September-October 2021

Machinery Lubrication

INDIA

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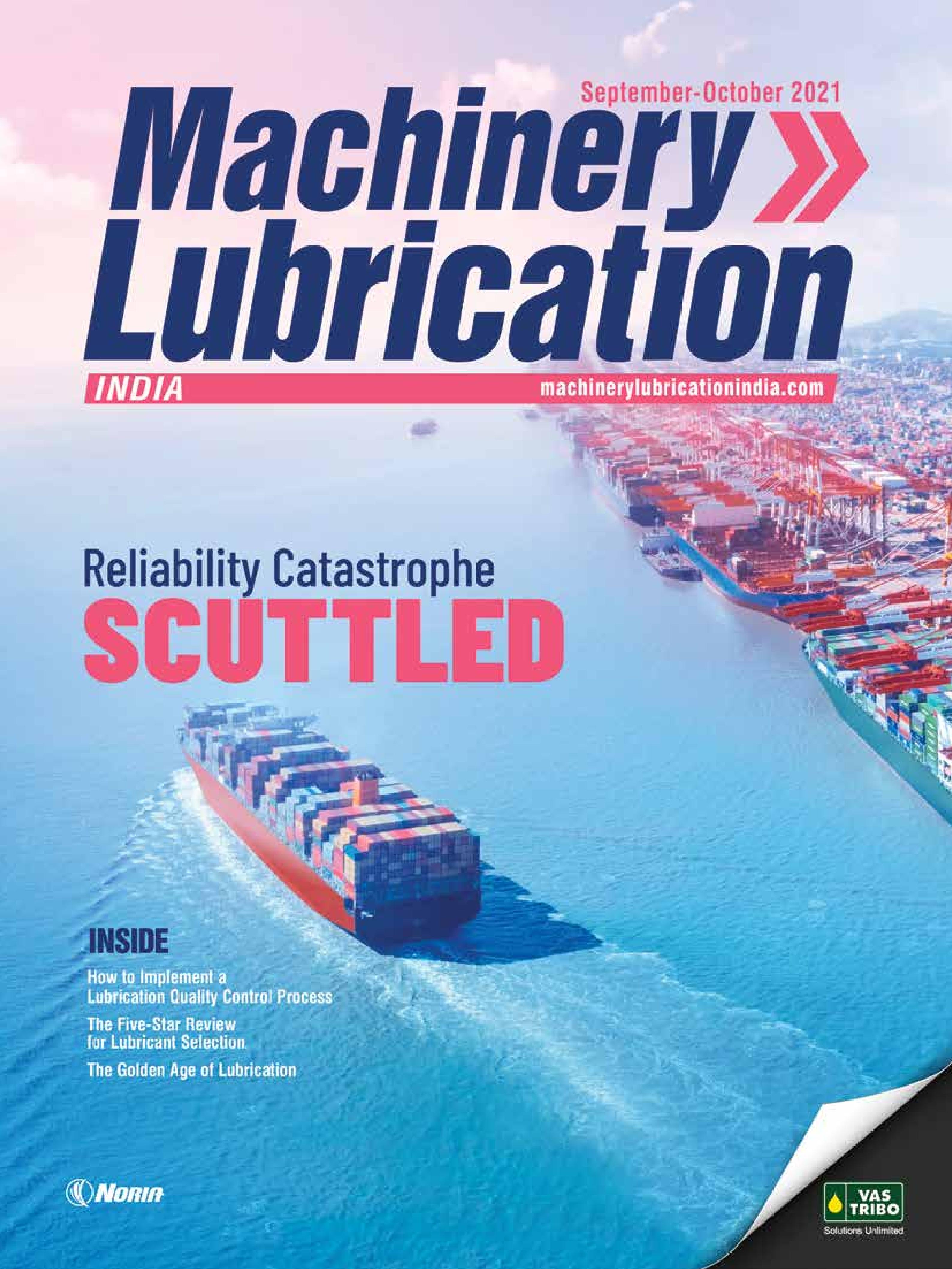

Reliability Catastrophe SCUTTLED

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ICML 20 YEARS 2001-2021

FROM THE DESK

Publisher's Note

Since our cover story is pertaining to lubrication of shipping and allied assets on the shore, we thought it important to cover the impact of International Maritime Organization (IMO) 2020 regulations on marine lubricants.

The regulation limiting sulfur in ship fuel from 3.5% to 0.5% is having a dramatic effect on how marine engine lubricants are formulated. The International Maritime Organization's (IMO) 2020 sulfur regulation will drive a dramatic shift in the types of fuels used by ships. The global 0.5% limit on fuel sulfur means that most shipping vessels will switch to lower sulfur fuels – mainly new very low sulfur fuel oil (VLSFO) blends formulated specifically for IMO 2020 compliance.

Traditionally marine main engines burning HFO have needed cylinder lubricants with a high acid neutralization capability (expressed as base number or BN) to tackle the corrosive qualities of a high sulfur content – something that is becoming even more important as modern engine designs and operations exacerbate corrosive conditions. For ships using fuels with lower sulfur, such as those designed for use in Emission Control Areas (ECA), engine oils with lower BN are more appropriate. Changes at both ends of the fuel sulfur spectrum will demand more from cylinder lubricants.

IMO 2020 will change the market for marine lubricant additives. Anticipated fuel challenges mean that more advanced additive chemistries will be needed to protect engines. The anticipated wide range of fuel characteristics and potential instability of VLSFO blends will increase the deposit handling capability demanded from cylinder lubricants, while the low sulfur content will reduce the requirement for acid neutralization. Conventional high-sulfur HFO has required high BN and strong deposit handling, but low-sulfur fuels need low BN lubricants that maintain the deposit handling performance of higher BN oils.

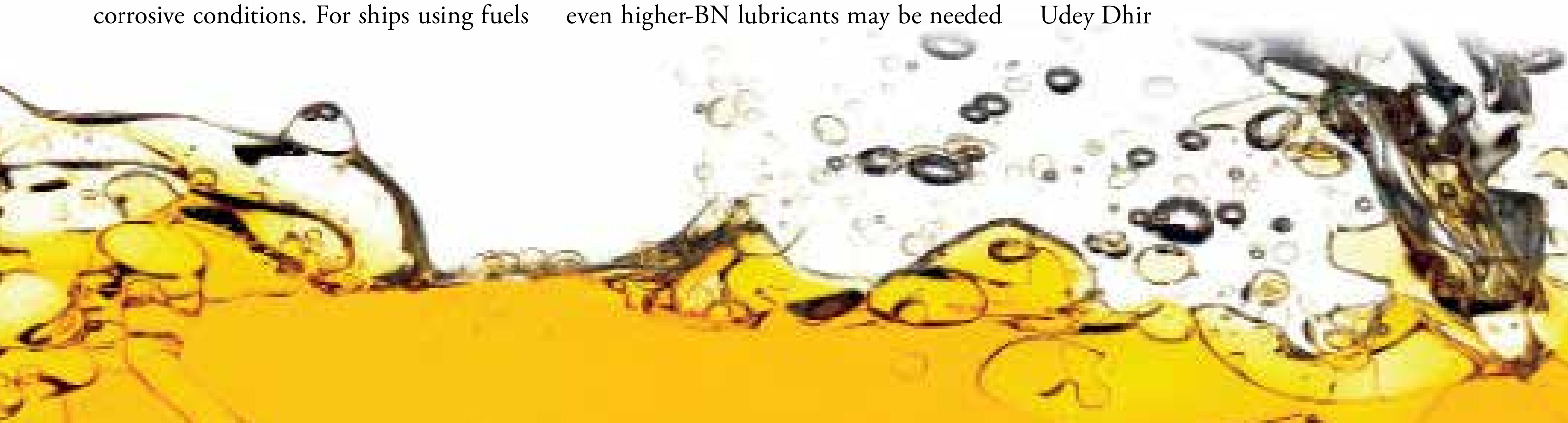
Just as IMO 2020 will be a defining point for the marine fuels market, so will it reshape demand for marine engine oils. For now, the scrubber-installed fleet will operate on existing cylinder oils - although the potential for higher sulfur fuels means even higher-BN lubricants may be needed in the future. But the new VLSFOs will need robust BN40 oils to handle anticipated stability concerns and to ensure peace of mind for ship owners. Lower-sulfur fuels need good deposit handling performance and advanced additives are being deployed to meet the challenge. Their development will not stop in the years to come.

A series of articles that we started with the cover story titled ASCEND to Lubrication Excellence in our May-June 2021 issue, we are trying to cover most of the 40 elements continue to be covers in this issue also. These articles have been very popular with our readers and many of you have written to us on how you are able to impact the state of lubrication though improvements in these respective areas.

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

Wishing all our readers a happy Dashahara & Diwali.

Warm regards,
Udey Dhir



Jim Fitch | Noria Corporation

The Golden Age of Lubrication

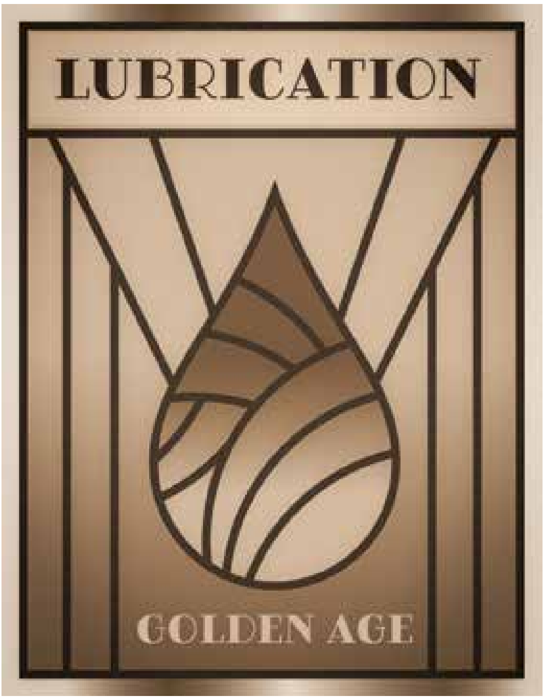
> "If we fix lubrication first, we don't have to fix the machine later."

As Noria enters its 24th year, we have a lot to be thankful for. It is particularly gratifying to see organizations vigorously practicing what we have been teaching for years. Many impressive success stories have been shared.

Contamination control has been a constant theme at Noria, and for good reason. It speaks to the real root of a lot of problems. Not just the dirt we can see or feel, but also those tiny and invisible particles many believed were harmless. Instead, we now know they wreak havoc on even the strongest and most powerful of our machines. Every maintenance professional should know that for most machines, "Ten times cleaner oil results in 50 times longer machine life." This is not fantasy.

The body of evidence that justifies investment in real changes to lubrication and reliability is enormous. This is the main reason I titled my column "The Golden Age of Lubrication." There is so much untapped potential available if organizations invest in fundamental things such as education, certification, machine modification, contamination control, standardized work and so much more.

Noria's founding business model of publishing, education and services could not have been more intentional. That same business model persists today and is backed by the six basic premises that follow.



1. Pay Attention to What Works

During the pre-Noria years, I was obsessed with collecting case studies. I amassed hundreds of them, looking for common threads. What did highly successful lubrication programs do that others did not, or at least did not do well? I found many.

From that collective knowledge, we discovered a new maintenance philosophy that we now call proactive maintenance. This maintenance philosophy is not about searching for machine faults and predicting a future failure. It is about instilling a machine lifestyle change that suppresses the very essence of failure. It is an aspirational pursuit of a sustainable state of reliability. Not only does it work, it also preserves maintenance budgets and costs less overall than other practices.

Reliability is a lot like quality. As W. Edwards Deming (father of the quality movement) is famous for saying, "You cannot inspect quality into a product." The same is true for reliability. Condition monitoring tries to "cull out" bad reliability, machine faults etc. by giving them encouraging names like "saves." Instead, what we really need is a zero-faults policy related to machine reliability similar to the "zero-defects" that Six Sigma aspires to achieve. This is the foundation of proactive maintenance.

"What we really need is a zero-faults policy related to machine reliability"

2. The Most Controllable Expenditure in a Plant

Maintenance is the No. 1 most controllable expenditure in a plant... PERIOD! Everything hinges on what is controllable. While there are always things we can't change, there are far more things within our realm of control.

Most of us have heard of the Pareto Principle, also known as the 80:20 rule (e.g., 20% of the causes of failure are responsible for 80% of the occurrences of failure). This is a simple concept that helps us properly focus our time and resources. When it comes to change, there is a fundamental need to achieve early and decisive wins. This fuels momentum to stay the course and garners support from peers and decision-makers.

But maintenance and reliability are vast concepts, the subjects of hundreds of books. There are so many "controllable" choices to navigate. What should one do first, second, third etc.? Where exactly are those elusive silver bullets and big bang-for-your-buck opportunities? Their discovery is the mission of today's lubrication and reliability professionals.

3. Find the Hidden Plant

Every plant has a hidden plant that must be found. What does that mean? Basically this: within every plant there are assets and resources (including people and energy)

Figure 4. Large gearbox (4 reduction stages) used in a steel mill. Leakage around oil pump went unnoticed, ignored or just deferred for later repair. Little by little the gearbox drained of oil resulting in a thick dust cake. Oil pressure gauge was obstructed by the cake. *Ref. Ronald van Druten*

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that go unutilized or underutilized for considerable periods of time throughout a work year.

The extent of unutilized or underutilized assets and resources defines the magnitude of the hidden plant. This is usually where denial creeps in. Many in the maintenance field say they are already "too lean" for there to be a hidden plant. They might also say, for this reason or that, that they can't operate production at a higher capacity and certainly not near 100% capacity. A good place to start in solving this paradox is to take a careful look at metrics like planned work versus reactive work for unmet opportunities for change.

Back to proactive maintenance. There are three simple steps to successful implementation that we have gleaned from hundreds of case studies. These are listed below, using the example of lubricant cleanliness to provide context:

1. Set target cleanliness levels needed to achieve the reliability objective (e.g., a 2X machine life extension).
2. Through contaminant exclusion and removal, achieve the target cleanliness levels.
3. Routinely monitor fluid cleanliness to verify that target cleanliness levels have been achieved.

I am guessing that fewer than 10% of maintenance organizations follow these three steps. Those who say they do are unknowingly failing at the most important step: No. 1. Machine life extension is achieved by setting targets significantly lower (cleaner) than historical averages and typically even lower than OEM and laboratory recommendations.

Proactive maintenance is NOT achieved by trying to catch and control "unusually high" contamination levels (a commonly held misconception). Instead, proactive maintenance is achieved by a controlled state of "unusually low" contamination levels. That single concept is the real magic behind proactive maintenance, which can be applied across numerous machine failure modes (root causes) in addition to particle contamination.

Therein lies the hidden plant.

4. The #1 Cause of Failure

We've all heard it. Lubrication is the No. 1 cause of machine wear and failure. If we fix lubrication first, we don't have to fix the machine later. As someone once told me, the vast majority of reportable alarms from routine vibration analysis are rooted in poor lubrication. This includes dirty, wet, aerated oil and so much more.

A good way to substantiate this claim on rotating equipment is simply to tally and rank the most common issues flagged

From Dream to Reality

I've been involved with the ICML since it was but a germ of an idea, back in the year 2000. Today, the ICML is world-renowned and is arguably the largest certifying body in the reliability space. It proudly celebrates its 20th anniversary of service to the lubrication and oil analysis community worldwide this year.

In 1999, on the sudden passing of my dear friend and colleague Peter Ball, I was appointed the position of Convenor of Working Group 4 (tribology) for the ISO condition monitoring committee TC108/SC5. We met once or twice each year in such places as Nanjing (China), Vienna and London. The international membership of my working group was extensive. A new standard was under development and later published, now known widely as ISO 18436-4 related to training and certification of machinery lubricant analysts.

However, with that standard there was need for a certifying body to develop and administer testing around the world. That need led to the inception of the ICML. Since then, I've served on the ICML's Board of Directors, and over the ensuing years we have added many certifications and awards.

The most recent is Machinery Lubrication Engineer (MLE) which is the ICML's flagship certification. In my opinion, the MLE is the most prestigious lubrication distinction on the planet.

The development of the MLE was long and arduous, starting with the Body of Knowledge, then the Domain of Knowledge and finally the large bank of test questions. Many lubrication experts shared their time and skills to bring the MLE to fruition.

Recently, the ICML's Executive Director, Leslie Fish, informed me that they have updated their records and currently have over 26,000 individuals who hold one or more certifications. That is an exceptional feat to say the least. Hats off to the hardworking and outstanding team at ICML!

by inspection, vibration, oil analysis, ultrasound and thermography. Knowledge from this exercise can greatly help focus time and resources related to training, certification, condition monitoring tools/ activities, machine modifications etc. We've learned this from the 500+ plant lubrication assessments we've performed over the years. Not only do the assessments confirm this, but they also continue to point out that lubrication programs are often overlooked, underutilized and generally performing at a sub-optimum level.

While good lubrication is not a panacea for many unrelated machine maladies, it should always rank high in reliability resource and program planning. This is strongly supported by the huge body of case studies on reliability.

5. Training and Human Behavior

There is no greater influence on the state of lubrication than training and human behavior. I often say, "You earn what you learn." I do not say it because it rhymes or it sounds cool. I say it because, to me, it is an unvarnished fact.

The words "optimum" or "optimization" are commonly used in maintenance and reliability. Their use refers to a balancing of costs, opportunities, benefits and risks. Common examples include PM Optimization (PMO) or the Optimum Reference State (ORS). Can "optimum" be applied to training and education? Most certainly!

Figure 1 is the Education Needs Chart (ENC) for Lubrication Technicians. On the chart are three plotted lines and three zones. The upward sloping green line is the cost of education relative to the amount of education received. The precipitously downward sloping orange line is the cost of ignorance related to the financial consequences of not investing in training for lube techs. The cost of ignorance is largely defined as opportunity cost, such as opportunity to reduce repair costs and downtime. The blue line is the total of the two: cost of ignorance plus cost of education.

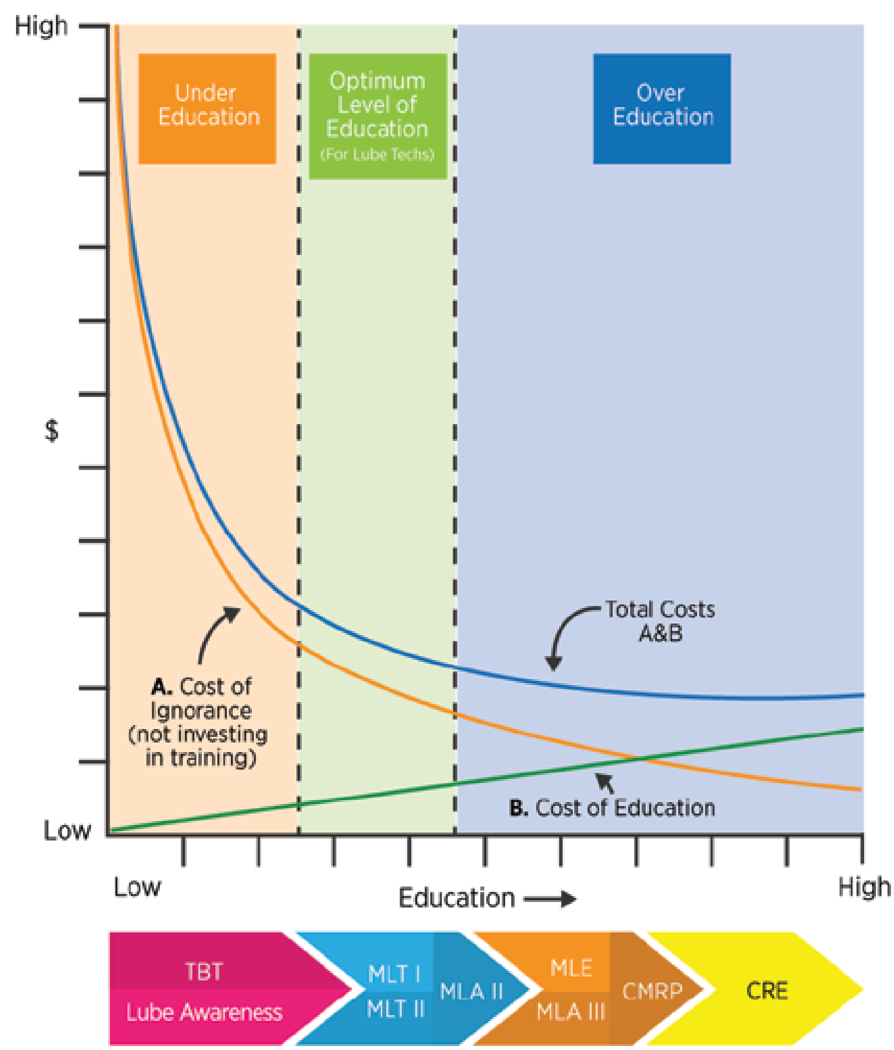

Figure 1 Legend: TBT=Task-based Training (Noria); CRE=Certified Reliability Engineer (ASQ); CMRP=Certified Maintenance and Reliability Professional. All other acronyms refer to ICML certification designations and levels. Note, TBT is considerably different than certification training. TBT is linked specifically to commonly performed and standardized tasks and procedures.

The vertical Yellow Zone relates to a state of under-education and the high associated opportunity costs (penalties). The Blue Zone on the right relates to a state of over-education. Note the cost penalty of over education is negligible. The center Green Zone relates to the optimum level of education; not too much, not too little. The point of diminishing return is roughly the left edge of this green zone.

Note, this version of the chart only applies to lubrication technicians. Different version of the chart would be used for lubricant analysts and lubrication engineers.

See if you can make sense out of this sentence, "The vast majority of what we need to know is what we don't know we don't know." Or this, "If we don't know what we don't know, we can't seek what we need to know." Why is this important?

> "If we don't know what we don't know, we can't seek what we need to know."

A well-constructed training curriculum organized by people with real practical experience in their field will always include topics that students think they are going to learn. While this is technically true, it should be the bare minimum. The real bounty from high-value training is found in all the extra knowledge students received that they did not anticipate learning about. This type of learning is rarely received from on-the-job training passed down from old-timers and tribal knowledge.

Education teaches us what we need to know. Culture and human behavior determine whether this knowledge will be put to practical use. Long ago, I learned that lubrication and reliability are more about human behavior than anything else. For much more on this, see my article "Remedies for a Bad Maintenance Culture" at machinerylubrication.com.

6. Change Must be Enabled

All progress depends on change, and change must be enabled. Crisis is an enabler. The world's greatest examples of major change were all preceded by crises (or chaos). As they say, "don't let a perfectly good crisis go to waste."

Of course, the ambition and aspiration of motivated leaders can also enable change. Management of change is a field of professional and academic pursuit. We can't wait for change to happen by itself. It needs to be intentional — to be driven into existence.

Of course, there are always those who prefer things to remain the same. It is human nature to want to maintain the status quo. However, today we have much more of a "change culture" than ever before. These are people who study successes, follow and enable successes and celebrate successes. As a result, we are seeing excellent examples of change and progress related to lubrication and reliability by user organizations. The golden age is now. ***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 books. He serves as a U.S. delegate to the ISO tribology and oil analysis working group. Since 2000, 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.

Reliability Catastrophe SCUTTLED

By Werner Ruster, Chief Engineer Onboard

Construction projects on land are challenging and complex, however building on water is even more so. Marine infrastructure projects require tremendous knowledge, experience and more importantly, specialized equipment. And if this equipment fails, there is considerable financial loss—not just because of the downtime, but because of their specialized nature and how difficult they are to access and repair. One of the ways offshore operations prevent costly machine failures is through the application of condition monitoring principles and tools. This is exactly what happened in 2016 during the construction of one of the world's largest container terminals.

MAKING ONE OF THE WORLD'S LARGEST

PORT CONTAINER TERMINALS

The construction project is a next-generation container terminal costing over $1.5 billion USD. When completed, this mega-port will be one of the world's largest, both in size and capacity. Construction began in 2015 and the terminal is set to begin operation of its first two deep-water berths later this year. This mega-infrastructure project required the reclamation of over one square mile (640 acres) of new land with a five mile (8 km) sea wall comprised of hundreds of some of the world's largest caissons. Other than its size, what made this project unique was that each caisson was placed on rock mounds created by a revolutionary new construction vessel specifically developed for the project.

NEED FOR EXTREME RELIABILITY

Rock mounds typically require four different vessels to dig a trench, lay sand, rock, and then compact it all down. Because of the scale of this project, coordinating four different vessels to construct the hundreds of rock mounds would have been too complex and time-consuming, so a new all-in-one rock mound construction vessel was developed. This next generation vessel was able to do the work of four vessels in half the time and with a fraction of the workers. The simplification and cost savings that this technology brought to the project became vital to its success. The only problem was that there was only one of these vessels, so its continuous operation and reliability were of the upmost importance. As Chief Engineer

Onboard, and as a certified Machinery Lubrication Technician (MLT1), it was my job to oversee its maintenance and overall reliability.

Onboard the ship we had twenty-two winches. Each winch had a different job and all of them were super critical. To ensure their reliability, I established daily inspection routes and implemented condition monitoring procedures and protocols, including taking random samples and using comparator cards to identify changing conditions. Unfortunately, none of the winch gearboxes had sampling valves, 3D sight glasses, or desiccant breathers. Samples had to be taken using a drop tube, and visual inspection was limited to a flat window sight glass, which told us very little other than the oil level. However, the constant monitoring soon paid off, and during one of the inspections we discovered high metal content in one of the oil samples.

Figure 1 - The first and only all-in-one rock mound construction vessel

Unfortunately, using a drop tube meant we could not see exactly where the tip of the tube was inside the gearbox. The tube could have pulled a sample from a stagnant zone that had been stock piling debris for months, not from an active zone that would have given us a better idea of the severity of the problem. What we needed to know was the rate that at which the debris was being produced in real time.

HOW LAND RECLAMATION WORKS

Constructing land on the water requires building a sea wall. This wall creates a perimeter that is then backfilled to create the land. The sea wall built for this land reclamation project was made of caissons, which are huge watertight concrete structures that are prefabricated on land, towed out to sea, and then sunk to the seabed. This particular project required hundreds of caissons, each as tall as a 10-story building and weighing 15,000 tons, or the equivalent of 34 Boeing 747-8's.

INNOVATIVE MULTIPURPOSE SIGHT GLASS

After doing some research, I contacted a company called Luneta and inquired about their Condition Monitoring Pod (CMP). Their CMP seemed like a good solution, considering it could replace the original flat window sight glass with a 3D sight glass, a visible magnet, a corrosion indicator, and a sampling valve with a pilot tube. The 3D sight glass would allow us to better monitor the color and clarity of the oil, the magnet would capture and alert us to ferrous wear debris, and the sampling valve would permit live zone sampling, all in real time and all without having to shut down the winches. In many ways, the CMP was a lot like our rock mound vessel—it was an innovative solution that consolidated many tasks into one.

In addition to desiccant breathers, filter carts, and other oil-related improvements, I purchased CMPs for all the winches. All onboard engineers and technicians were instructed on how to inspect and use the new condition monitoring tools. Filter carts were permanently filtering the oil and were rotated from winch to winch every 7 days. Visual inspections were conducted every 12 hours and included checking the CMP sight glasses for changing conditions using comparator cards, checking oil level, inspecting the CMP magnets for wear debris, and inspecting the corrosion indicator for corrosion. If any change was observed, engineers were instructed to notify me or another senior onboard engineer and then pull a sample for analysis.

To our surprise, within the first 24 hours, several of the CMP magnets had collected noticeable amounts of wear debris. We did not expect to see anything for weeks because we had just filtered the oil with the filter carts. We could literally see the wear particles grow on the magnet. We were aware that small amounts of wear debris were common in machine oils, and we expected to collect some over time, but not this much and so quickly. Wear particles signify that surfaces within the gearbox have begun to break down, and the greater the rate of wear debris generation, the more likely machine failure becomes. The rate that wear debris was collecting on our CMP magnets was very high, so we knew we had a problem. What we did not know was the root cause and what to do to prevent the winches from failing. Needing to act quickly, we decided to have four of the gearboxes opened and inspected.

DISTRESSED GEAR FLANKS DISCOVERED

A visual inspection of the inside of the winch gearbox quickly uncovered surface deterioration on two of the four gears on the compound gear train. Damage included pitted surfaces, indentions, feathered edges, and uneven surfaces. Additionally, all the deterioration was on one side of the gears, indicating that the damage was occurring when the winch was pulling. This type of

Figure 2 – One of the twenty-two winches with Luneta's Condition Monitoring Pod (CMP) installed.

"HAD IT NOT BEEN FOR THE CMP'S WE WOULD NOT HAVE REALIZED THE EXTENT OF THE PROBLEM."

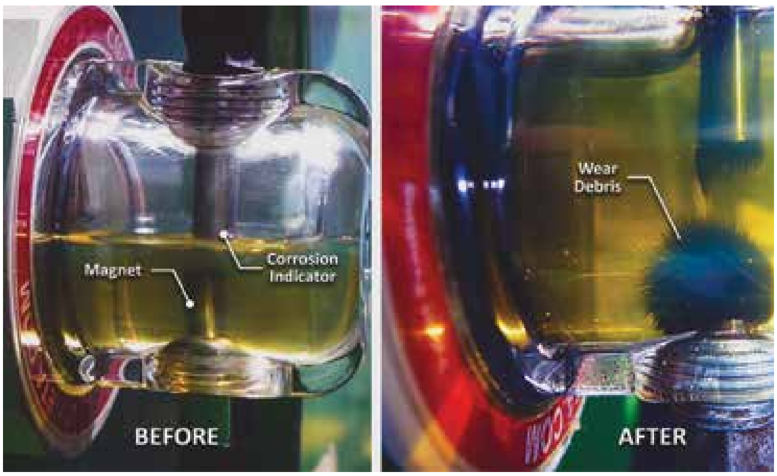

Figure 3 – After only 58 hours, large amount of ferrous wear debris can be seen on the CMP's visible magnet. Notice that the steel corrosion indicator has also become magnetized and has also collected debris.

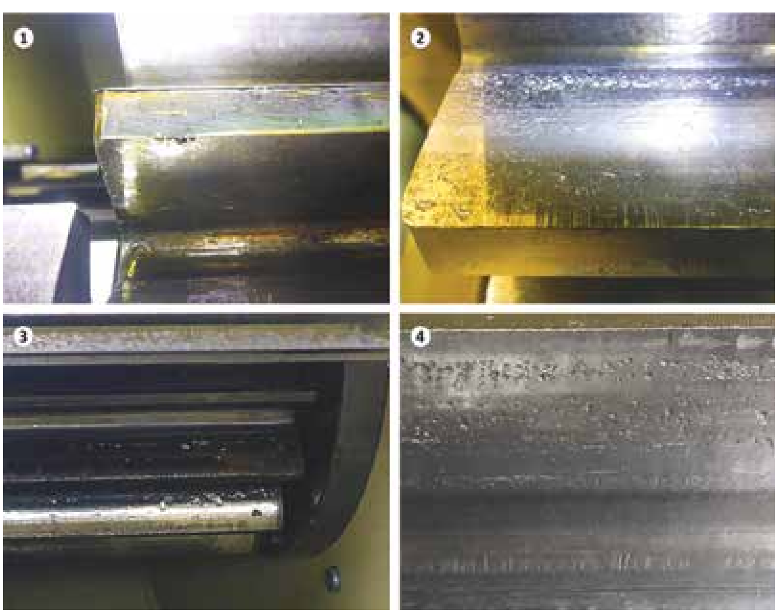

Figure 4 – Visible damage on two of the four gears in the winch's compound gear train. Damage included: 1) Feathered edges, 2) Uneven surface finishes, 3) Indentions, and 4) Pitting

damage typically indicates either a lack of lubrication, high pressure gear loading or an issue with the gear material used. We were confident that the lubricant and loading were within specifications, so we focused on the gear material and decided to have them tested. We purchased a rebound hardness tester and conducted three readings on every tooth. All the gears were supposed to have a hardness above 35 Rockwell C, however two of the four gears came back below this limit. It was no surprise to us that these were the same gears that were damaged. We found the root cause.

EARLY ALERT SAVED THE DAY

By now, many more of the CMP's were showing signs of wear debris. Knowing this as well as the fact that many of the winch gears were not to specification, we decided to have all suspicious gears in all the twenty-two winches replaced. The cost of having just one winch fail in the middle of the job was too great. The gears had to be manufactured and there were no spares that could be pulled off a shelf. At minimum, it would have taken at least four weeks to fabricate, harden, air freight from Europe, move through customs and install. The winches were a vital part of the operation. If one of the winches failed, the rock mound operation would have stopped, and this would have delayed the building of the caisson wall, which would have ultimately slowed construction of the whole project. If the project was delayed by just one week, let alone four, because of unexpected failure of the rock mound winches, the cost to the overall project would have been unimaginable.

Fortunately, the CMP alerted us to the problem well ahead of machine failure, giving us enough time to contact the supplier and have new gears manufactured and shipped. There was also time to make the gear exchange during previously planned maintenance. Had it not been for our condition monitoring procedures, we would never have discovered the high metal content. And had it not been for the Condition Monitoring Pod, we would not have realized the extent of the problem in time to identify the root cause and prevent a very costly failure.

Offshore construction projects are all about specialized equipment, and during the building of the world's largest container terminal, a specialized Pod kept our specialized vessel running so it could do a very special job. In the end, condition monitoring saved the day, and we finished constructing all of the rock mounds without any machine failures or delays. In fact, the project was so successful that we finished ahead of schedule. *ML*

Wes Cash | Noria Corporation

Factor: S2P

The Five-Star Review for Lubricant Selection

"We need to look at both ends of the chain here and put metrics in place to ensure all parties are doing their tasks to the utmost of their abilities to pinpoint areas for improvement."

With so much emphasis put on selecting the proper lubricant, using lubricants approved by OEMs, and ensuring our lubricants arrive on time and with the correct properties, it is shocking that most organizations have no means to measure how well they are performing in these critical areas. Most lubrication professionals understand the importance of metrics as well as the importance of getting the right lubricant from the start, but most fall woefully short in ensuring these activities are scrutinized with any level of detail. As programs evolve and advance, they begin to track and score application, cleanliness, failure rate—the list goes on. However, these are all lagging metrics for your lubricant selection process. How can we flip this situation around and start looking at leading indicators for machine and lubricant health by focusing on lubricant selection?

Does your selection process pass the test?

Throughout my academic years, I was constantly measured. High test scores, timely submission of assignments and active participation are just a few examples of the unique blend of metrics and criteria I was expected to work toward. At the end of the semester, the final grade in the class was a reflection of my performance, not the performance of the instructor. When entering college, I learned of a web service that allows students to "grade" their professors. Finally, the shoe is on the other foot and I can get that feeling of karmic justice to bring to light those educators who upheld their end of the agreement to impart knowledge to the class. These services are very much alive today and are used by most students to determine which professor's class to enroll in.

This is analogous to our lubricant selection process. Our machines and technicians are "graded" against a curriculum based upon time between failure, cleanliness, safety—again, the list continues indefinitely. However, the lubricants used, the supplier of these lubricants and even the tools used to aid in selection are seldom scrutinized. We have the same scenario as the student to the teacher. The machines and technicians are the students, and the lube selection team and lubricant suppliers are the teachers. We need to look at both ends of the chain here and put metrics in place to ensure all parties are doing their tasks to the utmost of their abilities to pinpoint areas for improvement.

Let's boil this down to the two parties that should be reviewed and graded: the lubricant supplier and the lubricant selection committee. Understandably, most facilities may not have a lubricant selection committee, and the lubricant supplier may have been selected based upon ease or proximity to the plant. It's unfortunate that such critical roles are simply left up to happenstance or reverted to "the way we have always done it."

Lubricant Suppliers

In a previous article, I outlined the business case for why you should select a lubricant supplier that will partner with you on your reliability journey. This is a relationship that is of the utmost importance, especially as it pertains to getting the proper lubricant at the proper time with the proper support. In some cases, a supplier contract may be instated to target all these areas so there is an agreement of responsibilities between both parties.

Think about your personal life and the amount of research you likely do prior to subscribing to a service or buying an expensive item. We typically gravitate toward the customer reviews. We read who had great service, who had a poor experience and what to be wary of when purchasing. If we were to review our lubricant supplier, what would a five-star rating even look like? What should they be judged against? Three critical items should be considered when deciding how many stars should be doled out.

On-time Deliveries

Perhaps the easiest metric to put in place is compliance of on-time deliveries. All lubricants are going to have a lead time associated with them, some of which may be up to a couple months depending on the type and where it is coming from. The impact this can have on our equipment is devastating. If we find ourselves in a situation where a lubricant is needed for start-up and the lead time is long, it often results in a suboptimum lubricant being used instead, and ultimately the machine suffers and the lubricant supplier takes the blame. Clear communication between delivery times and on-hand inventory needs to be had. Review the stated lead times in your agreement and cross that with the elapsed time between orders and deliveries. On-time compliance is a great leading indicator of lubricant inventory control and having the correct lube on hand.

Support

Most lubricant suppliers offer technical support with their products. Sometimes this support includes items such as oil analysis support (sampling and testing), training, field visits etc. If this support is relied upon to make maintenance decisions or just general knowledge transfer, the responsiveness and compliance of this agreement should be tracked and measured over time. For instance, if the supplier is to provide oil analysis sampling and test results for critical assets each month, we should be tracking the compliance of this occurring. The same holds true if there are to be scheduled learning sessions as well as general responsiveness for technical support by phone, email, site visits or any other means related to the agreement.

Contamination

It's no secret that new oil doesn't necessarily mean it is clean or defect-free. We should have a process in place to test incoming lubricants to make sure they meet the standards set for lubricants prior to putting them in service. While the supplier may not always have direct control over packaged lubricants' cleanliness if they are not the point-of-fill, they do have some control to make sure deliveries are defect-free. One way this can be done is ensuring the fill-date is as recent as possible during reception. All lubricants have a shelf-life, and we want to make sure our supplier is giving us fresh lubricant in order to preserve the remaining shelf-life when it hits the plant. Reviewing the age of incoming lubricants, those that arrive dirty or wet, as well as those that arrive cross-contaminated with other fluids is a great metric to determine the quality control practices of the supplier.

If the supplier scores well in all three of these areas, they earn the five-star rating. Remember these metrics should be reviewed, and any discrepancy should be shared with the supplier to put a plan in place for remediation. Even so, this rating only addresses half of the equation—now we need to think how our internal lubricant selection committee should earn their five-stars as well.

Lube Selection Committee

Oftentimes, the responsibility of selecting a lubricant is done by someone who isn't as involved in the lubrication program as they should be. I've experienced lubricant selection ran solely by purchasing, whose main intent was simply to purchase the cheapest product they can, regardless of its performance. This line of thinking needs to end. If we are going to require our supplier to uphold their end of the bargain, we need to take our side seriously as well to ensure we are asking for the right products in the first place. Let's start with deciding who should be on the committee to begin with.

The committee should be comprised of the stakeholders in the lubrication program as well as purchasing. Typically, you would want to have representatives from reliability, maintenance, management, and purchasing to make all the decisions needed in a quick manner. It is understandable that there can be overlap between roles and variance in the structure of facilities, so finding the right blend of personnel for your committee may fluctuate a little. The end goal is to let everyone have a voice in the process who should and to keep in check any "drift" away from a specification over time. The big three things that should be tracked for the performance of this committee are below.

Selection review

There are many criteria by which a lubricant should be selected. Some major ones include:

- OEM Approvals
- Price
- Availability
- Brand Preference
- Performance
- Historical Use
- Consolidation

Sometimes the simple act of selecting a lubricant for use can become an exercise in engineering chemistry crossed with materials science. Other times, people revert to whatever the OEM recommends and have over sixty different lubricants on-hand. The sweet spot is somewhere in-between. Ultimately, the committee needs to ensure the performance characteristics of the lubricant meet or exceed the demands of the equipment and are being purchased at the most reasonable rate. The above mentioned "drift" occurs when there isn't a periodic, formal review of the lubricants in use or there isn't anyone responsible for selection. This leads to complacency, resulting in frustrated technicians and failing machines. Measuring the lubricants on-hand against the needs of the machines should be performed annually at a minimum.

Training

It will be nearly impossible for the committee to do their job properly if there isn't a plan on how they should increase their knowledge in the field of lubrication. Base oils, additives and greases are all evolving at a rapid pace, with new technology in their chemistry and performance changing the rules of how they traditionally have been used and selected. Without focusing on keeping our knowledge abreast of the changes, we will slip further away from the use of an optimum lubricant to something that might not give us the best performance for our dollar. A great way to track this is to measure the number of staff certified or, at minimum, trained in lubrication-specific curriculum. This should be reviewed to keep the knowledge current and applicable for all involved in the lubrication program.

Labeling

While we typically think about lubricant selection relating mostly to purchases, it's important to remember that the technicians must select the proper lubricant from the lube room to apply to the equipment as well. Therefore, it is critical that the committee develop and implement a robust lubricant labeling program. Every lube point should be labeled, and the corresponding label should be found on the appropriate tools or product in the lube storage area. This helps ensure the correct lubricant is applied to the equipment, reducing accidental cross contamination in the field. The implementation of the labeling program should be measured and reviewed to make sure there is progress in this area. A periodic walk-down of the plant should be done to audit the labeling on the equipment and ensure any areas of deficiency are addressed.

Provided that our committee performs well in these three areas, the five-star review is virtually guaranteed. Measurement and metrics go a long way to showcase areas of improvement and help us understand where we need to focus our efforts. Once we have a great supplier and a great selection committee, our technicians and equipment will reap the benefits resulting in less downtime, more engagement and improved culture throughout. ***ML***

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Factor: R1P

How to Implement a Lubrication Quality Control Process

About the **Acend Factor** in this story

Stage:
Lubricant Selection

Factor:
S6K - Lubricant Selection

Level:
KPIs

About:
Ficte vitem incime que aliam, sectam, as reium re etur, torione ctaquam volore ea deliquist, vid mo eaque est omnimag namusapit,
Ficte vitem incime que aliam, sectam, as reium re etur, torione ctaquam volore ea deliquist, vid mo eaque est omnimag namusapit,

With the high price of quality lubricants and the demand placed on machines to run harder and faster, there is a great need for high-performance lubricants. We expect lubricants to arrive on-site as they were advertised at the time of purchase: having the proper viscosity, base oil, performance characteristics, and last but certainly not least, the ability to meet certain contamination cleanliness targets. However, assuming every lubricant that arrives on the dock meets those expectations would not be reasonable—in fact, it would be downright dangerous.

Why a Quality Control Process is Important

The process of refining base stocks, blending these base stocks with additives at a blend plant, and delivering finished lubricants to a customer is quite lengthy and has significant potential for error. The base stock, being the main portion of the lubricant, can pose one of the biggest problems from the start as not all base oils are compatible with each other. Most lubricants are formulated from two to three different base stocks—a simple mix up of base oils in the blend plant could result in catastrophe right from the start. If the wrong additives are mixed in along the way, it only makes things worse. Many different lubricants may also be mixed at the blend plant using the same pump or hoses, and failure to flush the used equipment can result in cross-contamination. By now, you should have an idea of the many issues that can occur before you ever receive the lubricant on your dock. This is only magnified when the point-of-fill into drums occurs further down the supply chain.

What's Involved?

A quality control process can help prevent bad lubricants from making their way into machines. The process should include a flow path that establishes where lubricants are to be delivered onsite, who oversees the quality process and what actions should be taken if a product is wrong or fails certain tests. A key objective of this process is inspecting the lubricant package and properties. This can begin even before a lubricant arrives on the receiving dock by requesting quality certificates from your lubricant supplier. These certificates generally come in the form of an oil analysis report that shows the approval of the batch by the manufacturer's QA/QC department. The report will usually look different from that of an in-service lubricant as these are very specific to the lubricant's composition.

Product Inspection

Inspecting products is one of the easiest steps in the quality process, yet it is the step that is most often missed. Lubricants can be delivered in many ways. Greases are generally delivered in small boxes containing several tubes, while lubricating oils can be delivered in bulk by a truck, bulk totes, barrels, buckets and even quart jugs. If you are receiving bulk lubricants, it is critical that you obtain a quality control certificate as most vendors will not let you detain their truck to further examine the lubricant they are delivering. However, there are a few things that can be done before the lubricant is offloaded. You can verify that the pump they will offload with has been properly flushed and ensure that any other lubricant transfer equipment is capped or stored in a way that reduces the possibility of introducing contaminants.

Inspection of Packaging

Greases and the other smaller oil-filled containers mentioned above, such as barrels and buckets, also need to undergo an inspection. Key things to look for include the product name, expiration date and any physical abnormalities of the container. The product name should match exactly what was ordered, and if a viscosity is listed, it should also match. The expiration date should not be passed and in general should be more than a year in the future. Improper bung fit and rust on the threads should be questioned on oil barrels, as well as any missing seals on barrels and buckets. When inspecting a grease package, check the box for oil, as this is most likely a sign of the oil leaking out of the grease thickener and should be cause for concern.

Lubricant Analysis

Depending on factors such as the number of lubricants, criticality of equipment and availability of on-site laboratory equipment, we can go a step further than an inspection of the package and perform lubricant analysis on lubricants received. The level of analysis performed also depends on the previously mentioned factors. For instance, if you only have two lubricants on site totaling 200 gallons, it is probably not cost-effective to have a laboratory full of oil analysis equipment. With that being said, there are some inexpensive tools that can be used to measure different properties of a lubricant, which can then be used as indicators of whether or not the lubricant supplied meets expectations. Viscosity is the most important physical property of a lubricant; every delivered lubricant should be tested to make sure it has the right viscosity. As I stated earlier, making lubricants is a long process and it is not unheard of to have a lubricant arrive that has a different viscosity than the one mentioned on its container. A simple visgage or viscosity comparator can be used on each delivery for a quick "go/no-go" acceptance test.

Depending on the size of your program, another tool you can use to test incoming lubricants is a particle counter. This will tell you how clean your oil is—remember, not all new oils are clean oils. For more critical machines, you might even decide to send samples to an offsite laboratory before putting newly-delivered lubricants into service. An oil analysis laboratory can give you a deeper understanding of the lubricant to confirm that it is up to specifications.

Post-Assessment Steps

So, what happens when abnormalities are found with lubricant deliveries? This is usually going to depend on the contract terms that you have with your lubricant vendor and what the issue is with the lubricants. If there were problems found with the packaging such as broken seals or base oil leaking out of grease tubes, you can probably ask for a straight exchange for the same product. When it comes to more in-depth inspections such as an oil analysis report, if the report came up showing a different viscosity or incorrect additives, these should be sent back. Risks like this are a good reason to quarantine your lubricants while they are being analyzed; if you fill a bulk tank with bad lubricant, you could potentially cascade the issue and now at least have more problematic oil than just the initial barrel, even if the contamination isn't spread into your plant's machines. If you have a cleanliness contract with your vendor stating how clean your lubricants should be when they arrive, and they bring them to you with a higher level of contaminants, you might be able to filter them yourself and get a credit towards your next purchase. This is generally done because the problem can be fixed, and a barrel exchange can be avoided.

Implementing a quality control process at your plant can save time, money and potential headaches. Creating a step-by-step guide that details the key members and their roles in the process will help to ensure it is a success. *ML*

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Matt Adams | Noria Corporation

Factor: H1P

Task Standardization: Maximizing Opportunity by Minimizing Variance

> "Many industrial facilities remain stubbornly short-sighted about the acquisition, installation and operation of their machines."

Looking back on math class in school, a well-known concept indicates that adding supplementary variables to an equation results in the problem inherently becoming more complex. During on-site lubrication program assessments or public training seminars, I frequently relate back to this and how it aligns with the process and ownership of specific tasks within your lubrication program.

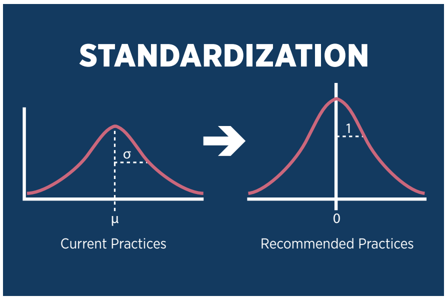
As we begin to review site lubrication processes, let's take a look at those associated with **Lubrication Handling Tasks (H1P)**. As the number of individuals performing these tasks increases, we begin to see increasing opportunities for variance to occur. Identifying these needlessly distributed practices and acting on them with controlled administrative measures is imperative to minimizing the overlooked problems I commonly see in plants. As your program advances, the creation of standardized procedures, tasks by application type and application types by asset will begin to address unnecessary variance in the program that will pay dividends for years to come.

Culture is another specific objective that is coincidentally being addressed simultaneously during this standardization. In this context, culture is defined as the common habits, rituals and beliefs of the site. As we begin to organizationally change the steps noted below, reliability leaders are directly affected by how lubrication handling tasks are carried out and play a key role in setting a new expectation for excellence at the site.

Procedure Standardization to

Lubrication Tasks

It is vital to understand that when sites choose to work towards improving their lubrication program, they can easily get caught up in physical improvements through capital expenses, such as updates to lubrication rooms, tools and laboratory equipment. While all these have proven benefits if you truly desire the improvements at the site to last for years to come, we must also be extremely aggressive in developing documentation for the program at the outset. I tend to agree that working on specific lubrication procedures is not as exciting as purchasing and installing a fancy new lubrication room, but there is something to be



said for buy-in with physical purchases. We as reliability leaders must understand the importance of investing in the long game first.

The initial step is arguably the most important. We must review the procedures for lubricant handling task documentation. At this time, we review certain established practices and the level of detail involved in delivery of the lubricant to the plant floor. Lack of documentation regarding these practices is extremely common, and when there is documentation, it embodies the bare minimum, such as which lubricant to use. It seldomly identifies how much lubricant or where to specifically apply it. Since this is often the case, it is important that all personnel, including craft, operators, lubrication team members, engineers and management understand the detrimental effect that lack of detail can have on the quality of work. This is imperative for anyone truly interested in nurturing and developing their lubrication program.

The next step is to recognize and address ongoing variance within the plant's operations. It's common for sites to have several highly experienced craft or lubrication team members with a general understanding of the importance of lubrication and adhering to best practices. But what happens when these individuals retire? What happens if they bid out on another job or move to a different company? If this position isn't prioritized within your plant, it may be given to someone with little experience or given to individuals new to the site in an effort to enhance their familiarity with the department equipment and processes. Either way, it's highly likely that they will be unaware of previous practices or the importance of the role they are stepping into. Is your site a company that practices Total Productive Maintenance (TPM)? If so, this tends to rely on team members from several different plant organizations (operations, maintenance etc.) to execute miscellaneous lubrication tasks. Consider that even experienced and well-trained individuals may have ancillary activities (home life, other work-related tasks etc.) on their mind while performing lubrication tasks, resulting in substandard performance. All of these are examples where variance can occur due to too many hands being in the pot, individuals not understanding the recipe and failure to stir in unison. We need to recognize this often-present gap and implement a comprehensive strategy to minimize these concerns.

When enhancing your lubrication program, there should be assigned roles and responsibilities along with qualifications for each of these positions. When developing this organizational structure, standardization of procedures should be taking place as well. Each specific lubrication task (and there are several) should be accompanied by a defined procedure.

These specific procedures should include:

- the purpose
- materials necessary to complete the task
- preparation requirements
- task setup
- line by line task execution instruction
- area for recording information
- detail regarding clean up

Additional information relevant to task procedures should include

- task type
- task name
- operation state
- estimated time of completion
- location of lubrication points
- frequency of occurrence
- volume

Addressing this level of procedural documentation within the lubrication program works to ensure that these practices are harmonized and carried out the same way from individual to individual, shift to shift and department to department, every single time they are performed.

Tasks Standardization to Applications

Once procedures are in place for specific lubrication tasks, the next area within Lubricant Handling and Application to focus on is standardization from the tasks to the specific application types. As mentioned earlier, there are several types of lubrication-related procedures that need to be developed into clearly identified tasks. These tasks can then be grouped by application type, with separate groups for categories such as lubrication replenishment, re-greasing and oil top ups, or equipment inspections, filtration and sampling.

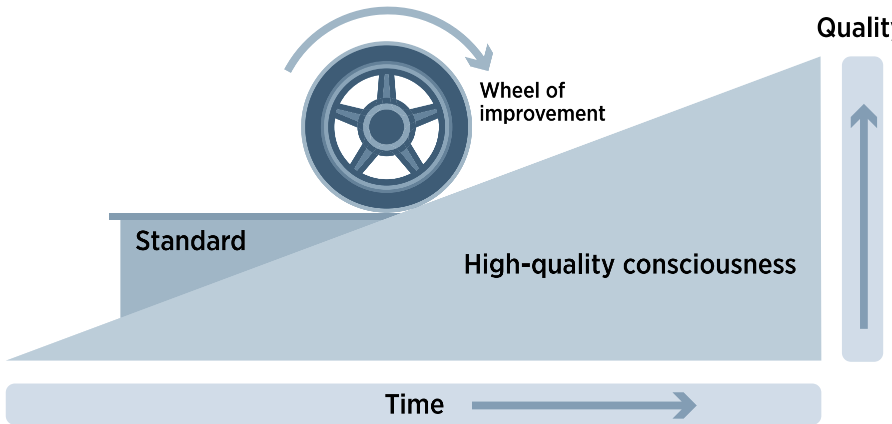
Most underdeveloped lubrication programs group these specific application types into assorted overall lubrication PMs or even part of other PMs not related to lubrication and instead associated with various other plant activities. It is during this process that sites lose sight of the importance of details, resulting in diminished value of the task at hand, compounding the variance in task performance. Once all standardized procedural tasks have been properly developed, they must be grouped in specific application-based lubrication PMs like the ones noted above. This should add precision to tasks at hand and maintain a level of definition within each group of tasks carried out.

Application Standardization to Assets

Finally, after developing standardized documentation processes for procedural tasks and application types, we begin to look at normalizing these application types in the form of PMs on equipment types in the field. Once again, it is all about minimizing variance in order to achieve lubrication excellence.

For equipment already present on the plant floor, a guideline should be developed for application types based on categories of components such as pumps, motors and gearboxes. While criticality and size can vary for each component type, the levels of execution can be put in place for small, medium and large assets alike. This information is often organized during the development of a corporate lubrication standards manual but can also be useful during Failure Modes Effects Analysis (FMEA) and Management of Change (MOC) documentation.

Similarly, there needs to be an established guideline for incoming future equipment as well. While the steps mentioned above can be utilized, an additional form of control with regards to employing application task types to inbound equipment should be implemented. One way this can be managed is with TPM measures in the form of Early Equipment Maintenance (EMM). Applying these documents and processes can aid in application type deployment of onsite assets and drive standardization of task execution.



Wrapping Things Up

In summary, when reviewing your site's lubrication activities, there may be numerous opportunities for variance during the **Lubricant Application Tasks (H1P)** processes. Identifying an improvement, formalizing these processes and acting on them with administrative measures will directly lead to minimizing overlooked downfalls in your program. Finally, do not forget to consider the fact that these techniques directly influence both standardization and process improvement, as well as deliver enhanced long-term site cultural development. ***ML***

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Jorge Alarcon | Bureau Veritas Global

The Bathtub Curve Applied To Gearbox Oil Analysis

What happens in the aging failure zone?

" The high solubility of varnish at different lubricant temperatures makes varnish contamination a complicated problem to tackle. "

In recent years, the term "industrial revolution" has taken on new meaning, and many of those involved in the world of maintenance have taken notice of this transformation. The Fourth Industrial Revolution, characterized by ongoing automation of traditional manufacturing and industrial practices, is yielding significant environmental and financial benefits, and it's clear machine efficiency will continue to progress even further over the next decade.

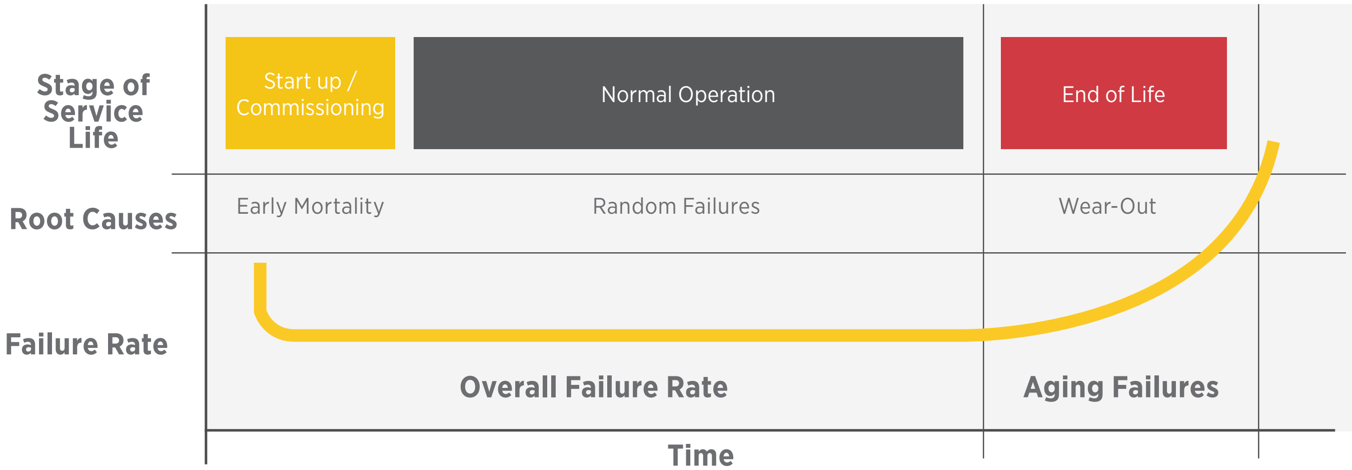


Figure 1: Bathtub Curve as a function of component wear

This whole interconnected future sounds wonderful and has the potential to take us into a new world where machines emit almost zero waste and have the capability of communicating the precise moment they need attention. Surely that day will come, although for that we will have to cross many deserts and shipwreck in unexpected places. Today, machines still suffer unexpected failures and millions of dollars are lost in downtime and whether in that marvelous new era to come or in the current one, machines will still age and will ultimately be replaced.

Those of us who have seen a machine/component fully degrade wonder what can be done to extract a few more service hours before the replacement. The most notable event of this type that I've experienced happened in the Bolivian highlands at an altitude of more than 13,000 feet above sea level. We only needed the machine to last 20 more hours (a little more than a day of operation) in order for the project completion costs to be kept to planned levels, but the oil leaks in the powertrain were nearly unstoppable. Using SAE 40 oil, consumption was over 50 liters per hour and the outlook was rather grim. It was at that moment that a senior technician, one who had lived through countless maintenance-related battles, decided to mix tar with the oil; the leaks were minimized and we reached the desired 20 hours needed to complete that part of the project.

Applying a chemically equal but higher viscosity oil is a common solution when the machine is approaching its end of life, as doing so reduces wear, leaks and friction. Under most circumstances, it is necessary that a machine continues to operate under a regime as close to ideal as possible in order for the operating line to be maintained without causing losses or breaks in production.

In the United States, the current average age of machinery depends on the industrial sector as well as its geographical location.

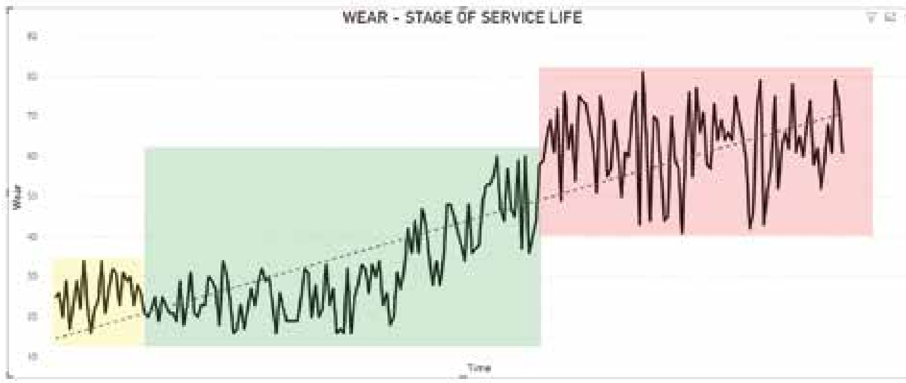


Figure 2: Iron (Fe) wear values from a set of samples of 63 gearboxes

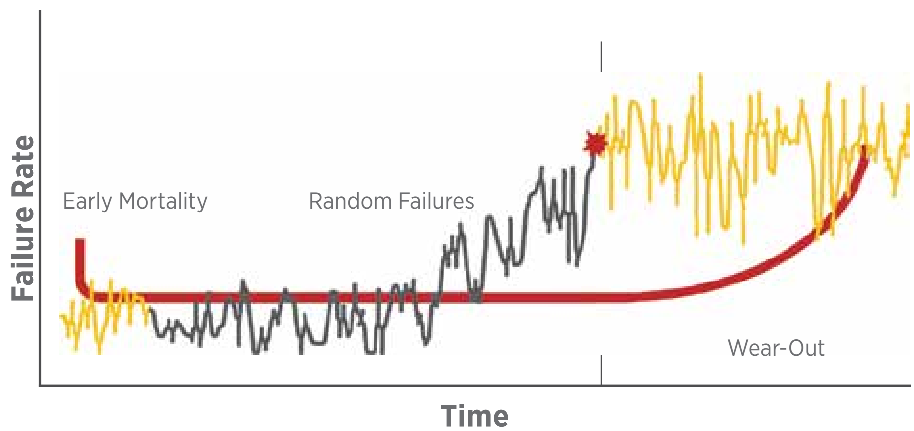


Figure 3: Iron (Fe) wear measured values updated to Bathtub Curve

There are sectors that come from an economic boom with an average machine age of close to ten years. However, at the other extreme are industries whose assets, such as gearboxes, began operating in the 1980s. In many cases, this machinery is under a predictive maintenance program that uses technologies such as vibration, thermography or oil analysis. When using oil analysis as a maintenance tool, it is relatively easy to set limits for component surface wear when the machine is in the flat phase of the bathtub curve. When we move to the sides of the curve, current data becomes less certain and it is very difficult to set those limits. In recent years, the bathtub curve has a short and simple initial stage, meaning the machines undergo a short premature life and enter full performance quickly. Additionally, due to all the technology available, we have been able to extend the service life of the machines, anticipating potential catastrophic failures and healing injuries before it is too late.

At the other end of the curve in question, we can see that the effects of proper maintenance, advances in component improvements and control mechanisms on machines have allowed their service life to be extended as much as possible, although in many cases this has a downside to predictive maintenance itself. What reasoning should be applied in the aging fault zone? Let's address this question using a case study.

Case study and field application

In 2016, with an approximate population of 80 gearboxes and good traceability of oil analysis reports as a maintenance tool, Industry "A" was aware that these machines were already close to completing

ELEMENT	NORMAL OPERATION		END of LIFE	
	VALUES	LIMIT	VALUES	LIMIT
Fe	34	60	76	
PQ	7	20	28	
Cr	2	4	5	
Zn	45	64	51	
Cu	3	5	12	
Si	12	25	28	
P	345	220	318	
PC	19/17/15	22/20/18	23/21/20	

Table 1: Oil analysis values of gearboxes

ELEMENT	NORMAL OPERATION		END of LIFE	
	VALUES	LIMIT	VALUES	LIMIT
Fe	34	60	76	**98**
PQ	7	20	35	**67**
Cr	2	4	6	**7**
Zn	45	64	51	**76**
Cu	3	8	12	**21**
Si	12	25	28	**41**
P	345	220	318	**308**
PC	19/17/15	22/20/18	23/21/20	**24/22/20**

Table 2: Limit values for the stage of the aging zone

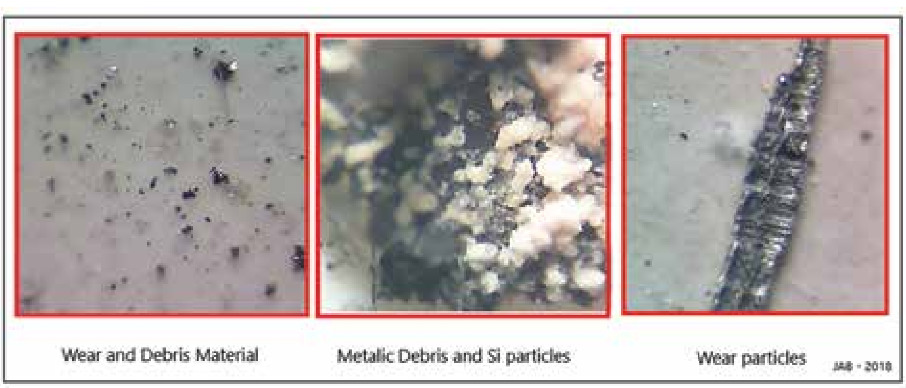


Figure 4: Wear and contamination under the microscope

their life cycle. Around 30% of this group of gearboxes showed signs of aging wear and the subsequent unscheduled downtime was directly related to aging failures. The remaining 60% showed evidence of following the same path as the previous group, and the last group did not show very aggressive signs of aging. The Planning & Scheduling department estimated that it would take between 5 to 6 years to replace all machines with clear signs that they had entered the final stage of their useful life (90%). This meant that it would be necessary to control and extend the life of the assets for the 5 to 6 years it would take to replace them.

Within this scenario, all predictive maintenance tools would need to be be used with an understanding of this stage in which the wear was high and the clearances of the machine had increased. This meant the critical limits of the machinery needed to be recalculated. The question is, how do we achieve new oil analysis limits according to the aging state of machines like this? How do we ensure that these new limits will not have a negative effect on the machinery and will allow it to function as normally as possible without suffering unscheduled downtime?

If we analyze the wear data measured as iron (Fe) throughout the service life of the most representative set of these machines, the 3 zones can be clearly observed from an operational point of view.

Superimposing the wear graph over the bathtub curve allows us to obtain an estimate of the most representative wear values measured as a function of time while also using the failure rate as a background, or what we consider closer to the gearbox potential failure that are part of this analysis.

So far we have laid the foundations necessary to demonstrate the benefits of oil analysis as a maintenance tool. If an adequate sampling frequency is followed and accompanied by a coherent analytical methodology, maintenance can take great advantage of this technique.

In the beginning of this article, we said that increasing the viscosity oil grade is one of the most applied practices if you want to keep equipment in service that has entered the last part of its service life.

In the previous graph, the inflection point where this practice is carried out can be seen and the high-risk zone is entered with the equipment still in operation. It is at the beginning of this inflection that it is necessary to rethink the limit values from the wear point of view, taking into account that the previous values are no longer adequate. Although the viscosity of the oil has increased significantly, in some cases the loads and the oil might increase during operation as well.

There are a couple of statistical methods for determining the new critical limits for oil when equipment enters the last zone of the curve. However, to understand these statistics it is necessary to apply the knowledge that is obtained over many years of reading oil analysis reports, visiting sites and knowing the machine performance and working conditions.

Based on this set of variables, it is possible to determine coherent limits that once again allow those maintaining the machine to use oil analysis as a tool to respond with necessary corrective actions. To define the new limits for iron (Fe), the following information is required:

- Unit wear rate

$$\frac{W2 - W1}{T2 - T1}$$

- Average of the wear rate of the components analyzed and compared with a much larger database

$$\left\{\sum_{1}^{n} \frac{W2 - W1}{T2 - T1}\right\} / n$$

- Comparison of distributions of the analyzed components and comparison with a much larger database

Thus, we obtain new critical limits for the end of the component's service life. Each of the elements represented in Table 1 and Table 2 has previous analysis not only from the statistical point of view, but, as mentioned before, a comprehensive analysis from the point of view of lubrication and component wear. Each of these elements behaves differently and must be treated as such. For example, the variation and limits determined for an element such as iron (Fe), should not be applied to other elements, since their presence depends on the alloy or the type of component on which the analysis is developed.

Additionally, it is important to take into account that the values reported as Particle Count (PC) do not refer only to the solid contamination that may exist in the oil at this stage, but may also indicate the generation of wear particles, which play a much more important role. It's also notable that solid contamination, measured as Silicon (Si), doesn't appear to be of concern in this case since in most of the analysis carried out under the microscope, it was observed that the Silicon particles are much smaller and less harmful than the metallic particles typical of component wear.

Once the critical limits for oil analysis have been determined, it is necessary to continue with the rest of the tasks related to the lubrication of the machines. Among these, the most important are:

- **Sampling frequency** — In the flat phase of the bathtub curve, the sampling frequency was quarterly. In this case, the frequency is increased to bimonthly. It is possible to reduce some tests such as the water determination by Karl Fischer ASTM D6304 and TAN ASTM D664 to a less frequent interval, and only include these analyses in every forth sample.

- **Filtration tasks** — This is one of the most critical tasks during the aging phase. It is necessary to take into account that the most significant change is the increase in size and quantity of the wear particles. This indicates that the consumption of filters is much higher, that there is much more solid material that the filter must retain and with an additional conditioning factor and that the viscosity of the oil has increased by at least one degree, or even two degrees in some cases. This also implies that some filter carts that were already in operation probably need to be replaced or require some modification to be able to work with higher viscosities.

- **Desiccant filters** — Due to the increase in clearances in certain parts of the machinery, it has been noted that the desiccant filters have reduced their service life by around 30%. This is quite logical, since increasing clearances allows moisture to enter more easily, contaminating the oil at a higher rate than normal and exhausting the desiccant material in the filter more quickly. ***ML***

About the Author

Jorge Alarcon l Bureau Veritas Global Technical Manager, OCM

Reliability engineer, laboratory operations manager, project manager, researcher, and consultant in the power generation, manufacturing, and wind power industries, among others.

Extensive knowledge of the European and American predictive maintenance markets. Complete technical support to the client, focused on improving plant reliability through oil status monitoring, lubrication best practices and digital transformation strategies.

David Dise | Noria Corporation

Factor: C3M

The Ultimate Guide to Contamination Exclusion

"When machine parts and the lubricant protecting the machine's internal surfaces are exposed to contamination, it is like pouring gasoline on a lit fire."

Keeping possible contamination sources away from lubricated equipment is the best line of defense against contaminants entering machine parts. It is significantly more difficult and expensive to remove contaminants from the system than it is to modify and protect equipment against contaminant ingression in the first place. I am not saying build a bubble around every piece of equipment, and in some industries this would be impossible. Instead, contaminant exclusion is aimed at modifying equipment to protect it from water, solid particles, high temperature environments, chemicals, product and other contaminants from entering the machine. Or, even better, from ever contacting machine surfaces. Rotating equipment is already challenged by internally generated abrasive particulates (such as wear debris). It only makes matters worse when contaminants are free to enter from the outside.

Figure 1. Temporary solutions can turn into catastrophic contamination. The picture shows the oil reservoir hatch opened with a hose running directly into the reservoir.

The Risks of Contamination

When machine parts and the lubricant protecting the machine's internal surfaces are exposed to contamination, it is like pouring gasoline on a lit fire. The lubricant that should be protecting these metal surfaces is now having to fight against contamination as well. Additives meant to emulsify water, envelope particles, disperse foam, and even improve the lubricant's viscosity index are now in overdrive trying to compensate for the additional harm caused by incoming contaminants. Over time, the additives will deplete at an increasing rate, and the oil will become less effective at protecting metal surfaces. As the oil becomes more contaminated and finally loses its lubricating characteristics, machine parts will start exhibiting premature wear. When machine parts start to fail, it's like tipping

Figure 2. Use protective covers and wipe down quick connect fittings before attaching any equipment.

Figure 3. The bowl on the left show's sediment buildup and the bowl on the right shows water buildup. Bottom Sediment & Water bowls are a key tool for recognizing a problem exists and excluding the problem on the spot.

Figure 4. "Water will find a way" Keep standing water away from machine parts. Do not let a small water leak or containment drain problem destroy machine parts.

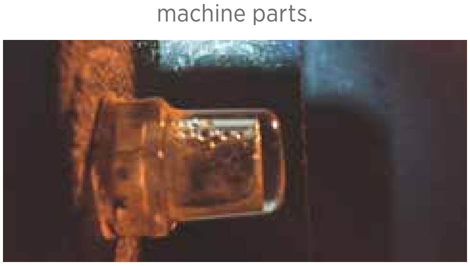


Figure 4. Keep oil levels tight. Allowing oil levels to drop will create more condensation as you can see from this picture.

over the first domino in a row. It only takes one domino falling to catalyze a chain reaction down the line and cause the rest to fall. Protecting all equipment down the line is critical. You cannot just protect the critical gearbox or expensive bearing from contaminants while leaving the oil reservoir that is feeding the system in a dark wet corner with dust and debris piled on it. I have seen this more times than not—where the components of the machine are modified, protected and clean from contamination, but the oil reservoir feeding the equipment is neglected. It's important to consider the state of the entire lubrication system. Next time you can, walk the length of a system at your facility and verify that every component down the line is being protected from contamination ingression. The last thing any company wants is machine failure that could lead to downtime and loss of production.

Water Contamination

Throughout my years, I've worked with many different industries. The most common lubricant or machine contaminant I have found is water. This is likely because water is used throughout the process in almost every industry. Water is used for cooling machines, cooling the oil in machines, mixing with product and cleaning the equipment and facility. Of course, water can also come from rain, snow, or condensation from humidity. When equipment heats up then cools down, condensation will start to form in the headspace of equipment. Over time, that condensation adds up and we all know what happens when you mix water, heat, air and metal. The oil will oxidize quickly, eventually destroying the lubricant and the equipment if left untreated.

How to Detect Water Buildup

One way to monitor equipment for water buildup is to utilize a bottom sediment and water bowl (BS&W Bowl). This is a clear, often cylindrical sight glass that is installed on the bottom side of the oil reservoir or lowest drain, allowing water and other contaminants to naturally settle inside the cylinder for quick visual inspections. Not only does the BS&W bowl allow you to visually inspect what is happening inside the reservoir or sump, but it often has a valve that allows you to drain off or exclude any water or sludge that may have accumulated over time. I would recommend installing a BS&W bowl on all large reservoirs, especially reservoirs utilizing an oil cooling system. These oil cooling systems are the most common source of water contamination on large systems. I always recommend that plants have all oil cooling systems on a routine changeout. Some might think this is excessive, but spending the little bit of time and money is pennies compared to what happens if water is introduced into the system. Cooling systems will start rusting from the inside and eventually water will start leaking into the oil reservoir or sump, contaminating the oil. With no way of being able to perform a visual inspection on oil coolers, using a BS&W bowl on the oil reservoir can allow you to catch a leak and exclude water before it becomes catastrophic.

Managing and Eliminating Water Contamination

Water is used throughout the process in almost every industry, so figuring out ways to manage water is important. Some of the ways I have seen water enter machine parts almost seems impossible. I like to say, "water will find a way." Modifying, building barricades, training your staff and making sure equipment seals and gaskets are fresh and tight are all measures you can take that will help exclude water from the system all together. You should also begin a "No Leak" initiative and fix all the seal water leaks or any other water leaks throughout the plant. Make sure water drains are clear of any debris so water does not pool around and make contact with machine parts . Seal water

> Controlling the amount of contamination on and around machine components should be a top priority.

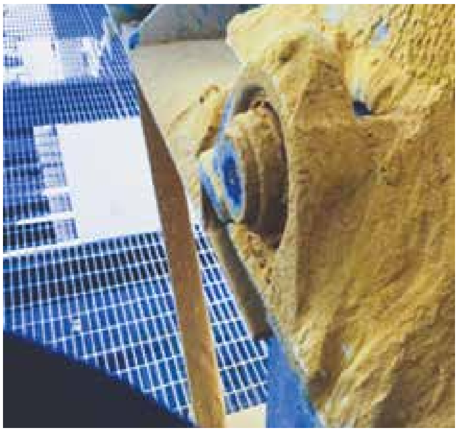


Figure 5. "Stop the domino affect" Repair, modify, or replace equipment before contaminants spread throughout the plant.

and cooling water is important to the process and is what helps us protect our equipment. Performing routine leak inspections on all water lines and fixing any leaks will help exclude water from entering the equipment. Some machine parts have oil spill containment underneath to catch spilled oil. What I have noticed is that most of these machines also have cooling water running to the shaft. The cooling water is usually not contained and is either leaking onto machine parts or leaking into the containment underneath and eventually filling the containment with water. Without draining the containment, the water will just sit and eventually find a way into machine parts and will also begin rusting base mounts. Even worse, if there is an actual oil leak, the oil will drain into the containment mixed with water and overflow, creating an environmental concern. Try to exclude all water contact with machine parts except for necessary washdowns.

Performing washdowns on machine parts is tricky. We want to keep our equipment clean without contaminating the lubricant in the process. I cannot tell you how much damage I have seen from people spraying down equipment. Training and machine guarding is the best line of defense. Anyone spraying down equipment can cause damage if they don't know what to spray or how to spray; this is why training is so important for anyone holding a hose. The last thing you want is a 100 HP motor being sprayed down with high pressure hose. Adding modifications like spray shields on or around equipment is another way to stop water from entering machine parts during washdowns. Installing wash down caps on breathers and making sure all gaskets are sealed tight is also important on oil reservoirs in heavy washdown or water prone areas.

Water can enter the system from a plethora of outside sources, but water can also come from within. Condensation is another contamination problem that is often overlooked. Left unchecked, it can be a silent killer inside equipment that is in use as well as equipment not in use. Condensation is generated from humid air inside the oil reservoir or bearing housing during temperature swings. When hot, humid air cools down, the water molecules turn into water drops on interior surfaces.

The water droplets form on the unsubmerged areas of the reservoir housing and, when heavy enough, drop or slide into the oil. This is where a BS&W bowl can be a life saver. The BS&W bowl will give you an indication that there is excessive water present, and you can drain it off right away. On equipment that might be stored for extended amounts of time, it is often recommended to fill the reservoir with the recommended oil to the top. This will prevent condensation forming and will inhibit rusting while in storage. You should also ensure that the equipment is sealed with plugs to prevent air from entering during storage. When reservoirs are filled, you should always label the equipment with "Full" or "Drain Before Using" so that the next person can identify that the reservoir is full before installation. Using desiccant breathers is another way to control the amount of moisture being pulled in and out of the machine during normal operation. Some machines are in high-humidity areas and should have desiccant breathers installed to minimize these airborne contaminants from entering.

If condensation is uncontrollable, then using a filter with water capturing capabilities might be the route to take. Filters and dehydrators can be used for removing water from the oil in the system and may be effective at preventing subsequent failure if done quickly enough. Otherwise, if water is inside the system for too long, it is likely to cause damage. As I said at the beginning, eliminating the contamination problem before it enters the system is always cheaper than having to remove it, so focus on exclusion first and use removal techniques only if moisture cannot be prevented from entering the system.

Solid Contamination

Solid contamination is easily preventable with just a few easy modifications, training and corrections. Solid contaminants can enter machine parts and reservoirs through a variety of pathways or points on equipment. They can even exist in machine parts from the factory. Here's a word of advice: always flush equipment before installation or during the commissioning process and shortly after first start-up. Metal pieces produced during the manufacturing process could be stuck inside the reservoir housing, gears, or bearings. Flushing the reservoir will hopefully remove any large metal fragments trapped inside. Using magnetic plugs is also a great way of visually inspecting the ferrous metal concentration built up inside the machine housing. You should also anticipate that wear particles could be generated during early service as machines are running-in and you should be filtering them out appropriately.

Managing Particle Buildup

Controlling the amount of contamination on and around machine components should be a top priority. The more contamination you have surrounding your equipment, the more contamination you will have inside it. Product or dust buildup on equipment will also serve to insulate the machine, which can cause excessive heat to be generated. I see it time and time again: customers ask why the particle counts are so high on the oil analysis reports. During my investigation, I walk along the effected equipment and notice product piled high around the machinery and blowing everywhere because of a compromised fan duct or a broken conveyor belt dropping product from above. These are all things that can be fixed or prevented. Recalling the "domino effect" I mentioned previously when product or dirt is allowed to become airborne and blows around everywhere, it's likely that multiple pieces of equipment have now become contaminated.

A little oversight and simple proactive repairs can prevent a small hole or busted conveyor belt turning into a catastrophic shutdown. Installing covers or proper ventilation will help prevent contaminants from building up on machine parts. Performing normal housekeeping on equipment is essential to effective contaminant exclusion. This includes making sure debris does not pile up around fill ports, breather ports and hatches. When filling or inspecting equipment, dirt and debris that are allowed to pile up around these ingression points can easily fall into the reservoir or onto a lubricated surface. Keeping these areas clear of possible contaminants greatly reduces the risk of ingression during regular maintenance and inspections.

Atmospheric conditions are hard to control because they can change with the drop of a hat. You cannot predict when the next water line will bust, or fan duct will pop a hole. You can protect against these unforeseen problems by having systems in place to protect your equipment before and during these failures and by being creative and proactive when thinking about the modifications needed to protect your equipment. Contamination exclusion does not have to be hard or expensive. It takes pre-planning and a willingness to protect machine parts from contamination. Remember, taking the necessary steps to protect equipment from contamination will pay off in the long run and prevent that first domino from ever falling. ***ML***

About the Author

David Dise is an to Associate Technical Consultant for Noria Corporation. He works closely with plant managers and reliability engineers to develop lubrication and reliability programs. His goal is to help plants become world class. David has been certified as a Level II Machine Lubricant Analyst and a Level I Machine Lubrication Technician by the International Council for Machinery Lubrication. Before joining Noria, he worked as a flowback operator at 1st Rate Energy Services, traveling to several different locations around the United States.

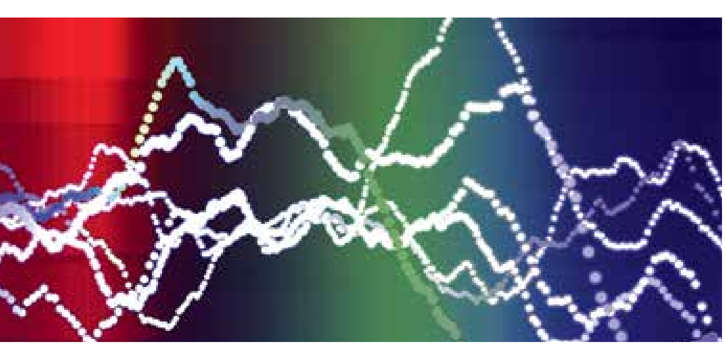
Michael Viset, Hydrocarbon Consultant | Frederik vand de Voort, McGill University

Universal Acid Number (AN) Determination Using FTIR Spectroscopy

> Current direct-read chemometric instrumentation serves as a "better than nothing" approach with limitations which are rarely grasped by users."

Traditionally, acid number (AN) has been measured by direct-read instruments reliant on chemometrics.

However, conventional Fourier-transform infrared spectroscopy (FTIR) spectrometers used for condition monitoring can now also be used for AN determination. This can be done by adding a spectrally active base to an oil to neutralize the acid and determining the unconsumed base spectroscopically. Unlike direct read instruments, the FTIR method is independent of oil type, does not require the use of chemometrics and can differentiate between weak and strong acids. With FTIR, AN testing is faster, uses much less reagent and is more precise than ASTM titration. This is especially true in the 0-2 AN range typically found in used turbine, hydraulic and compressor oils. The method is great for onsite condition monitoring (CM) labs and provides an alternative to potentiometric titrations while still reporting accurate ASTM-equivalent AN data.



FTIR in Condition Monitoring (CM)

Using FTIR based on the ASTM E2412 CM practice, the ASTM D7214-20 is the FTIR method for determination of oxidation using the carbonyl C=O group, formed when the lubricant combines with oxygen from the air. These are predominantly organic acids, but also include ketones, aldehydes and esters. The measurement is considered a rough acidity screen and requires confirmatory titration (ASTM D664 or D974), particularly in combustion applications where inorganic acids are also formed. Currently, the only FTIR AN determinations are chemometric-based methods, the most common using direct, neat-oil instruments. Another is the diluted-oil stoichiometric procedure used in high-volume laboratories. Both are problematic since they are not universal and are reliant on "Library Calibrations" or additional chemometric modeling to obtain results. Due to shortcomings like this, all have diminishing veracity, particularly if the wrong oil type is assigned.

Direct-read FTIR instruments target users with extensive machinery infrastructure requiring on-site monitoring of in-use oils rather than sending samples to a commercial CM lab. Aside from conventional ASTM FTIR, the instruments relate the spectra collected using ASTM protocols to titrimetric AN data of in-use oils representative of a particular oil-type, class or family. The results determined are not part of the sanctioned ASTM method.

Users rarely validate AN results

and assume that the "Library Calibrations" will perform adequately, in part relying on its linkage to the ASTM protocol (e.g., D7418), which ultimately does not involve AN as part of its specifications. However, with no practical, reliable and rapid alternative to estimate AN (or BN), there has been little choice for users but to rely on potentially flawed chemometric direct-read FTIR technology as a determinative assessment without follow-up titrimetric confirmation.

Stoichiometric AN by FTIR

The concerns noted above have led to the development of a manual stoichiometric AN method which overcomes the limitations inherent to the chemometric approaches currently in use. This was prompted by the need for both onsite CM monitoring as well as concurrent determinative AN analyses in a remote mining site in Papua New Guinea. With potentiometric titration not being an option and direct-read AN systems considered inadequately deterministic, the automated stoichiometric method was re-examined and reconfigured. The FTIR unit selected for this work was a compact Agilent 5500t with an open architecture TumblIR® accessory (Figure 1), requiring only a few drops of sample and simply wiped between analyses. The method reconfigured was once used for edible oil analysis where high analytical throughputs were not paramount, but accuracy was. This used a paired split-sample approach which involves some additional sample preparation, but its benefits are substantive, including:

- Independent of oil type
- Avoidance of chemometrics
- Facilitating acid type differentiation (strong vs. weak)
- Robust analytical rate of ~20 samples/hr.

Calibration

The method employs pure oleic acid as a primary calibrant added at various levels to a neutral hydrocarbon oil for calibration standards. Each standard is split and a reagent-free solvent-diluent is added to one part (Ion) and a reagent-diluent containing NaPhenolate added to the other (In). These are scanned as a sequential pair, the first a background scan followed by the sample scan producing a differential absorbance spectrum, -Log (In/Ion) = ΔAbsn. This process gives rise to two measurable signals (changes in NaPhenolate and oleic acid absorptions) which facilitate AN determination as well as acid differentiation (see Figure 2) in real samples.

Generic Implementation

With access to basic spectral data collected by an FTIR, there is little to differentiate instruments. The main bottleneck is data processing, calibration, prediction and reporting. These limitations have been greatly improved by SpectraGryph®, a free, generic, post-spectral data processing software package. It is powerful and easy to use in this application and when combined with Excel, facilitates calibration, prediction and reporting of results for on-site AN analysis.

Implementation

Basically any FTIR equipped with a standard flow cell loaded by aspiration or an open architecture accessory can be used. Preparing only two 2.5 ml samples (sample-reagent-diluent and sample-blank-diluent, prepared with 1:4 oil:diluent ratio) was more than sufficient using a 100 µm "wipeable" TumblIR® accessory integral to the Agilent 5500 used and handled as per the protocol presented in Figure 3.

For both calibration and sample analysis, the 2nd derivative differential spectra were used and measured for the NaPhenolate absorptions at 1589 cm-1 (Figure 4a) and related by linear regression to the mg Oleic Acid/ml (Figure 4b) which represents total acidity (AcidityTOTAL). Similarly, the COOH signal available (~1710 cm-1), representative of weak acids (AcidityCOOH) present in unknown samples was calibrated. Both acidity values are converted to mg KOH/g (AN). In AN terms, the calibration precision (Figure 4b) is < ±0.10 over a range of 0-4 AN. With these two AN measures, the strong acids can be determined by difference:

$$AN_{STRONG} = AN_{TOTAL} - AN_{COOH}$$

This additional acid differentiation capability may be useful in gauging the relative corrosiveness of oils, especially if combined with moisture information.

Performance

The methods' performance are illustrated in Figure 5, where an oxidized mineral oil containing both weak and strong acids has been serially diluted with acid-free, ester-based oil. The ANTOTAL and ANCOOH values for blends were determined and plotted as a function of dilution. Both measures track linearly even though the spectral signature of the oil varies continuously by mixing the two dissimilar oils in differing proportions. Even so, the method succeeds in tracking AN because each sample analyzed serves as its own reference. The oil matrix changes are accounted for and ratioed out accordingly, leaving only the spectral changes associated with the acid-base reaction to be measured. All competing chemometric-based FTIR methods would fail this test as the spectral changes induced cannot be modeled or anticipated. As such, it addresses their key limitation: the need to know the oil type and to have modeled it in advance in order to have any hope of estimating AN. Even in the best of circumstances, the predicted AN is an approximation without even considering common confounding issues.

Conclusion

Conventional titrimetric AN and BN methods are slow, expensive and environmentally problematic. They also have no determinative ASTM-sanctioned FTIR AN methods available. Current direct-read chemometric instrumentation serves as a "better than nothing" approach with limitations which are rarely grasped by

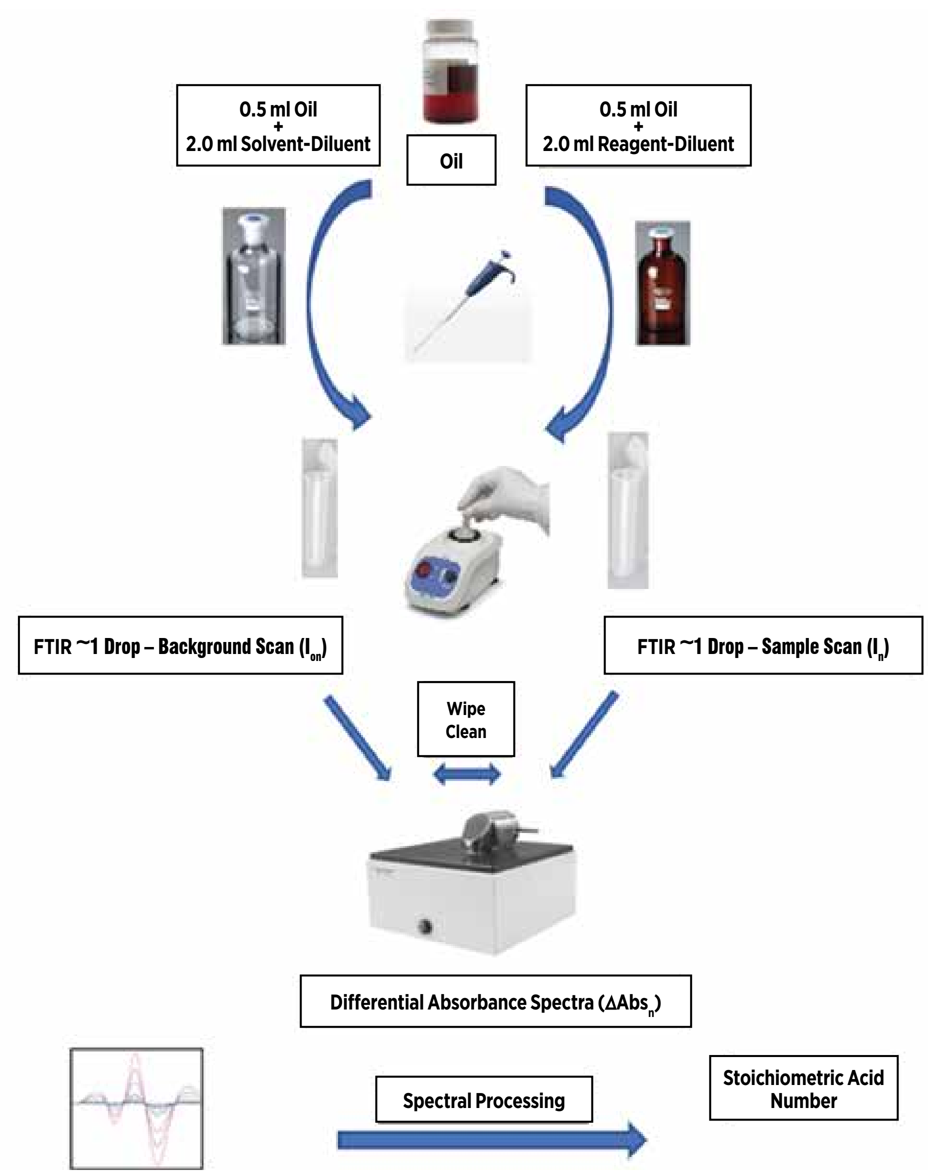


Figure 3. Basic analytical protocol used the paired-split sample calibration and analysis

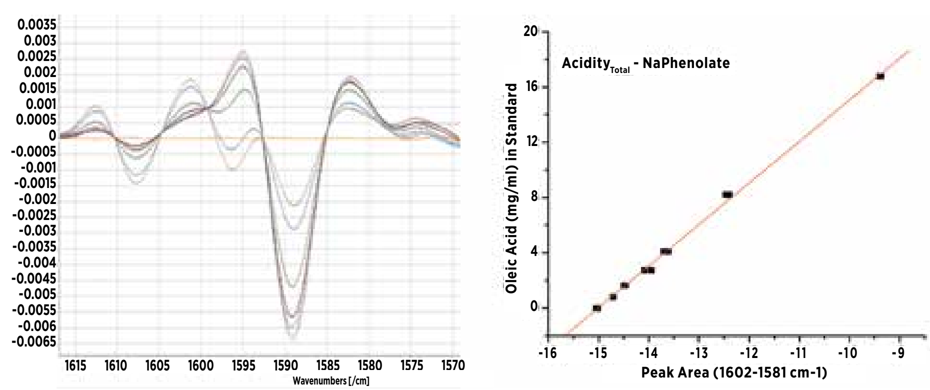


Figure 4ab. 2nd derivative spectra of NaPhenolate and its plotted absorbance response to added oleic acid i the calibration standards. Range ~ 0-4 AN, SD < ±0.10 AN.

users. In contrast, this new stoichiometric AN method provides a robust alternative and uses a readily understood Beer's Law cause and effect calibration, oil-type universality and ready validation as well as acid type differentiation.

Generic implementation via SpectraGryph® is available, and more substantive details of the methodology are to be presented elsewhere. Its lower cost, higher speed, better accuracy and minimal waste-stream are significant benefits over ASTM titrimetric procedures. Early adopters should consider involving ASTM or ISO to further assess, validate and standardize this methodology to fully define and characterize its benefits, especially its acid differentiation feature. ***ML***

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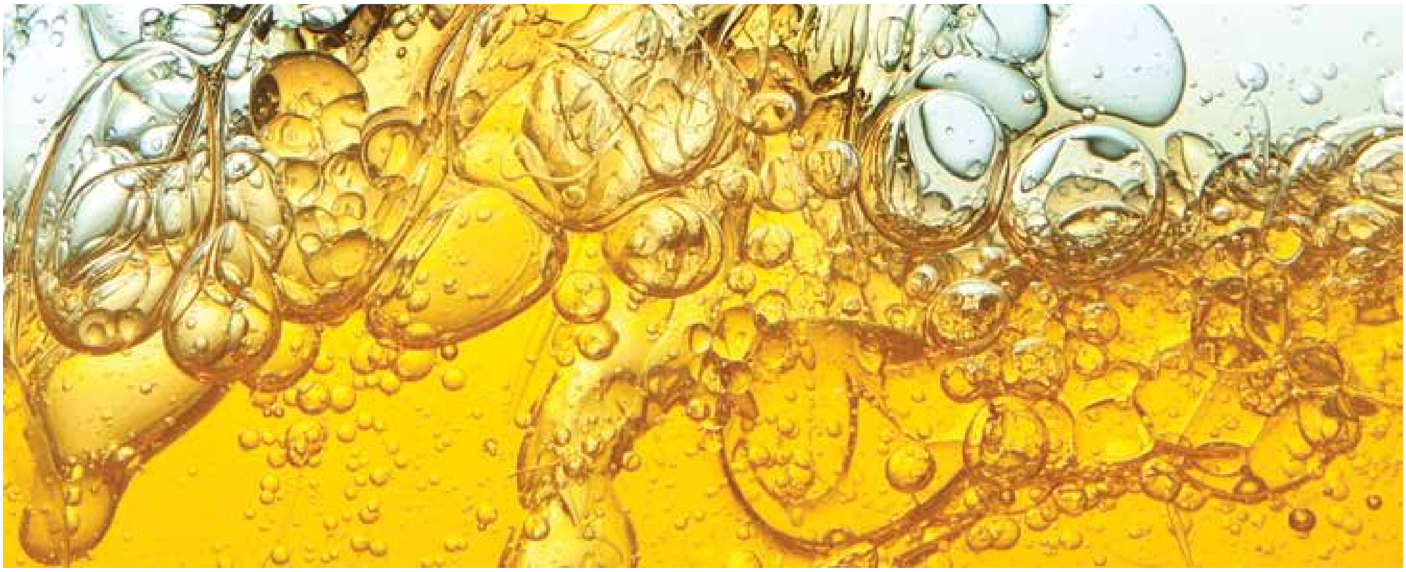
About the Authors

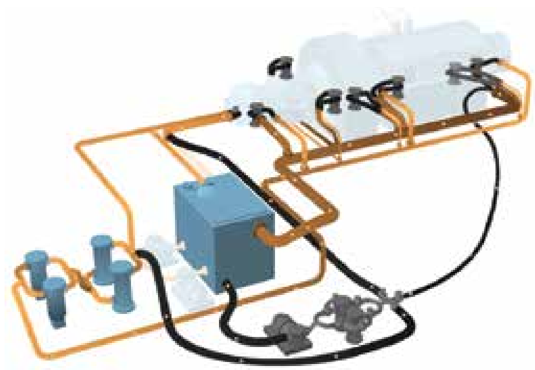
Michael Viset is a hydrocarbon consultant located in Australia and was instrumental in initiating the development and vetting the manual FTIR AN method and its implementation for onsite analysis at the OK Tedi mine in Papua New Guinea. Dr. Frederik van de Voort is Emeritus Professor at McGill University in Montreal, QC Canada and has been involved in developing quantitative FTIR analytical methods for lubricants and edible oils.

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



How Water Contamination Affects Oil Viscosity

It’s important to understand what can happen to the viscosity of an industrial lubricant, such as hydraulic or gear oil, when it is contaminated with water. A common misconception is that the water will reduce the viscosity of the lubricant. In fact, if an excessive amount of water is “whipped” into the oil in such a way that it forms a stable emulsion, the viscosity can increase, sometimes dramatically so. The oil/water emulsion will not lubricate as well as clean, dry oil. Not only that, but the viscometrics of an emulsion are different than that of oil, so other problems such as poor valve response or high-pressure drops across filters can occur.



Bearing Lubrication Caution

It is important that rolling-element bearings lubricated by an oil circulation system do not rotate at any time in the dry condition, especially after a long period when most of the oil will have drained away from the bearing. Rotation under this condition can cause severe damage to the rolling surfaces. This situation may be avoided by ensuring that the oil pump, which supplies the oil to the bearings, is started before the machine drive system is put into operation.

Check Makeup Valves in Oil Sumps

The oil sumps of modern gas engines are getting smaller while the power outputs are increasing. This puts increased stress on the oil in circulation. Many sump levels are controlled automatically by makeup valves. Check the setting of these valves, as they can often be set low, which means you do not get the full charge of oil in the sump and face shorter drain periods. Also, make sure you drain the oil cooler as well as the sump during the oil change, as there is often a considerable amount of old oil (up to 10 percent) held in the pipework just ready to contaminate your fresh oil.

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

ICML Marks 20 Years of Machinery Lubrication Certifications and Support with Special Activities

To provide your feedback to ICML or to pursue a certification or recertification, contact the organization via its website at lubecouncil.org.

The International Council for Machinery Lubrication (ICML) marks its 20th anniversary of continuous operation this year with several ongoing activities and recognition opportunities.

The nonprofit organization began its longstanding certification program for lubrication and oil analysis practitioners in January, 2001. Since then, ICML has administered thousands of exams and has supported individuals and organizations through additional programs that strengthen machinery lubrication and oil analysis as technical fields of endeavor.

Anniversary activities this year will include special pricing offers and advertising opportunities, multimedia profiles of longtime members and certificants, and a redesign of the ICML website and online support tools. Details and updates regarding these activities will be posted to ICML's website and social media channels throughout the year.

"ICML's twenty-year history is one of team effort," says Leslie Fish, ICML Executive Director. "We certainly would not be where we are today without our members and volunteer experts, nor would we be so well known were it not for partnerships and alliances with like-minded industry groups and independent training partners all over the world. With our celebratory activities this year, we hope to draw attention to their contributions."

Rosania Kloss, ICML's Operations Manager, concurs: "As someone who has been with ICML since the beginning, I am excited to see practitioners continue to appreciate what ICML has to offer."

Established in part to help lubrication practitioners succeed in their professional careers, ICML conducted its first exam when five oil analysis practitioners gathered on January 26, 2001, to earn their Machine Lubricant Analyst credentials in Biloxi, Mississippi. (They all passed.) By mid-April ICML had launched its second exam type to test machinery lubrication technicians. ICML went international with its first overseas exams in the UK and Australia later that same year, then expanded into multiple languages in early 2002, and they haven't looked back since.

In its first 20 years the organization has coordinated with a large network of independent training providers and allies to administer almost 40 thousand certification exams in nearly a dozen languages at over 48 hundred exam sessions across the globe. During this time, ICML issued 24 thousand professional certificates to oil analysts (MLA), lubrication technicians (MLT), laboratory analysts (LLA), and machinery lubrication engineers (MLE).

"The ICML fulfilled a previously unmet need in the field of lubrication and oil analysis," says Noria Corporation CEO Jim Fitch, ICML's founding director and a current board member. "It serves the working class of our industry, people who nurture the health of expensive and critical machinery."

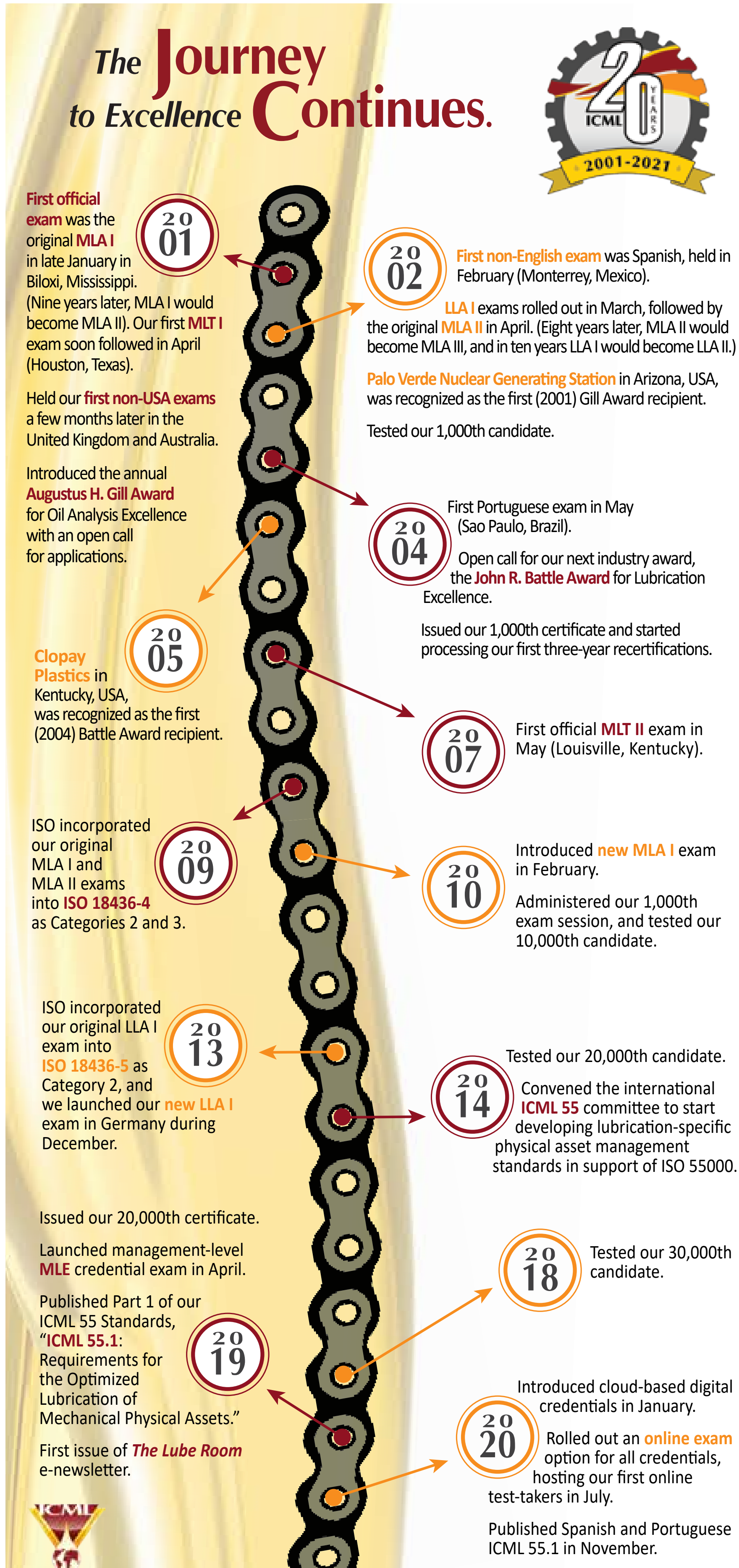
"Through certifications, ICML has provided a vital measure of lubrication fundamentals to our industry, and this has enhanced the professionalism of its practitioners," notes ICML Board Chairman Bryan Johnson of Arizona Public Service.

When local governments worldwide implemented restrictions on physical gatherings due to the 2020 Covid-19 pandemic, ICML quickly pivoted to develop online exam options, rolling out this new opportunity last July.

"Twenty years ago, our founding members recognized the integral but underrated role of lubrication practitioners in the broad scope of machine maintenance and reliability," says Paul Hiller, ICML Marketing Manager. "But the journey to excellence should never end. So, it was important to us that we continue supporting our certification candidates and our training partners alike—and the online exams allowed us to do that."

Beyond Certifications

ICML consists of members, professional staff and technical contributors from around the world. In addition to maintaining its fundamental role as a certification body for



20 years, ICML also oversees industry awards, professional memberships, and asset management standards.

ICML implemented its annual awards program in 2001, recognizing physical plants with the Augustus H. Gill Award and the John R. Battle Award for on-site programs that demonstrate oil analysis and machinery lubrication excellence, respectively. Past winners are listed at https://info.lubecouncil.org/awards/.

Membership packages were revamped in 2019 and offer flexibility, benefits, and engagement opportunities for organizations and certified individuals who wish to support ICML's mission, gain promotional exposure, collaborate with peers, and secure exam credits.

ICML engages subject matter experts to serve as technical volunteers on standing and ad hoc committees in such areas as test development, membership development, and awards assessment. To date, the crowning achievement of the volunteer force has been the simultaneous development of the ICML 55® Standards and MLE credential for machinery lubrication engineers.

"For twenty years, ICML has been playing an increasingly impactful role in standardizing machinery lubrication practices across industries with industry experts and volunteers," states ICML Board Member Yuegang Zhao of KPM Analytics, "especially after releasing the industry-first lubrication standard—ICML 55—and MLE certification in recent years."

The ICML 55 Standards comprise requirements and guidelines for effective, certifiable management of lubricated mechanical assets. These standards are strategically aligned to ISO 55000 and are intended to support an organization's physical asset management plans. Part 1 was co-authored by an international team of 45 technical contributors and was published in 2019: "ICML 55.1: Requirements for the Optimized Lubrication of Mechanical Physical Assets."

ICML developed its management-level MLE credential in conjunction with ICML 55. The extensive, 24-part body of knowledge targets reliability and asset leaders. To date, this rigorous, exclusive credential has been earned by fewer than 100 practitioners worldwide.

ABOUT ICML

ICML is a vendor-neutral, member-based, technical nonprofit organization serving global industry since 2001 as the world-class authority on machinery lubrication that advances the optimization of asset reliability, utilization and costs. ICML consists of both paid professional staff members and volunteer committees. It is a certification body serving industrial lubrication and oil analysis practitioners worldwide; a technical awards body recognizing companies that excel in oil analysis and machinery lubrication programs; and the developer of ICML 55 standards for lubricated asset management. Please direct media inquiries to Paul Hiller, ICML Marketing Manager, paulh@lubecouncil.org, 918-615-6575.

Masterclass in lubricants blending and quality assurance

Masterclass in lubricants blending and quality assurance was conducted from 20th to 23rd September, 2021. This 4 day training course provides an in-depth understanding of the principles, economics and flexibility of lubricant blending plants and how to operate a lubricants blending plant efficiently and economically.

This course lets you learn from anywhere around the world. If you get a chance to attend our training you would agree with us that our trainers are industry experts and are extremely passionate about teaching. Our trainers address all your queries, provide complete guidance, and are flexible to customize the course content as per your requirement. The training also included engaging pre, post and daily assessment tests.

Oil Analysis Fundamentals - MLA II

Oil Analysis Fundamentals which is equivalent to ICML's Machine Lubricant Analyst Level II (MLA II) was conducted from 23rd to 26th Aug, 2021. This 4-day training has combined power of in-person interaction and coaching with online convenience. This program covers topics like foundational to advanced oil analysis information including oil sampling, lubricant health monitoring and much more.

It's conducted by ICML certified trainers and includes ask me anything session by our experts. This training helps you and your teams learn faster, refresh your knowledge for ICML exam preparation and apply new skills at your workplace. The training also includes engaging pre, post and daily assessment tests. We are proud that many of them were happy with their experience. Just scroll below to see a few comments from our participants.

M. Wasantha Pushpakumara,
Assistant Technical Manager,
Chevron, Colombo,
Sri Lanka

Really good for those who need overall machinery lubrication fundamentals

Satya Chakra
Ferrography analyst,
Predict Technologies, India

This is a very useful training program for all guys who are involved in industrial lubrication related things, and also it is a very good session for ICML examination preparation.

Expand your skills from the convenience of your home or office with Noria's Live Online Training. Featuring the same benefits of live Instructor interaction and the convenience of learning in a comfortable setting, Live Online Training is conducted by industry experts with years of experience.

2021 ONLINE TRAINING CALENDAR

Machinery Lubrication Engineer (MLA II)
25-30th Oct.

Essentials of Machinery Lubrication (MLA I / MLT I)
22-25th Nov.

Oil Analysis Fundamentals (MLA II)
13-16th Dec.

Advance Oil Analysis (MLA III)
20-23rd Dec.

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Official Certification Training Partner of ICML

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