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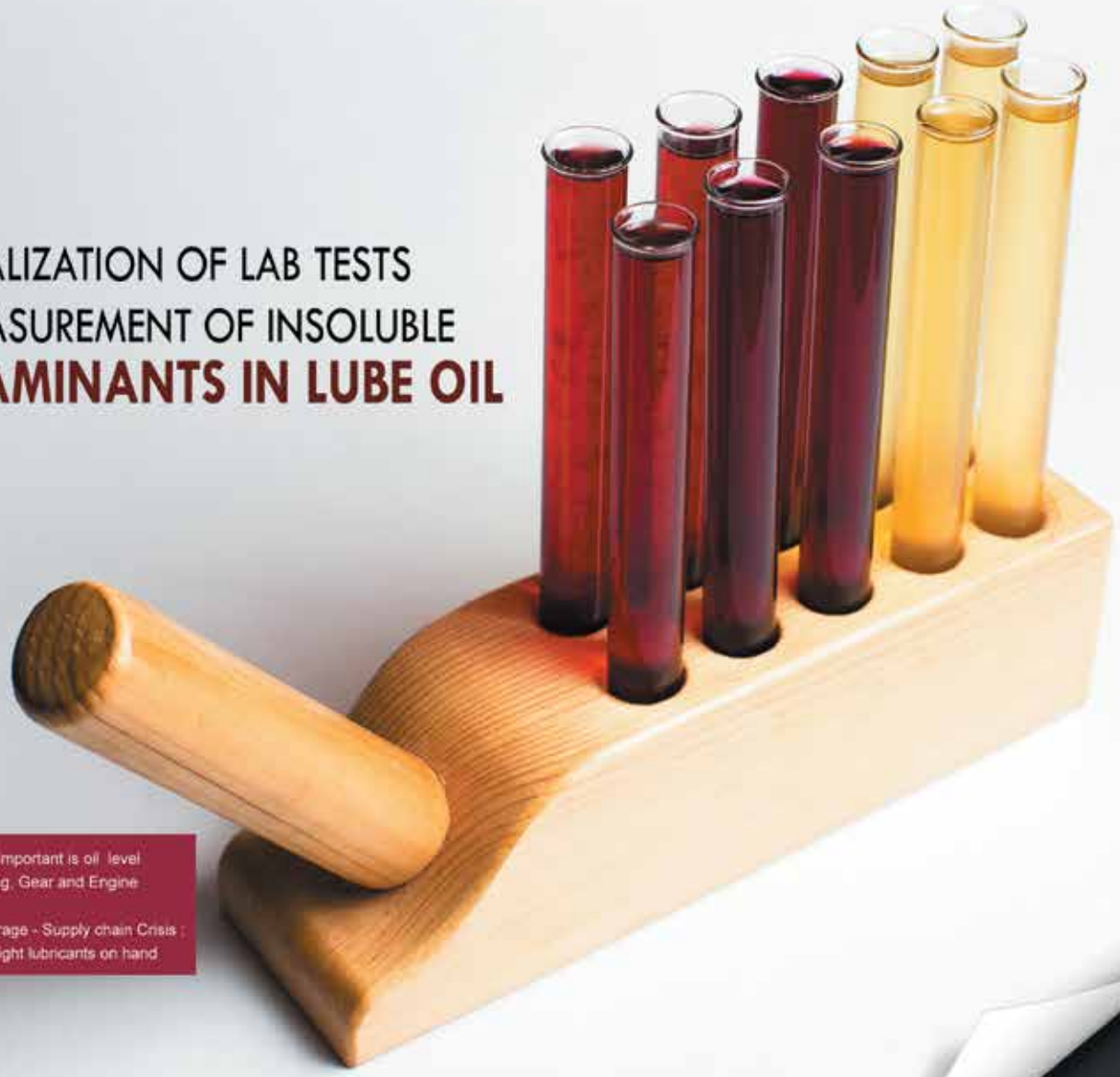

RATIONALIZATION OF LAB TESTS FOR MEASUREMENT OF INSOLUBLE CONTAMINANTS IN LUBE OIL

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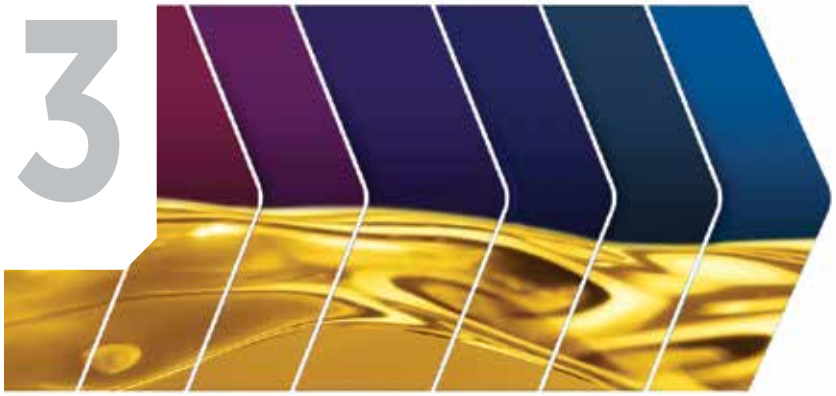
AS I SEE IT

The Seven Levels to Lubrication Excellence

3



COVER STORY

Rationalization of Lab Tests for Measurement of Insoluble Contaminants in Lube Oil

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EDITORIAL FEATURES

Publisher's Note

While the term Circular Economy is recent, the concept itself is not new, with earlier concepts like the cyclical system of production, performance economy in 1976, and concepts like industrial ecology and industrial symbiosis in circulation. The primary goal of the Circular economy is to recycle material flow and balance economic growth and development with environmental and resource use. The Ellen MacArthur Foundation outlines that a Circular Economy (CE) paves the way for economic growth aligning sustainable social, environmental, and economic development.

The UN Climate Change Conference of the Parties (COP) COP 27 asserted the importance of a transition to a circular economy through the elimination of waste and pollution, reduction and avoidance of emissions across the value chain, product and material circulation enabling retention of embodied emissions, and regeneration of nature.

The 5 R's of CE are: rethink, redesign, reduce, reuse and recycle.

PM Modi announced India's aim to achieve net zero emissions by 2070. The Government of India released the CE Report in August 2021 and the CE Action Agenda in 2022. Oil and lubricant reuse and recycling are one of the 11 key areas, to transition from a linear to CE and lubricant manufacturers.

While many believed that lubricants manufactured from RRBOs were inferior compared to those made from virgin base oil, there has been a shift in awareness, advancements in technologies used for oil re-refining, and the environmental and economic sustainability benefits of RRBO-based lubricants in the last decade have brought about an increase in their acceptance and adoption.

Global giants like Shell and Castrol are already working on internal targets of RRBOs constituting at least 10-25% of reused oil.

Like many nations in the world, The Government of India has been pushing to revolutionize material flow in manufacturing processes and move to a CE through new regulations that encourage reusing and recycling oils. With the growing acceptance of and a steady demand for recycled oil, there is no longer a real difference between virgin oil and reused oil. Though implementation has been challenging, the Government of India is incentivizing oil industries that are reusing at least 25% of the recycled oil. According to Technavio, the Indian lubricant market is expected to grow by 809.93 thousand tons from 2021 to 2026.

Mr. Sahil Bhargava, Head of Strategy, IFP Petro Products Pvt. Ltd., India, shared that they provide RRBOs to large organisations like IOC, HPCL, Bharat Petroleum, and many others. He shared that while the CE is in a nascent stage in India, the future needs technological upgradation. He added that the Ministry of Petroleum and the Ministry of Environment are cognizant of this and working towards encouraging EPR (Extended Producers' Responsibility) among oil and lubricant manufacturers in the country.

Shell's launch of a used oil management service initiative to increase re-refining rates and to reduce emissions related to end-of-life of lubricants, helping India meet carbon neutral targets and the goal of a CE. Hindustan Petroleum Corporation Limited's launch of ENKLO 68 Green, with 30% RRBO content on the barrel defines a new era of Green lubricants in the country.

The only challenge that remains is the raw material availability of used oil for diversion for recycling and procurement at a reasonable rate for industries. While used oil recycling is a challenge, the impetus, encouragement, and incentivization from the government are hugely motivating for the industries.

India remains at the lower ranks of recycling oils compared to countries like Italy that recycle up to 98%. While there is a long way to go, industries and the government are working towards making the planet greener and more sustainable.

Let's work towards sustainability, reduce carbon footprints, do our bit towards the environment, and rethink growth for long term well-being.

We thank the readers for their communication & look forward to your input and insights on our magazine.

Stay safe & healthy,

Warm regards,

Udey Dhir

The Seven Levels to Lubrication Excellence

> Once begun, you're halfway done."

Rome was not built in a day. Transformational change takes time. You've heard the expression, "once begun, you're halfway done."

But what are the milestones along the way? In other words, what are the stages or levels of transformation on the pathway to excellence? How can they be described in the most basic terms? That's the subject of my column today.

The seven levels are in sequential order. Some organizations may elect to skip or leapfrog over two or more levels. Others may realize the virtue of getting a few small wins first before moving on to higher levels. There could be danger or pitfalls in moving too fast.

Slow and steady wins the race. Moving rapidly through the levels may be more achievable if you are counseled by an experienced person or team who has step-staged through these levels before.

Defining Seven Levels of Excellence

The one-word descriptive titles of each level are listed to the right. The chart that follows provides a more detailed explanation of the meaning of these words. You can read through these descriptions to approximate the level your plant and team are at today. Better yet, have an independent auditor give you an unbiased assessment.

1. Survival
2. Awareness
3. Crawling
4. Walking

5. Running
6. Optimizing
7. Sustaining

In order to move organizationally through the levels, there is a need to focus the transformation efforts more tactically. This is the trenchwork that solidifies the state of activity or performance at each level.

I've grouped this trenchwork into the following four tactical activities:

- People and Culture
- Lubricants and Lubrication
- Machine Readiness
- Metrics and Condition Monitoring

These tactical activities can be described in progression across each of the seven levels too. For any given plant, the movement of the tactical activities don't usually stay in lockstep with each other. One tactical activity might be more advanced than the other three. Likewise, tactical change can be stretched across more than one level at any point in time.

Bird's Eye View

An overview of how this might look is graphically illustrated above. As shown, People and Culture are at various substages between Level 1 and 3. In contrast, the tactical activities of Metrics and Condition Monitoring are well into the "Optimizing" stage of level 6 and nearly at level 7. The tactical progress of Lubricants and Lubrication is stretched between Levels 2 and 4 while Machine Readiness is lagging at the Crawl stage of Level 3. Programmatically, progress can be represented visually as the weighted average of the four tactical activities.

ICML 55.1 Alignment

There are 12 primary subjects within the standard ICML 55.1 (Optimized Lubrication of Mechanical Physical Assets). These 12 subjects are cross-referenced to the four tactical activities. Any organization meeting the requirements detailed in ICML 55.1 should, by default, be at least Level 5 if not higher. Later this year, the companion standard ICML 55.2 will be published providing functional detail on how to achieve compliance with each of the requirements in 55.1. ***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.

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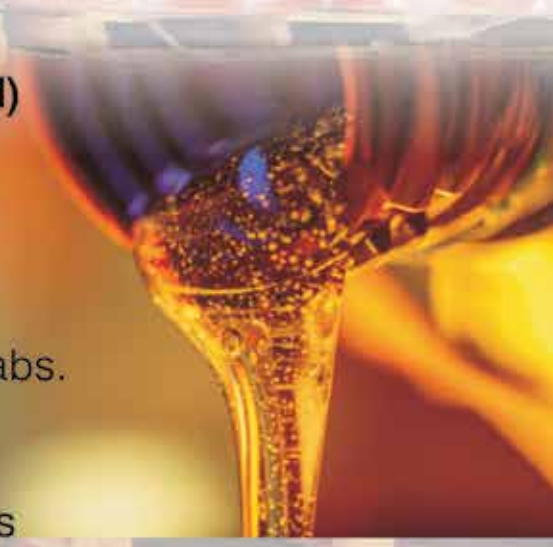

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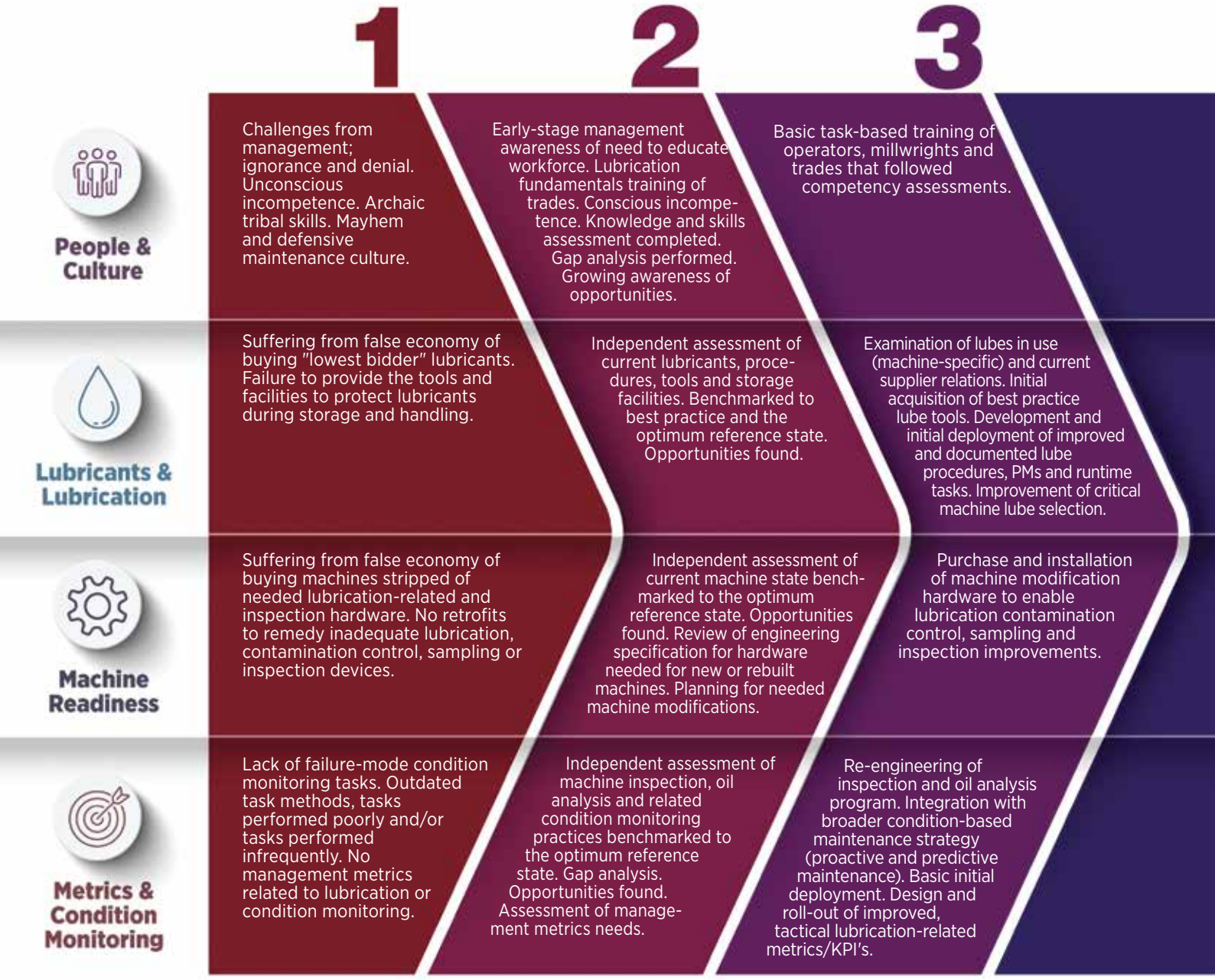
Seven Levels Of Lubrication Excellence



Survival

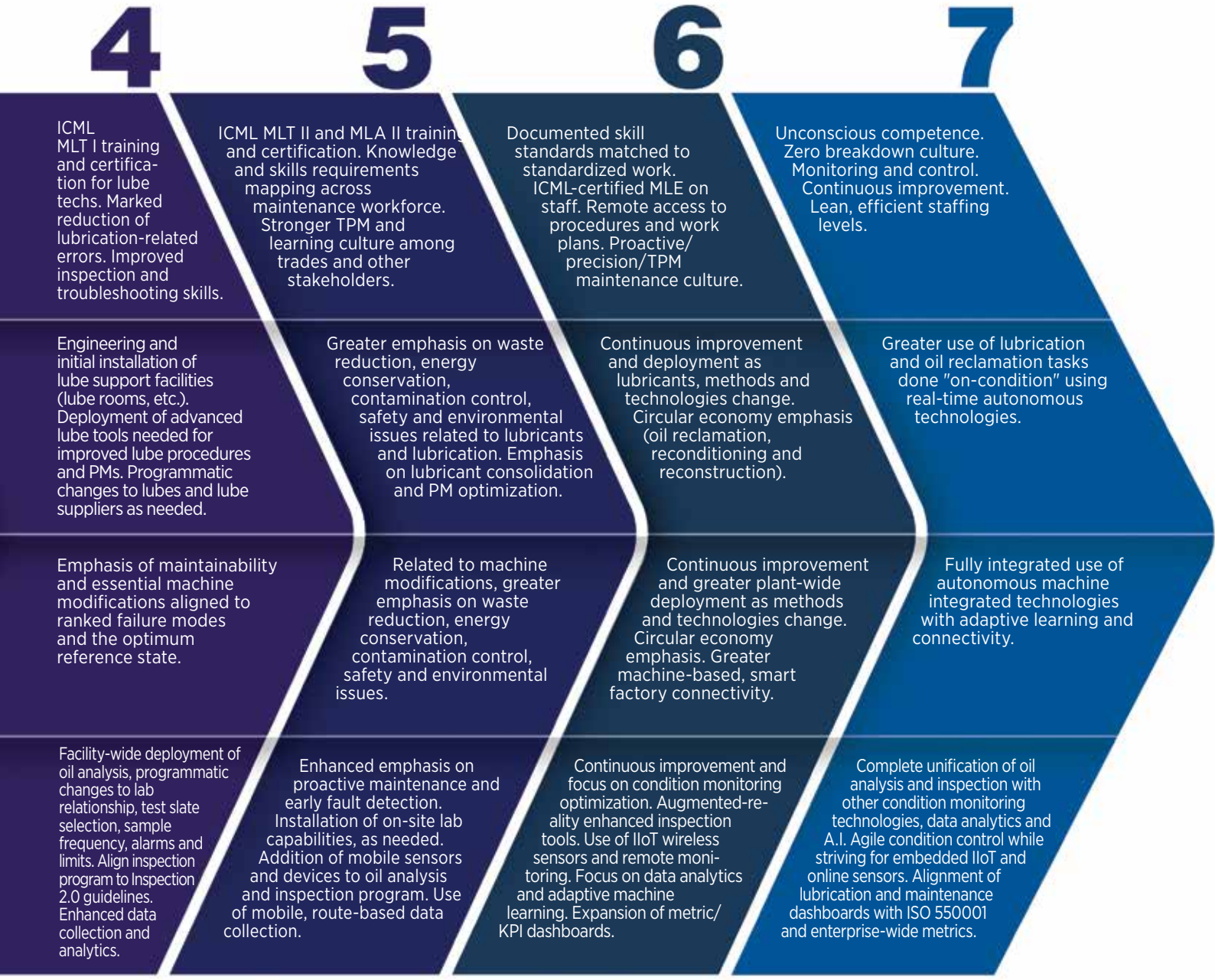
- Crisis and breakdown maintenance.
- High management turnover.
- Pretending to save money by not investing in reliability.
- Entrenched old-school or business-as-usual practices.

Awareness

- Basic management awareness.
- Conscious incompetence.
- Success case study awareness.
- Planning for change.
- Looking for low-hanging fruit.

Crawling

- Low-budget, low-risk changes are implemented.
- Focus on low-hanging fruit.
- Pilot programs.
- Bad actor and mission critical first.



Walking

- Major program expansion initiatives.
- Significant investments in programmatic improvements; training, support facilities, lubricants, tools, machine modification, route-based CMMS, inspection and condition monitoring.

Running

- System-wide deployment of lubrication program transformation plans.
- Stakeholder support to attain lubrication asset management compliance. (ICML 55.1).
- Focus on expanded waste reduction, energy conservation and environmental issues.

Optimizing

- Focus on program optimization initiatives (Optimum Reference State).
- Vision alignment across functional groups, suppliers and customers.
- Greater mission criticality and risk-based initiatives.
- Investments in wireless technologies.

Sustaining

- Sustainability mixed with an aspirational reliability culture.
- Holistic asset management (ISO 55001) integration.
- Corporate, enterprise-wide mandated support and deployment.
- Industry 4.0/5.0 integration.

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THEME

FUELS AND LUBRICANTS AS ENABLERS FOR NET ZERO GOAL

DR. SSV RAMAKUMAR
Chairman, NSC, ISFL 2023

Website: www.ISFL.in
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ISFL 2023 symposium will focus on the needs and solutions for Fuels and Lubricants as enables towards meeting Net Zero goal. Special emphasis will be given to energy efficient lubricants required for meeting emission regulations, energy & fuel efficiency, durability norms and environmental issues. In addition to the above, differentiated fuels and new excitements in additives for fuels and lubricants will also be discussed. Accordingly, technical sessions will be planned on the Oxygenated fuels, Hydrogen fuel, Differentiated fuels, EV fluids, Fuels & lubricants as enables for Net Zero etc. Thus, the following broad areas will be highlighted in this symposium:

- Oxygenated fuels for transportation
- Fuel Quality –Beyond BS VI
- Hydrogen as future fuel
- Differentiated fuels as enablers for Net Zero
- Automotive lubricants for liquid & gaseous and alternative fuels
- Re-defining lube base oil qualit
- New excitements in additives for fuels and lubricants
- Lubricants as enablers for Net Zero
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RATIONALIZATION OF LAB TESTS FOR MEASUREMENT OF INSOLUBLE CONTAMINANTS IN LUBE OIL

"The lube oil degradation can be the result of both physical and chemical actions"

Lubricants are essential and expensive compo-nents of machine systems and need sampling, analysis and monitoring.

Monitoring can be either performance testing or oil condition monitoring. Knowledge of the system's critical failure modes is essential for cost-effective oil and machinery monitoring. The deter-mination of insoluble contaminants in lube oil is one of the parameters usually recommended for evalu-ating the condition of in-service lube oil. The present study provides a comparative evalu-ation of two different tests that measure insoluble contaminants in lube oil. The objective of this study is to compare existing tests and adopt the most effective test to be used for the measurement of insoluble contaminants in lube oil. The first test utilizes the gravimetric method through a filter (filter test) to measure the weight of insoluble contaminants, while the second test utilizes centrifugal forces at high speeds (ultra-centrifuge) for measurement. A total of 305 different lube oil samples were used in this study for both tests, where the results are critically analyzed and compared against each other. In addition, the tests are evaluated in terms of efficiency as well as safety.

Introduction

Lubrication oil is an impor-tant information source for early machine failure detection, just like the role of human blood sample testing in performing disease detection. The condition of lubrication oil and its circulation system reflect the health status of the machinery and its components. Contamination in lube oil is the major cause of rotating equipment failures in industry. The impact of this contamination is exponential on equipment reliability over time. The lube oil degradation can be the result of both physical and chemical actions, internally generated or from extraneous contaminations. It should be remembered that lubri-cants are usually complex blends of chemical additives in a variety of base oils. Since these finished lubricants are often specifically designed for particular applica-tions, exposure of lubricants to conditions and component materials for which they are not intended may accelerate lubricant deterioration and result in equipment damage. Contamination control is the paramount factor needed to ensure equipment reliability and preserve system integ-rity. Therefore, it is critical to identify the presence of contaminants to eliminate potential catastrophic equipment failure by means of implementing timely corrective action.

There are different test methods used in industry to measure contaminants in lube oil. Currently, two test methods are utilized for measuring insoluble contaminants, and these tests are part of the regular test slate for specific types of lube oil testing. The insoluble contaminants in hydraulic, transmission, refrigeration and synthetic turbine oils are measured by the gravimetric method (filter test), whereas the remaining oils are measured through high-speed centrifuge (ultra-centrifuge) analysis. As the objective for both tests is identical, it was decided to evaluate both test methods by correlating their results, with the goal of keeping only one test to measure the insoluble contaminants in lube oil, irrespective of the lube oil type.

The study was conducted for the replacement of filter analysis by ultra-centrifuge (UC) test to determine insoluble contaminants by performing simultaneous analysis, i.e., gravimetric and centrifugal methods on various lube oil samples.

1 Gravimetric Analysis

This test method covers the determination of insoluble contamination in lube oils by gravimetric analysis. The contamination determined includes both particulate and gel-like matter, organic and inorganic,
which is retained on a membrane filter disk.

Insolubles in lube oil are determined by a known volume of the sample filtered through pre-weighed 1.2µ filters, and then the increase in weight is determined after washing and drying the filter. The total contaminant content of the particular sample is determined by the increase in the weight of the filter. This is a manual method, and the technician is exposed to two solvents: kerosene for dissolving oil and petroleum ether to remove oil from

2 Centrifugal Method

A small amount of lube oil sample in a test tube is run for 30 minutes at 17,000 RPM in a refriger-ated ultra-centrifuge. By subjecting the sample

to G-forces, the insoluble contaminants can be extracted with different sizes or densities at controlled temperatures. The density of the agglomerated material at the bottom of the test tube is visually compared to a reference chart. The shapes in the reference chart reading range from 0 (the cleanest) to 8 (the most contaminated). When the UC value exceeds 2, a marginal condition is noted. A UC value exceeding 5 is considered to be a critical result.

In this method, no solvent is used, and sample processing is not required to determine the contamination level.

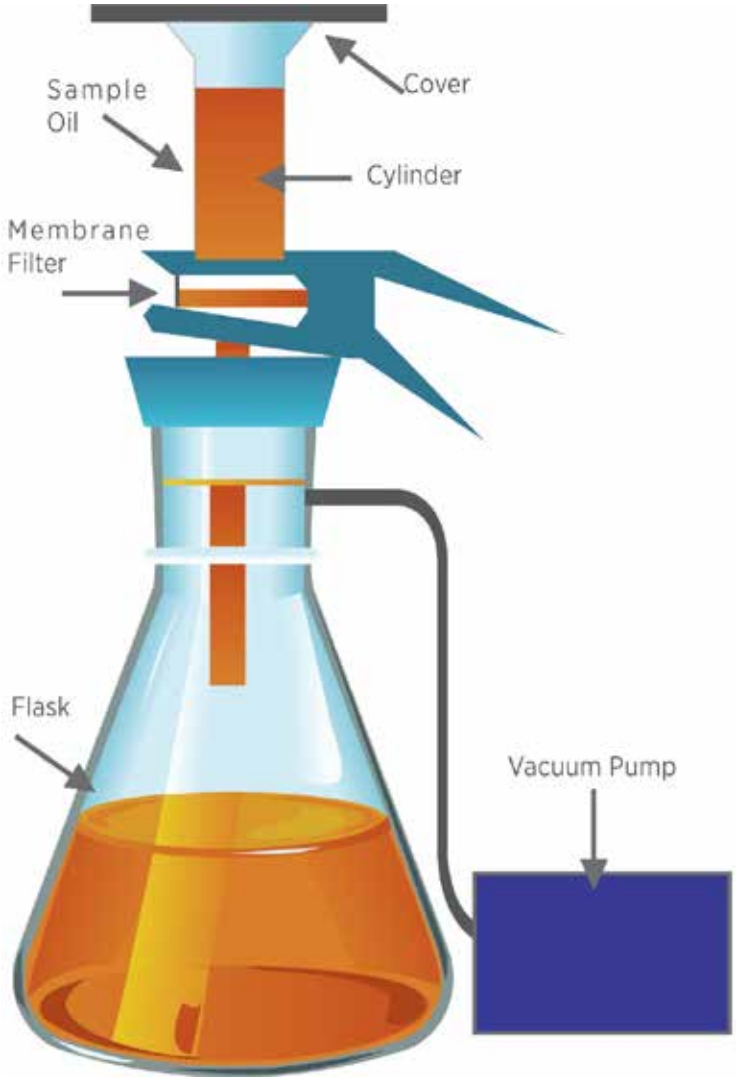

Figure 1: Filtering Test

Figure 2: Ultra-Centrifuge Test

Methodology

The popular test methodologies being followed in the laboratory for measuring insoluble contaminants in lube oils are:

METHODOLOGY	PROS	CONS
Gravimetric Analysis	Relatively cheap tools	Time consuming
	Results are based on weight, hence cannot be misinterpreted	Manually operated procedure
		Exposure to kerosene and petroleum ether
Centrifugal Method	Automated procedure	Expensive equipment
	Minimum manual input required and time-saving	Scale rating is judged visually and is prone to human error
	Can test multiple samples simultaneously	Prone to maintenance issues
	No chemicals needed	

Table 1: Pros and Cons of Filter Test vs. Ultra-Centrifuge Test

Pros & Cons

The pros and cons for both discussed methodologies are listed here:

Results and Discussions:

There were 305 lube oil samples from hydraulic, transmission, refrigeration and synthetic turbine oils, which were analyzed simul-taneously for insoluble contamination by both gravimetric and UC methods. The results are compatible and show linearity by both methods.

The comparison of insoluble contaminants in the analyzed 305 lube oil samples showed that the results by gravimetric method vary from 2 ppm to 414 ppm, whereas UC values lie between 0 and 8. Three samples deviated from linearity, but they were positive in the crackle test and had high water content. The results of these three samples

INSOLUBLE CONTAMINANTS MEASUREMENT	
Gravimetric Method (mg/liter)	Utra-Centrifuge
0 to 50	0
51 to 80	1
81 to 120	2
121 to 150	3
151 to 175	4
175 to 200	5
201 TO 280	6
281 to 360	7
>360	8

Table 2: Comparison of Filter Test vs. Ultra-Centrifuge

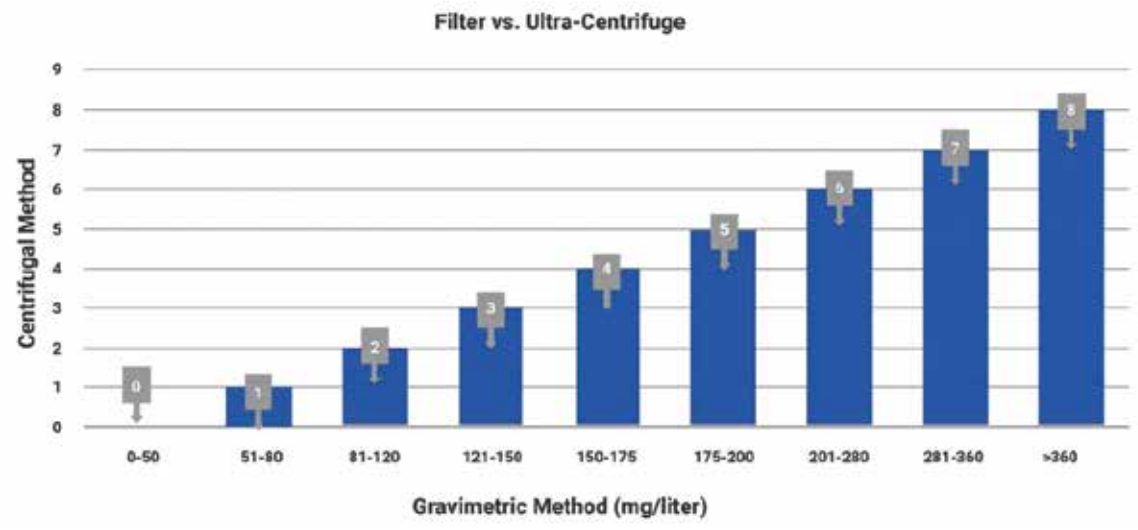

Figure 3: Comparison of Filter Test vs. Ultra-Centrifuge

were not considered in determining the equivalency of values obtained by both methods. The equivalency of contaminants/insoluble determined by both methods was critically analyzed and classified as per the graph in Figure 3 and Table 2 :

Conclusions

Experimental data were critically analyzed, and the results from both methods were compatible and had a linear correlation. The filter test involves the potential of hazardous solvent exposure for the lab techni-cian. It is a time-consuming process, as it needs the preparation of every sample to carry out the test. In contrast, the ultra-centrifuge does not require any hazardous solvent, and multiple samples can be tested at a time.

The hazards associated with handling kerosene and petroleum ether are:

Petroleum ethers are extremely volatile, have very low flash points, and present a significant fire hazard. Exposure to petroleum ether occurs most commonly through inhalation or skin contact.

The inhalation of kerosene fumes might cause dizziness or nausea.

The mentioned solvents used in the filter test are consumable. Therefore, it is recommended to adopt the ultra-centrifuge for measuring insoluble contaminants for all samples, as this method is safer and faster than the filter test. ML

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Often times in machinery lubrication, we preach precision lubrication. What exactly does that mean? Regarding the act of lubricating, it means utilizing meticulous calculations to determine the most accurate lubricant type, volumes and frequencies needed to reach optimal machine performance and machinery life. The goal of any lubrication program across the board is to decrease downtime and machinery failures. Here is where I would like to point out some of the obvious and not-so-obvious key players in precision lubrication, one of which is proper lubricant level (volume).

What is the proper lubricant level, and why is that specific amount the "proper level?" The proper level is simply the level that allows for optimal performance of the component. What is optimal performance? It is the point where your machine will have the maximum extended lubricant life and component life. There are a couple of key variables used to decide the correct amount of oil:

- **Size —** Whether it is a bearing, gearbox, motor, pump or hydraulic system, size plays a key role in deciding how much lubricant a component should receive. Larger bearing sizes in greased applications will obviously take a larger amount of grease; larger reservoirs in oiled applications require larger volumes of oil. This is the no-brainer of lubricant levels.
- **Speed —** Speed affects grease application volumes somewhat differently than oiled applications due to lubricant dispersion needs and required film thickness. For instance, a slow-moving greased bearing will more than likely need to have the grease packed into the bearing at a higher volume during installation because the grease will not be properly dispersed due to the low speed. Slightly less will be required on a higher speed bearing where the grease will be more easily dispersed throughout the bearing a lot quicker. However, the load and the speed will affect the viscosity needed for proper lubrication. As far as oiled applications go, splash lubricated components at higher speeds may require less oil volume in order to reach proper fluid film thickness. A lower speed splash lubricated system may require a higher volume. That is the effect of speed on lubricant levels.

The Importance of Inspections and Leak Detection

Routine machinery inspections

are paramount to a reliable machinery lubrication program. The members of the lubrication team aren't the only ones who need to be performing inspections. Inspections are a responsibility for every person working at the facility: operators, maintenance, lubricators, etc. Nobody knows the plant quite as well as the people working in it every day. Pay attention to the sounds, smells, vibrations and especially machinery lubrication levels and leaks as you're walking the floor. We need to utilize all of our senses to maintain a vigilant watch over our facility's health and condition. A lot like our own body, we need to take care of it with periodic health checks such as fluid pressures and levels, broken or fractured components, and behavioral health. We always train the facilities that we visit to "get to know your plant."

Damages and Hazards Caused by Overfilling

If you have taken any trainings with Noria or have dealt with any of the consultants, you will often hear us say, "clean, cool and dry." These are three of the most important conditions of any lubricant. When it comes to overfilling, you run the risk of increasing friction, which causes heat, which, in turn, cancels out the "cool." When heat is produced, machines start to fail; when the machine starts to fail, it starts to break down and introduces debris and particles into the oil, which cancels out the "clean."

Overfilling is extremely detrimental to any machine, whether over-greasing or overfilling with oil. Let's say you over-filled a gearbox or pump: this will build pressure, which could potentially cause seals to fail. Maybe not an immediate catastrophic seal failure, but a seal failure nonetheless. When that seal fails, it will allow air, particles, water or any other airborne contaminants into your machine. When this chain of events happens, it causes machinery failure and downtime. The reliability team will then be in a reactionary maintenance mode. Proactive maintenance strategies generally start with updating your lubrication program to a progressively more proactive approach. Choose the right lubricant, viscosity, volume and application frequency, and you won't be fighting so many fires throughout the year.

Damages Caused by Underfilling

Underfilling or starvation can cause many of the same issues as overfilling. Too little oil or grease in the component will lead to excess friction; this is where you will run a higher risk of adhesive wear due to the lack of fluid film thickness required to meet boundary film conditions. This will be especially detrimental in machines with hard starts and stops. Besides adhesive wear, inadequate lubrication will cause overheating and can lead to additive depletion and lubricant degradation. When a lubricant exceeds its upper range of temperature tolerances, the viscosity will drop quite dramatically. Viscosity is one of the most important factors to consider when selecting the proper lubricant. So, regardless of whether you choose the right viscosity and additive package for the application, if you aren't filling it to the right volume, it will eventually be degraded and lose its proper lubricating ability.

Running Level and Down Level

Running Level and Down Level particularly pertain to large volume reservoirs with columnar level gauges. Luneta columnar gauges come equipped with a red and green level indicator to mark the oil level, both when the machine is running and not running. Otherwise, we see a lot of columnar level gauges with two lines drawn in sharpie. Although that is doing the best you can with what you have, we often recommend moving to a more tactile approach: a physical marker — maybe zip ties or colored hose clamps; something that isn't going to be removed or wiped off easily. Believe me: your sharpie mark isn't as permanent as you think when you work at a chemical plant.

I wanted to add this bit about columnar level gauges because they are usually installed on highly critical assets. This all comes full circle back to precision lubrication and vigilant inspections. When it's critical to a process that simply can not have an unscheduled shutdown, ensuring you have the correct volume is absolutely paramount. Constant, vigilant inspections of the lubricant levels are a proactive approach to maintaining some of your most critical assets. Early detection of leaks, contaminant ingression, lubricant degradation, wear debris and many other conditions could potentially save the team days, if not weeks, of grueling work to get the asset back up and running.

Stored Machines

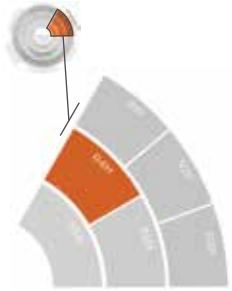
We should also take into account the lubricant levels in stored assets such as gearboxes, bearings, motors and pumps. Although they don't need to be inspected as much as in-service assets, it is still a good idea to ensure that you have the proper lubricant level and you are circulating that lubricant through the asset, generally by rotating the shafts and inspecting for leaks and lubricant level every so often. This will ensure that your backups in storage are ready for service the very instant they need to be. I always suggest viewing it like a sports team: maintain your starters and make sure they are healthy and prepared for the game. However, you can't forget about your bench depth. If one of your starting players goes down with an injury, you're going to need the player from the bench to be ready and willing to take the starter's place seamlessly. ***ML***

About the Author

Paul Farless is an Associate Technical Consultan for Noria Corporation. His duties include collecting data and preparing reports for the engineering team. Prior to joining Noria, Paul worked as an automotive maintenance technician for an auto-repair service company. He also served four years in the U.S. Navy as a gunner's mate third-class petty officer and as a seaman deckhand, where he was responsible for the troubleshooting and maintenance of electromechanical and hydraulic systems. A detail-oriented team player, Paul works well in fast-paced environments and uses his military background to excel and maximize efficiency.

Supply Chain Crisis: Ensure That You Have the Right Lubricants on Hand

More about this **ASCEND™ Factor**



Factor:
R4M— Inventory Management

Level:
Management & Training (M)

Stage:
Lubricant Reception And Storage

About:
Inventory management must define optimal inventory levels, prioritize keeping lubricants in appropriate and clean environments, and optimize inventory investments by adopting a FIFO (First In, First Out) strategy.

Learn More:
noria.com/ascend/

With many disruptions in the supply chain in the recent past, it is becoming commonplace for lubricants to have longer lead times, and in some cases, lubricants may not be available at all. In these times, it becomes increasingly important to optimize the lubricants we are using, our inventory levels and a host of other programmatic issues that lead to the increased usage and depletion of the lubricant. By making a few adjustments to our processes, we can help ensure that we have the appropriate lubricant on hand and plenty of lead time to backfill our supply when needed.

One of the first items that can be tackled is determining if the proper relubrication intervals and volumes are being followed. This tends to be a bigger issue when dealing with greases than with oils. It is common for bearings and other grease-lubricated components to get relubricated every week or two. When you multiply this across a plant

with several hundred to several thousand bearings, it can equate to a large volume of lubricant. If you were to determine proper regreasing frequencies, you might find that the component you are adding grease to every week doesn't actually need to be greased but every couple of months or more. Not only does greasing too frequently result in the overuse of lubricant, but there is a large labor requirement for this as well.

Optimize Volume

As mentioned, frequency is one side of the coin; volume is the other. It is common practice to "grease it until you see it," resulting in the damaging of seals and the overuse of the lubricant. By determining the proper regrease volume, we can help minimize this. Using the right volume of grease not only saves lubricants, but the equipment will operate at a lower temperature, and seals will be maintained in better working order.

The importance of lubricant volume also applies to

oil-lubricated equipment. Many splash lubricated components don't have a reliable method to check the lubricant level when in service, which can result in fluid levels that are too high. Not only does this cause more lubricant to be consumed in the initial fill, but it also makes the equipment run at an elevated temperature. The increase in operating temperature reduces the fluid's life, so more frequent oil changes are necessary. It's important to also consider the increased energy costs required to churn through the added volume.

Compare Factors

Not all lubricants are created equal; some provide additional protection in specific areas, and some perform better in terms of longevity. When selecting lubricants, compare factors such as base oils, additive packages and performance-related tests. Commonly, people refer to tests such as the Rotating Pressure Vessel Oxidation Test (RPVOT) and Turbine Oil Oxidation Stability Test (TOST) to glean insight into how long a lubricant's life might be. While these tests do provide insight into oxidative stability, you must determine the most likely means of lubricant failure for your equipment and then look at the appropriate test results. For instance, if your fluid is more likely to fail due to hydrolysis (water contamination), then select lubricants that perform better in hydrolytic stability tests. Choosing more stable lubricants may cost extra on the front-end, but you will reduce the number of changes and thus the number of gallons needed on-hand overall.

To dial in frequencies, the use of condition-based maintenance techniques tends to be the gold standard. For greasing, tools such as ultrasound and grease analysis are very common. By performing this analysis, we can make sure bearings, gears and other components are getting greased in the appropriate timeframe (analysis also helps determine appropriate volumes). Oil analysis serves a similar purpose to help change fluids only when the need arises. Also, the condition of the oil can be monitored so that action can be taken when contaminant levels rise, which, in turn, extends the life of the oil. In some cases, based upon the condition of the oil, you could avoid a complete changeout and potentially opt for a bleed-and-feed or partial changing of the oil. This can be done to extend the current charge of oil until such time that a full change can be performed. Lubricant analysis is a powerful tool, especially when it comes to helping you identify ways to extend intervals and change lubricants only when prescribed.

Proper Storage

Another place in the program where good lubricants can go bad is storage. Oils that sit in packaged options or bulk tanks can become contaminated, shortening their lifespan. Additives can separate in storage as well. To help minimize either of these from occurring, proper storage activities should be followed. This includes keeping lubricants sealed and in climate-controlled areas as much as possible. For bulk storage tanks, this may also include the use of kidney-loop filters. Periodically circulating the stored oil helps remove any contaminants that ingress, keeps additives in solution, and generally helps maintain the lubricant in a better condition prior to use. Lubricants that are stored outside and allowed to breathe in dirty, wet air often aren't fit for service and need to be disposed of before ever being used.

In the case that inventory levels can't be maintained, plan ahead for any oil changes. Work with your supplier to find an oil or grease that is compatible and whose operating characteristics are as similar as possible. Doing compatibility tests ahead of time allows you to quickly make the transition and lets you know if you need to flush the systems or simply do rolling changeouts. With the way the market exists right now, having a couple of candidate options available can save headaches that may arise later. ***ML***

About the Author

Wes Cash is the Vice President of Services for Noria Corporation. He serves as a senior technical consultant for Lubrication Program Development projects and as a senior instructor for Noria's Oil Analysis I and Machinery Lubrication I and II training courses. He holds a Machinery Lubrication Engineer (MLE) 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 Wes at wcash@noria.com.

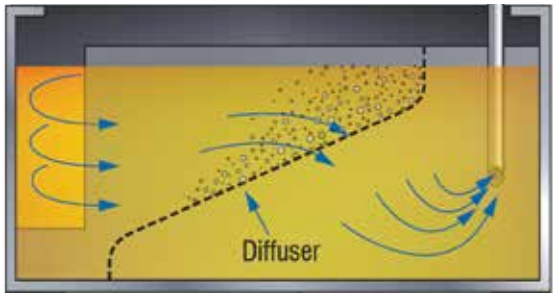
The "Lube-Tips" section of *Machinery Lubrication* magazine features innovative ideas submitted by our readers.

Determining **Additive Levels**

The most important aspect of determining additive levels is having an overall understanding of the state of the fluid. If there are unanswered questions with the initial batch of tests that are performed, it is imperative to perform additional diagnostic tests.

Remove Particles with **Electrostatic Separators**

Electrostatic separators remove insoluble byproducts of thermal and oxidative oil degradation (varnish particles) and submicron hard dirt or wear particles that are too small to be removed by conventional mechanical filters. When conditions are right, they make an excellent addition to an overall contamination control strategy, bringing into balance the focus upon large particles and water with the elimination of varnish particles and silt.



Reduce Foaming with **a Diffuser**

A diffuser fitted to the return line of the tank can reduce foaming and thus reduce oxidation and aeration, as well as decrease the risk of cavitation. It can also lessen the potential for varnish, erratic fluid flow, spongy hydraulics and overheating. ***ML***

Did You Know?

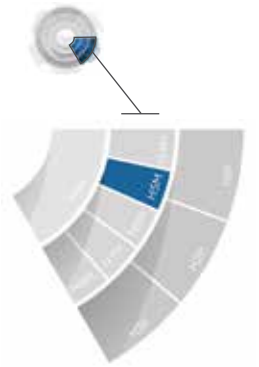
Additional tips can be found in our Lube-Tips email newsletter. To receive the Lube-Tips newsletter, subscribe now at MachineryLubrication.com.

Have Some Tips?

If you have a tip to share, email it to editor@noria.com.

Five Common Mistakes Made when Developing an Inspection Route

More about this **ASCEND™ Factor**



Factor:
H5M– Lubrication Routes
Level:
Platform (M)
Stage:
Lubricant Handling & Application
About:
Developing and maintaining lubrication routes allows for efficient control of lubrication tasks, optimizing resources, personnel and workload.

Learn More:
noria.com/ascend/

Developing and implementing inspection routes is a key part of a successful lubrication program. Inspection routes are complex, and the reality is that just because they are being performed doesn't mean they are being performed correctly. Let's look at an example:

Larry Smith is a lube tech. He has a few years of experience in this role but no formal training. His inspection route for today includes 64 machines spread throughout four different areas of the plant — a task that should take Larry four to six hours to complete. Larry is given simple instructions to "inspect"; it is also assumed that he will take corrective actions when needed.

At each inspection, Larry relies on his intuition. He looks at sight glasses (where available) to determine the oil level, and when necessary, he tops up the oil. He also looks for abnormal conditions, fixing the things he can (like a hatch left open), and noting unusual conditions that he can't address immediately (spent breathers, loose bolts on machine footing, leaky drain ports, gauge issues, etc.). Many of the machines that Larry inspects are not equipped with sight glasses, greatly limiting the scope of Larry's inspection abilities and leaving him only able to make general observations.

How does Larry's inspection route compare to your inspection routes? Are you relying on your intuition and experience alone to

5 Common Mistakes

made when Developing an Inspection Route

1 Not Giving Inspections Enough Importance

Unlike other condition monitoring techniques that have quality trainings, certificates and tools, inspection routes are seen as inherently straightforward, often leaving lube techs with only a vague understanding of what they should be doing. This is a mistake; human-sensory inspections have a lot of value. With the right training and collection devices, each person who walks by a machine, whether they're a lube tech or not, will have an opportunity for a quick inspection.

2 Not Collecting the Data

Larry's inspection route was filled with reportable conditions; some of them were even noticeable without formal knowledge or training. He made corrective actions where possible and documented some of his findings. Unfortunately, however, the only place he was able to document these findings was in the "notes" section of the inspection document — which Larry's supervisor will likely overlook or not fully understand.

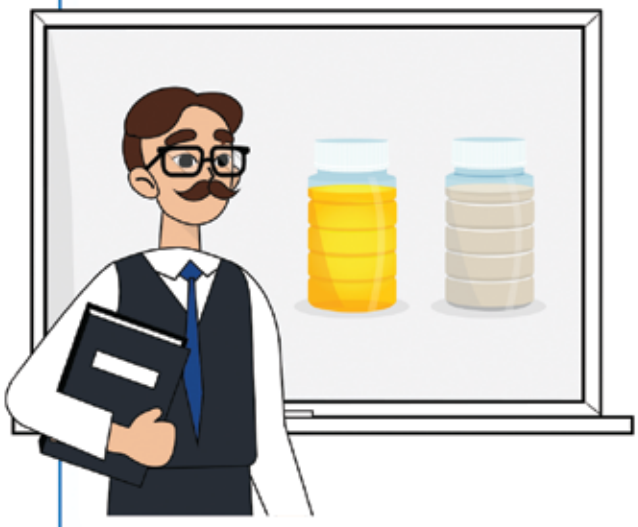
This is a common mistake with inspection routes because this data is easily lost in the endless tasks that must be completed. For inspection routes to be consistently successful, a systematic method of documenting and cataloging reports must be created. With visual observations, it's incredibly valuable to collect the data with pictures or videos as well. A simple comparison to a previous photo can quickly determine the rate at which conditions change. And with mobile phones acting as inspection collection tools (such as LubeP-M™), this can be done much more easily than in the past. When everything is tracked and records are accessible, follow-up actions are more likely to occur.

3 Not Modifying Machines

As mentioned, only some of the machines that Larry inspects are outfitted with sight glasses. The effectiveness of an inspection route is only as good as the individual inspections themselves. Visual accessibility is important to understand internal oil and machine conditions. If a critical gearbox, for example, is completely sealed up on all the ports with a simple OEM-provided vent plug or has an impossible to access sight glass (such as against a back wall), there is very little that Larry can inspect during typical operation.

One of the most common mistakes for inspection rounds is not preparing the machines correctly. Unlike other condition monitoring techniques, where special tools are often necessary, and lots of skills and experience are needed, inspections don't require much. But what they do require (sight glasses) is very important to get right.

4 Not Training and Cross-training

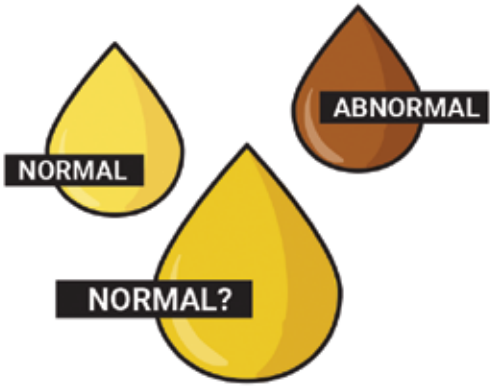


As mentioned, inspections are often perceived as straightforward, lacking sophisticated training or tools, but there is much that goes unnoticed to the untrained eye. Everything else may already be fully in place (people, tools and machine modifications), yet the inspections are still lacking because of gaps in the inspector's knowledge — gaps that Larry is unaware of. Luckily, this can easily be fixed through training.

One great practice is cross-training the experience each person may have. This can be done by bringing a team of personnel together around the plant and spending 10-20 minutes at each machine, letting each person talk about what they see and what it could mean. Each person has different experiences, based on certain equipment in their area or based on previous facilities where they have worked. This shared knowledge is critical for improving inspections and creating a healthy culture with a common goal. This is enhanced further by bringing in a professional trainer on inspections or similar personnel from other plants within the same corporation.

5 Not Defining Normal vs. Abnormal

Larry may not be aware that a particular color or clarity change in the oil (as observed through a sight glass) is considered abnormal. Some oil color is expected, but how dark? What about other unusual haziness observed? Any condition monitoring or testing, when done correctly, trends data and compares it against a baseline (this is necessary). Inspections are no different. A good example of a well-defined abnormal condition is the color gauge sticker on a desiccant breather. But not every inspectable condition is as simple to illustrate as a change in color. Yet, some abnormal definitions need to be well defined so that Larry can be confident in his role as an inspector and take the right corrective actions when necessary.



know what to look for? Do your machines lack the hardware to allow for good inspections? Here are some mistakes that, when fixed, will greatly improve the effectiveness of Larry's work:

About the Author

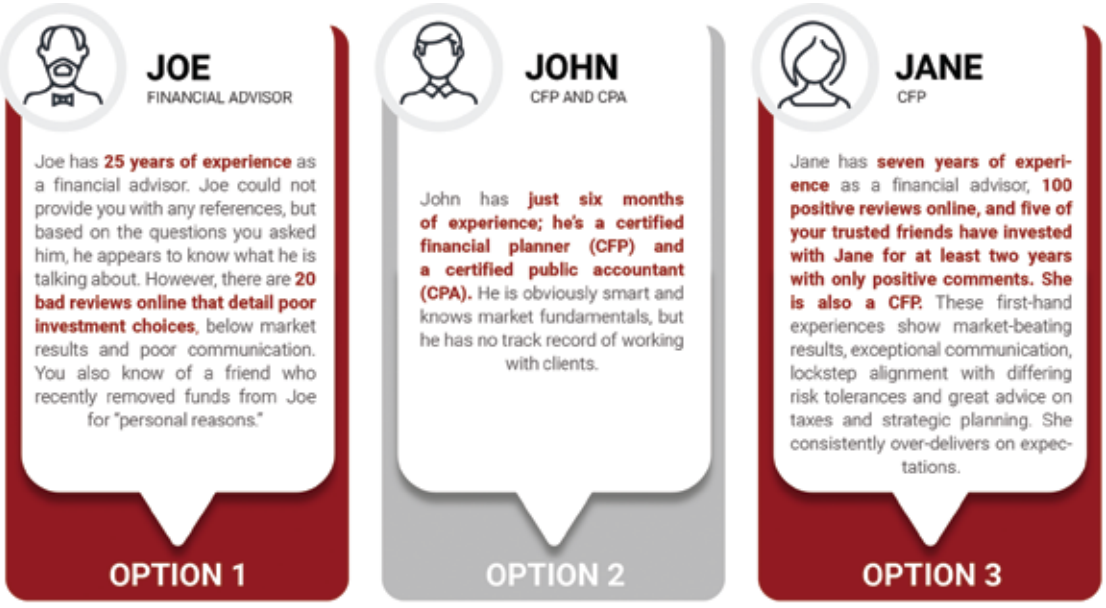
Bennett Fitch is the Chief Strategy Officer for Noria Corporation. He is a mechanical engineer who holds a Machinery Lubrication Engineer (MLE) certification, a Machine Lubricant Analyst (MLA) Level III certification and a Machine Lubrication Technician (MLT) Level II certification through the International Council for Machinery Lubrication (ICML). Contact Bennett at bfitch@noria.com.

How to Sell a Lube Program to Plant Management: **In a Word — Creditability**

"Creditability goes beyond what people say to sell us on ideas by adding past performance to predict future performance. Creditability is therefore earned."

Let's conduct a thought experiment. You just received a windfall inheritance of $1 million, and you have decided to invest the total sum in the stock market under the guidance of a financial advisor. You have just three advisors to select from:

Who do you select?



How did you decide? The obvious choice is Jane. While she doesn't have the most experience, she does have a track record of success and has earned externally-verified credentials. In a word, she has "Creditability."

A bank determines your interest rate based on your credit score. This is an attempt at measuring your creditability. Similarly, if you buy earbuds on Amazon, you will likely choose based on the number of reviews and the total review score by others who purchased the device. Consciously or unconsciously, we use creditability in our daily lives to make decisions. Creditability goes beyond what people say to sell us on ideas by adding past performance to predict future performance. Creditability is therefore earned.

Selling the Program

How do you sell a plant manager on a new lube program? To craft a business case, many maintenance managers or reliability engineers benchmark others who are best in class, reference articles, go to a seminar and quote rules of thumb. For example, they may conclude, "We should be able to cut our maintenance budget by 20%, increase our equipment uptime by 10 percentage points and improve our product yield by five percent. These total a business impact of $2 million per year. All I need upfront is $50,000 for training, $200,000 per year to hire two lubrication technicians, train them to level II technicians for $20,000, spend $100,000 upgrading our lube room and $130,000 to improve our assets with sampling ports, labeling, breathers, fixing leaks and small equipment modifications. With this $500,000 initial investment and $200,000 reoccurring each year, we expect to get $2 million in return, beginning in year three."

This is all packaged together in an impressive 10-slide PowerPoint presentation with pictures and animation for the leadership team. Impressive right? How could the plant manager say no? You are offering a return of $2 million for an investment of $500,000 in just three years. Nevertheless, they say no. Worse yet, they ask for more information; you return with that information, and you get asked for more information. Sound familiar? What is going on?

Let's get into the plant manager's head for a moment and expose some truths. Plant managers are expected to show improved results quarter over quarter (if they are lucky) or month over month (which is more typical). Plant managers want great ideas and are willing to take bold actions. However, you must recognize that you are competing for time and resources.

As a plant manager, I selected three to five game-changing initiatives to drive hard at my plants. Driving 50 initiatives leads to failure; maintaining 47 and driving three to a new level of performance changes the business. Every week, I would get asked to sponsor 10 new programs. Reliability and maintenance is just one of these — powerful, but just one. Production wants a new piece of equipment to replace a 60-year-old one; quality wants to purchase new inspection equipment to improve our defect rate and open up new markets; safety wants new machine guarding; environmental wants a new waste oil treatment facility, citing high maintenance cost and lost reclamation; and commercial wants to add a new product line. Each of these has a strong business case, and all want resources. Hidden in each opportunity are department and individual creditability ratings.

Forewarning, this may sting a little bit: did the plant manager and/or leadership team reject your analysis of the business impact of a strong lubrication program, or did they

Does this organization use its current resources efficiently and effectively? Said another way, does this organization have creditability? No and No. How is creditability earned?

really evaluate the creditability of the leadership team within maintenance and reliability? Creditability is most often the deciding factor. Rarely do you have a sales problem getting your lube program sponsored. Consider the current state of the maintenance department as a backdrop to the initiative request:

The best organizations earn creditability by using existing resources and funding to deliver great results. They seek external funding and support to accelerate future results. Great leaders seek out "zero-cost solutions" to problems. Zero-cost solutions present themselves and become obvious if you know the current state intimately. The only way I have found to understand the current state is through a process known as chalk circle observation, a technique pioneered by Taiichi Ohno, the father of the Toyota Production System.

Chalk Circle involves spending at least four hours (more is better) on the shop floor observing a lone failure

Next, seek zero-cost solutions. By zero-cost, I mean you need no approval from top management to execute these changes. Examples of zero-cost lubrication solutions:

mode, in the case of lube. For example: observing the installation of a bearing, observing numerous PMs being executed and evaluating precision, watching the machine being operated, observing other applications of the same machine type, discussing failures with mechanics and operators, observing failures in the field and conducting failed part autopsies. These facts are combined with expertise and key performance indicators (example: MTBF) to get a full picture of the current state.

How much did these ten actions cost the maintenance manager? Effectively zero. If you are convinced that you don't have enough resources to devote to lube proactively because you are too involved reactively, perhaps you should consider a career change. You must passionately believe the only way to dig out of a reactive maintenance death spiral is to practice proactive maintenance, predictive maintenance and problem-solving. Tomorrow will not be better without these. You must use the leverage you get from these best practices. Your job is to get the "flywheel" of reliability turning before

seeking outside sponsorship. The speed of this rotation is your creditability.

With creditability, investment will come seeking you. This happened to me. The plant manager was so impressed with our results that he asked me what it would take to go faster. We asked for $100,000 to improve our lubrication storage, transfer containers and autopsy area. We had funding that week.

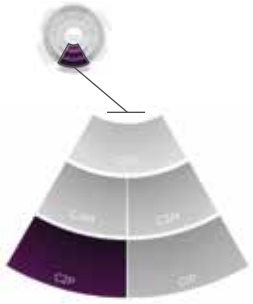
You must understand that every reliability tool, including lubrication, is designed to eliminate waste. A mantra of "we attack waste" is what I recommend to every reliability and maintenance organization. Not only is this accurate for what each best practice is designed to do, but it also aligns top management to the shop floor, conveying what you are trying to do in simple, everyday repeatable terms. Let's face it: we have made reliability too complicated. Further, a waste mantra is always in vogue regardless of the business cycle you are in. This enables reliability change efforts to accelerate in both good times and bad.

I promise you; your existing lube program has waste in it. Know it through observation. Fix it. Communicate results, linking them to your actions. Improve. Lube can be an excellent first step in your reliability journey; it was for my team. However, you must earn creditability by doing the basics well before selling any idea or change to top management. Prove you are a great steward of precious resources and watch the time, money and resources flow. As Yoda says, "Do or do not, there is no try." **ML**

Factor: C2P

Aeration and Foam: Good for Beer, Bad for Oil

More about this **ASCEND™ Factor**



Factor:
C2P – Contaminant Removal

Level:
Platform (P)

Stage:
Contaminant Removal & Lubricant Reconditioning

About:
A focused and consistent contamination removal strategy ensures that contaminants are eliminated as quickly as possible, optimizing machine performance.

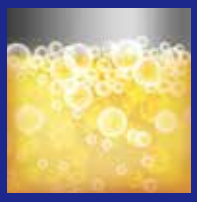
Learn More:
noria.com/ascend/

In the industrial maintenance and reliability field, it's safe to assume that we're the type of people that enjoy a cold one on Friday after a hard work week. Early on, I didn't like a lot of foam on my beer, and many others think the same way. After further research, I learned that you actually do want a little foam on top of your beer; it enhances the flavor of the beer by producing different aromas and taste profiles that wouldn't exist in a flat, airless beer. It also provides a level of insulation to keep the drink cooler longer. In an industrial oil, some air in the oil is quite common. Foam, however, is typically a problem and should not show up in your industrial oil. Foam can lead to a vast array of different problems and, unlike beer, has no enhancing properties for the oil.

Foam is extremely difficult to deal with. It can lead to false oil level readings and overall decreased

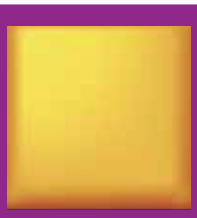
Four Phases of Air in an Industrial Oil

Free Air



Free air is the air often found in the headspace of a reservoir, but it can also be trapped within the system in various places. Free air can be especially troublesome in systems that depend on fluid pressure to operate (i.e., a hydraulic system). If the brake lines on your car or truck have some free air trapped in the line, it will produce a spongy brake pedal; apply the same logic to a hydraulic system. It can also lead to vapor lock and restrict the movement of fluid. Free air is the air that has not necessarily mixed with the oil yet. This air moves in and out of the reservoir quite easily, through the breather, labyrinth seal, or even an air leak in the reservoir. Free air is also the easiest air to remove.

Dissolved Air



Dissolved air is very common in most oils. This is when the air bubbles are microscopic; they are not detectable by your naked eye. One thing to note about dissolved air is that it needs to be degassed before performing any optical particle count; it can cause a false reading. High levels of dissolved air can also lead to an increased oxidation rate.

Entrained Air

Typically, this is the worst-case scenario. You will know when there is entrained air in the oil: the oil will look very milky and discolored. This occurs when you have small air bubbles suspended throughout the fluid. These bubbles take a long time to rise to the surface and produce an oil that is more spongy. Entrained air can lead to cavitation, micro-dieseling and many other serious problems.

Foam

Foam is generally caused by overfilling, impaired air handling properties, contamination or mechanical problems. Referring back to the automotive oil analogy, if you overfill the crankcase in an engine, it will become frothy and foamy, putting excessive pressure on the crankshaft and leading to further and more damaging issues.

performance, which can cause the machine to airlock. Small amounts of foam aren't necessarily detrimental, but if gone unmonitored, it can ultimately lead to failure. Foam is always a problem when the oil level can no longer be controlled or when the foam is doing the lubricating instead of the oil itself.

There are a few ways we can exclude, remove and attempt to prevent air entrainment in our industrial oils. Most quality industrial oils these days will have some sort of defoamant additive. Silicone additives and acrylate copolymers are common types of defoamants (there are no incompatibilities between the two if you are wondering). However, acrylate copolymers are pretty sensitive to certain polar contaminants, making them slightly less effective after a given period of time.

As for removal, it really depends on the source of air ingression. Most of the time, if the air ingression is aggressive enough, it could indicate improper setup of the machinery. The following are common causes of air ingression:

- The return line is above the oil level (causing splashing and the trapping of that air)
- Too small of a reservoir
- Improper oil level in gearboxes

Besides additives and proper setup, there are mechanical methods of controlling air in our oil, such as baffles, diffusers, and wire mesh on the return lines. We often teach in our classes to keep a sharp eye on W.H.A.M. (Water, Heat, Air and Catalytic Metals). If we are able to control entrained air, we are often able to control foam issues. Trying to keep the oil healthy and minimize turbulence in the reservoir are key factors that should be analyzed any time a foam problem exists. ***ML***

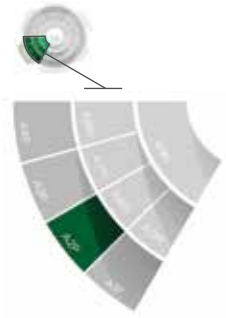
About the Author

Paul Farless is an Associate Technical Consultant for Noria Corporation. His duties include collecting data and preparing reports for the engineering team. Prior to joining Noria, Paul worked as an automotive maintenance technician for an auto-repair service company. He also served four years in the U.S. Navy as a gunner's mate third-class petty officer and as a seaman deckhand, where he was responsible for the troubleshooting and maintenance of electromechanical and hydraulic systems. A detail-oriented team player, Paul works well in fast-paced environments and uses his military background to excel and maximize efficiency.

Factor: A2P

Particle Counting: **Why Smaller Particles Lead to Big Trouble**

More about this **ASCEND™ Factor**



Factor:
A2P – Lubricant Analysis Test Slate Selection

Level:
Platform (P)

Stage:
Condition Monitoring, Lubricant Analysis and Troubleshooting

About:
Critical failure modes should be considered when selecting tests. It is best to build a program that is proactive.

Learn More:
noria.com/ascend/

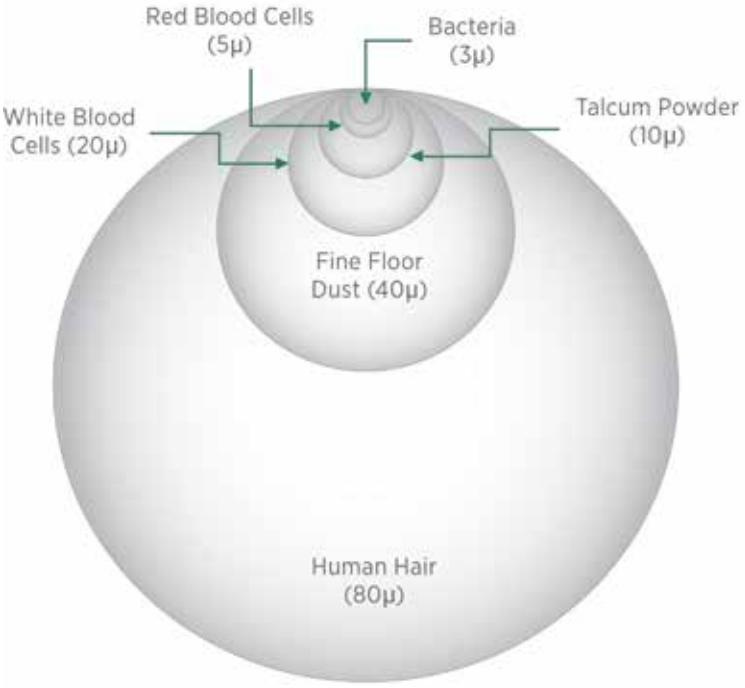
If you have been in the Maintenance/Reliability space for any length of time, you may have heard someone say, "We need to drain or change the oil because of the number of particles that can be seen."

While checking for contaminants is a must for any great inspection program, it is important to know that the particles doing the most damage to machine parts are far too small to be seen with the naked eye.

Why Small Particles Matter More

Without a magnifying glass or microscope, the human eye can only see particles down to about 40 microns in size. The particles doing the most damage to our lubricants are in the 3-10 micron range, way smaller than what can be seen on a typical visual inspection of the lubricant. These particles are more concerning than their larger counterparts because they are close to the size of typical film thicknesses, which

Understanding Particle Size and Particle Count



SIZE		TYPICAL NUMBER OF PARTICLES IN 1ML
Microns (µ)	Inches	
3	0.00012	1036
5	0.0002	584
10	0.0004	183
20	0.0008	36
40	0.0012	5
80	0.0032	1

Particle size range causing the vast majority of machine wear

As size gets larger... ...number becomes smaller

Microns (µ)= micrometers (µm)
1,000,000 microns = 1 meter
25,400 microns= 1 inch
25.4 microns= 0.001 inch

can allow them to go through the load zone, causing damage to machine parts.

- **Hydrodynamic Lubrication (Sliding)** — Typical oil films are 5-20 microns.
- **Elastohydrodynamic Lubrication (Rolling)** — Oil films can be less than 1 micron.

Breaking it Down

Another issue with small particles is that they are harder to break down. To understand this concept better, think of breaking a large stick down to use for kindling in your fireplace. When the stick is long, you can snap it over your knee or in your hands, breaking the larger stick into smaller pieces; however, if you have done this before, you know that when you get a stick about the size of your hand, it's almost impossible to break down any further. The same is true of small particles; instead of being broken down to even smaller sizes when they pass through the load zone, they cause abrasive wear.

Built in

When a machine comes in new from the OEM or has been brought back to the plant after a rebuild, it is always a good idea to perform a flush. This flush will help send any particles that may still be in the machine out the drain port.

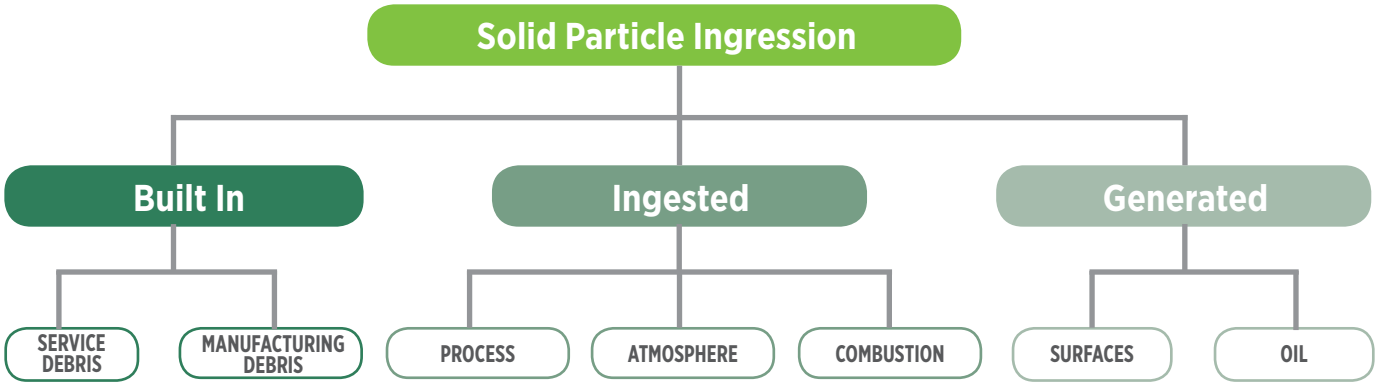
Ingested

Particles can be ingested from the process, atmosphere or combustion by way of leaking seals, pipes and hoses; the most common method of entry is through the headspace. Open hatches or ports on the top of a reservoir should be closed to deter particle entry. One of the most overlooked items for particle ingression is the breather. Machines often come with a vent or vented plug to allow a machine to breathe. These allow a direct path for contaminants. Hydraulic lubricants often have tight cleanliness goals but think of the headspace protection on most of the units — a cap with tightly woven steel wool. Replacing these with a low micron filter will help eliminate this easy path.

Generated

Particles coming from this type of ingression are most often controlled by lubricant filters. Something to consider here, though: remember the size of the film thicknesses we discussed earlier? If your components are separated by very small film thicknesses, and you are running a 40 micron filter, are you eliminating the particles that are doing the damage? When choosing filters for machines, it is important to keep your lubricant cleanliness goals in mind.

Where Does Particle Contamination Come From?



- Repairs
- PMs
- New filter
- New oil
- Dirty hose, fitting components
- Top-up containers

- Burrs
- Machining swarf
- Weld spatter
- Abrasives
- Drill turnings
- Filings
- Dust
- Comtaminated components

- Compressed air/gas
- Pulp
- Pulverized coal
- Ore dust
- Aggregates
- Cement
- Catalysts
- Molecular sieves
- Process chemicals

- Breather ingestion
- Seal ingestion
- Tank opening
- Rock dust
- Mill scale
- Quarry dust
- Foundry dust
- Slag Particles

- Blow-by
- Soot
- Fly ash
- Induction air
- Contami-nated fuel

- Mechanical wear
- Corrosive wear
- Cavitation
- Exfollation
- Hose fibers
- Filter fibers
- Break-in debris
- Elastomers
- Paint chips

- Desedimentation
- Filter desorption
- Additive precipitation
- Sludge
- Oxide insolubles
- Carbonization
- Coke

Do Your Machines Have an Issue?

Lubricant analysis is the most common way of quantifying the number of small particles found in machines. This information can be very helpful, as it will tell if proactive steps such as controlling the headspace are working, as well as letting users know that the current filtration strategy is helping to eliminate particles of the right size.

About the Author

Travis Richardson is a technical consultant for Noria Corporation. He holds a Level II Machine Lubrication Technician (MLT) certification and a Level III Machine Lubricant Analyst (MLA) certification through the International Council for Machinery Lubrication (ICML). Contact Travis at trichardson@noria.com.

Jeremie Edwards | Noria Corporation

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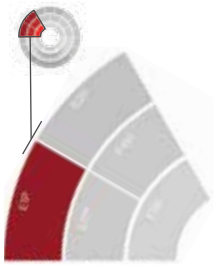

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Platform (P)

Stage:
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About:
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Anybody who has worked anywhere that deals in larger volumes of oil (I'm talking anything over five gallons) knows that you never spill more than five gallons at a time. I'm not really sure where this number came from, but it generally holds true. The actual volumes can vary from state to state, country to country, where the oil is spilled (ground spill, water spill, concrete, etc.) or the actual type of lubricant. So, the five-gallon mark is a pretty conservative way of looking at this. If our biggest spill is five gallons, we likely won't need to report the spill to any alphabet organization and cause a whole lot of headache.

Why do we even need to worry about spills?

Well, it turns out that almost everything on earth needs water to live, and when we start introducing random stuff to the water supply, we start making that water unfit for consumption. In fact, there's a pretty good chance that the water will have stuff in it that will lead to major health concerns — ever heard of Flint, Michigan? Yeah yeah, I know; Flint's issues were caused by a number of things: lead pipes, contaminated water, organic and inorganic contaminants, trihalomethanes, etc., but the comparison still holds true with groundwater and oil spills. Have you ever read the SDS/MSDS for a lubricant? There is a whole bunch of stuff in there that isn't good for living things to consume.

What can we do about any of this?

There are regulations in place that give us a window into what is "safe" (safer) for the environment when it comes to oil spills. Testing is done in controlled environments to help us determine how much of a risk we are creating for ourselves, our

families and the wildlife. A couple of different standards are used in determining the toxicity of substances, and it can get a little confusing. There are only a few hundred pages of regulations, tests and methods (in multiple languages), which, to be honest, makes things a bit of a nightmare — especially when you take a look at an SDS/MSDS and all you see are two lines with minimal explanation, like the following, which shows the results of toxicity tests performed on two different species: Oncorhynchus Mykiss and Daphnia Magna.

The "LL50 1003 mg/l" part tells you that the test was done with a load of 1,003 mg of the lubricant per liter of water in the reservoir. At this load, there was a < 50% death rate of the fish in the 96-hour test period. In regard to the fleas, reproduction

TEST	DURATION	ORGANISMS TYPE	TEST RESULTS
Aquatic - Acute Toxicity	96 hours	Oncorhynchus mykiss	LL50 1003 mg/l: data for similar
Aquatic - Cronic Toxicity	21 days	Daphnia magna	NOELR 1mg/l: data for similar materials

It might be beneficial to know what this stuff means.

properties were observed. With a load of 1 mg/l in the fleas' reservoir, there was no obvious change in the reproduction cycles. The NOELR actually stands for "No observed effect loading rate." The Load Limit (LL) is used to show the maximum contamination level before you start killing off half of the test subjects, but it isn't the only acronym that you might see on this testing. Read the sidebar on pg. 37 to learn more about some of the common acronyms.

Oncorhynchus mykiss – Rainbow Trout; these guys are one of a few species used in the testing.

Daphnia Magna – A larger common water flea.

Aqueous toxicity can go a whole lot deeper than this as well. You might see terms like Tw(X) or Ts(X), where the (X)

SAFE CONCENTRATION (SC)

This one refers to the propagation of the fish. It means the fish reproduce at normal rates, and no significant changes are seen in their habits and offspring volumes.

NO OBSERVABLE EFFECT CONCENTRATION (RATE) (NOEC(R))

This is typically a long test result and looks at the overall life span of the test subjects. The "Rate" is how loaded the test reservoir is; statistical analysis is performed to determine how much of the test oil can be placed in with the subjects without a noticeable change to the lifespan as a whole.

LOWEST OBSERVED EFFECT CONCENTRATION (LOEC)

This result is given where there is an obvious change in the life cycle of the test subjects and shows at what dilution point change was first observed.

EFFECTIVE CONCENTRATION (EC)

This one is essentially an estimation or calculation of when you would see a more catastrophic event (meaning there would be an observable difference in how the animals act). This could be a catatonic state, listing or tilting when they swim, or even death. While a 49% death rate is acceptable for the "LL," this figure would push it over that 49% rate.

LETHAL CONCENTRATION (LC)

This one sounds dire, but it isn't too far off from the LL50 rate. This is the dilution that causes a death rate of >/= 50%. The EC and LC are the same numbers when the observed difference is actual death for the test subjects.

INHIBITION CONCENTRATION (IC)

Unlike some of the other numbers that look at the death of the test subjects, this one is looking at the reduction of population growth in the animals. You might see an IC25 indicated, meaning that at that specific load level, there was a reduction of growth by 25%. So, an IC50 would mean that the population growth would be around the 50% reduction rate.

represents a number between 1 and 4. So, what are these indicating?

The Ts stands for Toxicity in soil, and the Tw indicates Toxicity in water. The numbers correlate to the LL50 rating and the concentration of oil contaminant it takes to get there. Simply put, a Ts/Tw 1 rating means that the Load Limit is greater than 1,000 mg/l. The 2 rating means that the contaminant load is somewhere between 100-1,000 mg/l, the 3 rating between 10-100 mg/l and the 4 rating would be the most harmful, coming in at <10mg/l to reach the LL50 mark.

You may be asking, "How are they going to test rainbow trout survival rate in soil?" Well, they aren't. For soil testing, they use earthworms and lettuce. The chart below is an EPA reference that gives breakdown of what species are tested and when they might be the test subjects:

ECO-TOXICITY IN SOIL	ECO-TOCICITY IN WATER	LOADING RATE WPPM (LL50)
Ts1	Tw1	›1000
Ts2	Tw2	1000-100
Ts3	Tw3	100-10
Ts4	Tw4	‹10

Chart 2. Toxicity loading rates

There are quite literally hundreds upon hundreds of pages of regulation, test methods, results, etc., on this subject. This article isn't meant to be a source for "how-to" and "what does all of it mean," but rather is meant to provide a better basic understanding of what those lines in an SDS are actually telling us and why that stuff is important. But if someone really wanted to get DEEP into the weeds on the subject, I've collected some useful EPA links. To check those out, visit the web version of my article by going to machinerylubrication.com/Magazine/Current and clicking my article title.

About the Author

Jeremie Edwards is an Associate Technical Consultant at Noria Corporation. He is one of an elite few certified by the International Council for Machinery Lubrication (ICML) as a Machinery Lubrication Engineer (MLE) and did so in order to become the best advisor for clients when it comes to their continuing education needs. Before joining Noria, Jeremie served six years in the U.S. Army as a parachute rigger and was deployed in Afghanistan, Uzbekistan, Turkey and Germany. Contact Jeremie at jedwards@noria.com

MEDIUM	TEST ORGANISMS	TEST TEMP (°C)	LIFE STAGE
Freshwater	Vertebrates		
	Brook trout (Salvelinus fontinalis) Rainbow trout (Oncorhynchus mykiss) Fathead minnow (Pimephales promelas)	12 12 20- 25	30 - 60 days 15 - 30 days 1 - 14 days
	Invertebrates		
	Amphipod (Hyalella) Waterflea (Daphnia magna, Daphnia pulex, Ceriodaphnia) Mayfly (Hexagenia limbata, Hexagenia bilineata) Midge (Chironomus)	20 or 25 20 or 25 17, 20 - 22 20 or 25	7 - 14 days 1 - 24 hours Young nymph First to second instar
	Alga		
	Selenastrum capricornutum	25	4 - 7 days stock culture
Marine and Estuarine Waters	Vertebrates		
	Sheepshead minnow (Cyprinodon variegatus) Silverside (Menidia species)	20 or 25 20 or 25	1 - 14 days 9 - 14 days
	Invertebrates		
	Sea urchin (Arbacia punctulata) Mysid shrimp (Mysidopsis)	20 20	‹ 1 hour old 1 - 5 days
	Alga		
	Champia parvula	23	Sexually mature
Freshwater Sediment	Amphipod (Hyalella azteca) Midge (Chironomus tentans and Chironomus riparius)	20 - 25 20 or 25	7 - 14 days First to second instar
Marine Sediment	Amphipod (Rhepoxynius abronius) Amphipod (Eohaustorius estuarius) Amphipod (Ampelisca abdita) Amphipod (Grandidier lla japonica)	15 15 20 15 - 19	Mature 3-5 mm, mixed sex Mature 3-5 mm, mixed sex Immature or mature female only Immature 3-6mm, no female w/ embryos
Oil	Earthworm (Eisenia foetida) Lettuce (Latuca sativa)	22 24	300 - 600 mg adult Seed

Chart 3. Plant and Animal Species Used in Standard Toxicity Tests

The Future of Mobility - Klüber Lubrication

Klüber Lubrication showcased their state of the art solutions at the Auto Expo Components 2023 (January 12th to 15th, Pragati Maidan, New Delhi). There was a special emphasis on their competence as a complete lubrication solution provider for all automotive needs, the latest generation of their 'noise kit', custom-made solutions for electric vehicles and strong focus on sustainability.

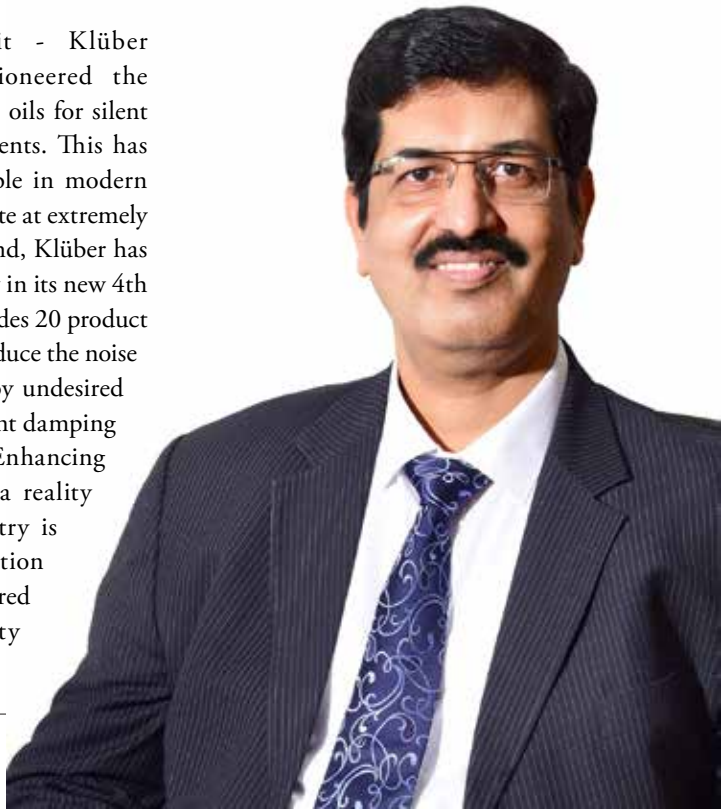
Klüber Lubrication is one of the world's leading manufacturers of speciality lubricants, offering high-end tribological solutions to virtually all industries and markets worldwide. Most products are developed and made to specific customer requirements. Set up as a retail company for mineral oil products in Munich in 1929, is today part of Freudenberg Chemical Specialities SE & Co. KG, a Business Group of the Freudenberg Group, Weinheim. The Business Group includes five largely independent divisions which are active in more than 50 countries: Klüber Lubrication, Chem-Trend, SurTec, Capol and OKS. It has provided high-quality lubricants, thorough consultation and extensive services, which has earned it an excellent reputation in the market. The company holds all common industrial certifications and operates a test bay hardly rivalled in the lubricants industry. "Klüber lubrication, now a few years shy of being a century old company, has developed customized products for all these applications. In the instance where an existing product does not fulfil the requirements, the Klüber team has state of the art resources and competence to work together with customers to develop a tailor-made solution," says Hitendra Bharagava, CEO and Regional Management Board Member Asia Pacific, Klüber Lubrication. Some of the key areas of expertise showcased were –

1) Klüber Lubrication - Complete lubrication solutions for the automotive industry. The average automobile has more than 250 lube points and each of these presents its own set of challenges. In addition to the lubricants needed within automobile itself, the manufacturing process poses equally demanding and complex lubrication challenges. Klüber Lubrication is future ready with custom made products to handle all challenges from components rotating at much higher speeds to extremely low NVH level requirements. These solutions extend even to the exponentially growing electric 2 wheeler market in India.

2) Automotive noise kit - Klüber Lubrication has long pioneered the development of greases and oils for silent operation of machine elements. This has become increasingly valuable in modern electric vehicles which operate at extremely low decibel levels. To this end, Klüber has developed the noise kit, now in its new 4th generation. The V4 Kit includes 20 product samples that substantially reduce the noise in vehicle interiors caused by undesired friction, stick-slip, insufficient damping or material compatibility. Enhancing mobility of the future is a reality that the automotive industry is in a state of rapid transition from conventional IC powered vehicles to new mobility solutions, electric vehicles in particular. This has led to many new requirements from lubricants. For example, electromechanical components – such as ball screws and other actuators in the steering, clutch and brake systems of hybrid and electric vehicles – require special lubricants that are adapted to the new requirements.

Contributing to a sustainable future Klüber Lubrication India's manufacturing plant in Mysore derives more than 55% of its energy from renewable sources. "Where Klüber really shines, is in helping their customers be more sustainable through use of their longer lasting and higher performing lubricants thereby reducing waste, improving productivity and reducing energy consumption," adds, Mr. Bhargava.

Hitendra Bhargava
CEO, Kluber Lubrication India Pvt. Ltd



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