improved reliability culture for lubrication involves assessing, revising and documenting the results. This is addressed by ensuring all implemented cultural transformation steps can be tracked and enhanced as your team continues its progression. Key performance indicators (KPIs), statistical process control (SPC) charts and lubrication-related area audits are all great tools to help your program

function with a positive culture from year to year. KPI options might include measuring the compliance percentage of lubrication-based preventive maintenance tasks, the compliance percentage of contamination control hardware installation or the compliance percentage of the training initiatives. SPC charts should be utilized, documented and reported for oil targets such as cleanliness, moisture content and additive levels. Area audits can be as simple as 5-S reviews of the plant's lubrication-related areas, such as the lube room or satellite cabinets. These methods should all be focused on achieving the current and future goals that were set in place when the program was developed.

Continually Advance and Evolve

If recurring success is the end goal for your lubrication program, you must develop and sustain a flourishing reliability culture. The steps mentioned previously provide a sequential progression for program success. Remember, this is a process and not a project. Your program should be continually advancing and ever-evolving. Putting this course of action in place not only will help ensure a strong program in the near future but enable long-term achievements as well. ***ML***

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Every Drop of Oil Counts

Up to 5 gallons of oil could remain in a drum of oil that is sitting on its side while being drained through a bung. Consider tipping the drum to get the remaining oil out. If you figure that the oil costs $4 a gallon, a waste of 5 gallons per drum on one drum each month will end up costing you $240 a year. The savings can really add up if your company uses multiple drums each month.

Sources of Copper in Oil

Typical sources of copper within an engine include wrist pin bushings, thrust washers, oil pumps, governors, valve train bushings, cam bushings, oil coolers and bearings. Copper can also be an anti-wear additive in some oils. Additionally, high copper readings may occur during the run-in of a new engine (say, after 500 to 1,000 hours of service) and when changing from one brand of an oil to another.

Getting a Handle on Oil Drums

Proper handling of oil drums is important. Drums aren't designed to be bounced or dropped. Full drums weigh approximately 450 pounds, while empty drums weigh around 36 to 38 pounds. A pail of oil weighs about 40 pounds.

Gearbox Magnets Can Be Helpful

In enclosed gear drives with either splash or circulation systems, a magnetic plug or magnetic filter will help collect harmful wear debris. For splash systems, use a magnetic plug or a magnet in the bottom of the case. For circulation systems, a magnetic filter can be used. Removing wear debris can help extend oil and machine life. Wear debris can also be examined upon removal for troubleshooting purposes.

Did You Know?

Additional tips can be found in our Lube-Tips email newsletter. To receive the Lube-Tips newsletter, subscribe now at machinerylubricationindia.com

Have Some Tips?

If you have a tip to share, email it to admin@machinerylubricationindia.com

TEST YOUR KNOWLEDGE

This month, *Machinery Lubrication* 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. The deformation of a rolling element to carry a load is known as what?

A) Boundary lubrication
B) Hydrodynamic lubrication
C) Elastohydrodynamic lubrication
D) Deformative film lubrication
E) Mixed film lubrication

2. Which additive is responsible for giving a multigrade lubricant suitable viscosity over wide-ranging temperature?

A) Viscosity index improver
B) Over-base detergent
C) ZDDP
D) Dispersant
E) Antioxidant

3. A common sampling frequency for an industrial oil would be:

A) Every two weeks
B) Monthly (500 to 1,000 hours)
C) Quarterly
D) Six months
E) Yearly

ANSWERS

1. C

It is known as elastohydrodynamic lubrication, which is a form of hydrodynamic lubrication (full-film separation). However, it is called elastohydrodynamic because the mating surfaces deform elastically (slightly) to enlarge the contact area in order to carry the load.

2. A

The viscosity index (VI) of oils represents how the viscosity changes with respect to temperature. VI improvers, which are made from long-chain polymers, are added to the base oil at concentrations as high as 10 percent for better viscosity/temperature performance.

3. B

A common sampling frequency for industrial oil would be monthly. Two weeks is not considered cost-effective, while a sampling frequency of three, six or 12 months would not be practical, since detecting problems and rectifying them early are essential to avoid major repairs and in some cases production loss.

Training on Essentials of Machinery Lubrication in Chennai

Three days training program on Oil Analysis Fundamentals and Essentials of Machinery Lubrication conducted in Mumbai and Chennai recently. The training was a great success as the participants enhanced their knowledge on various topics like Oil sampling, Lubricant health monitoring, Contamination measurement & control, lubricant selection, troubleshooting, predictive maintenance and more. Case studies were also discussed. Essentials of Machinery Lubrication course provide the foundational skill sets for applying best lubrication practices and product knowledge. Companies like Vestas Winds, Wimpey Laboratories, Intertek, NTPC, Ultra Lubes, Kuwait Oil, Essar, Atlas Lab, Apar Lubricants, Raj Petro, MOPAR India, Aramco, Indian Oil Corporation, Fuel Pro, Emirates Steel, Chennai Petroleum Corporation participated. Participants learned proven industry methods for selecting, storing, filtering and testing lubricants to boost reliability and generate lasting results in machine efficiency/maintenance through these trainings. ICML Certification exam was also conducted at the locations, where majority of the participants joined the elite group of certified professionals. For additional details on similar trainings, visit-http://lubrication-institute.com/

Training on Oil Analysis Fundamentals in Mumbai

BASE OIL REPORT

Oil prices edged higher after a steep fall, supported by extended output cuts by OPEC and its allies despite concerns that a slowing global economy could crimp demand. An expected large draw in US crude oil inventories also underpinned sentiment after a bigger-than-expected stocks fall in a private survey.

India's state-run Mangalore Refinery and Petrochemicals Ltd (MRPL) has made its first purchase of U.S.-produced Thunder Horse crude oil via a tender for mid-October delivery, an industry source said. The state-run refiner placed an order to buy 1 million barrels of the oil with BP recently, the source said. The deal comes as Indian refiner's ramp up purchases of U.S. oil to compensate for the loss of Iranian oil supplies.

India imported 229572 MT of Base Oil in May 2019. Base Oil import of India has gone down by 22% in May 2019, as compared to last month i.e. April 2019. Base Oil import of India has gone down by 1% in May 2019, as compared to same period last year i.e. May 2018.

The Indian base oil market remains steady with inventories at optimum levels with surplus of imported grades. During the month of May 2019, approximately 229572 MT have been procured at Indian Ports of all the grades. Compared to last month i.e. April 2019, import of the country has decreased by 22% in the month of May 2019.

The Indian domestic market Korean origin Group II plus N-60–70/150/500 price at the current level is marginally down for lighter grades and heavier grades. As per conversation with domestic importers and traders prices for N – 70/ N- 150/ N - 500 grades and at the current level are quoted in the range of Rupees 45.15 – 45.30/46.00 – 46.15/51.90 – 52.10 per litre in bulk plus 18% GST as applicable. Discounts being offered for sizeable quantity.

While in the month of May 2019, India imported 229572 MT of Base Oil, India imported the huge quantum in small shipments on different ports like 148754 MT (65%) into Mumbai, 18340 MT (8%) into Hazira, 15572 MT (7%) into JNPT, 15054 MT (7%) into Mundra, 13326 MT (6%) into Chennai, 9462 MT (4%) into Pipavav, 6927 MT (3%) into Kolkata and 2137 MT (1%) into Other Ports.

Dhiren Shah
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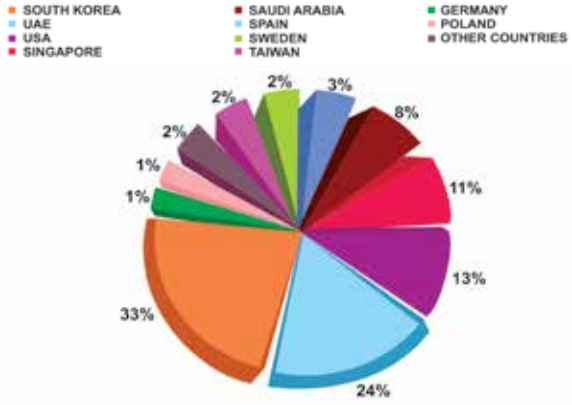
Month wise input of Base Oil in India

Origin wise Base Oil input to India, Country and %- May 2019



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

Month	Group I - SN 500 Iran Origin Base Oil CFR India Prices	Group II - N-500 Singapore Origin Base Oil CFR India Prices	N- 70 South Korea Origin Base Oil CFR India Prices	Bright Stock 150 Base Oil CFR India Prices
May 2019	USD 660 – 670 PMT	USD 710 – 720 PMT	USD 665 - 675 PMT	USD 940 – 950 PMT
June 2019	USD 645 – 655 PMT	USD 695 – 705 PMT	USD 650 - 660 PMT	USD 925 - 935 PMT
July 2019	USD 630 – 640 PMT	USD 680 - 690 PMT	USD 635 - 645 PMT	USD 910 - 920 PMT
	Since May 2019, prices have decrease by USD 30 PMT (5%) in July 2019.	Since May 2019, prices have fall down by USD 30 PMT (4%) in July 2019.	Since May 2019, prices have decrease by USD 30 PMT (4%) in July 2019.	Since May 2019, prices have dipped down by USD 40 PMT (4%) in July 2019.

PILOT (Practical Industrial Lubrication Orientation Training)

An accessory and activity based onsite practical lubrication training

PILOT is a skill based lubrication training program specifically designed for lube technicians, operators and shop floor associates. The objective of this training program is to upgrade the skill of technicians who actually perform the lubrication and inspection tasks. This training program is a combination of classroom as well as onsite practical training (activity and accessory based). The main focus of the training program is to illustrate how to perform various lubrication related tasks effectively, effciently and safely.

Main contents of the course include:

- Basics of lubrication
- Contamination control
- Hands on training for handling lubricants
- Sampling
- Field inspection of lubricants

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