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May - June 2024

Machinery Lubrication

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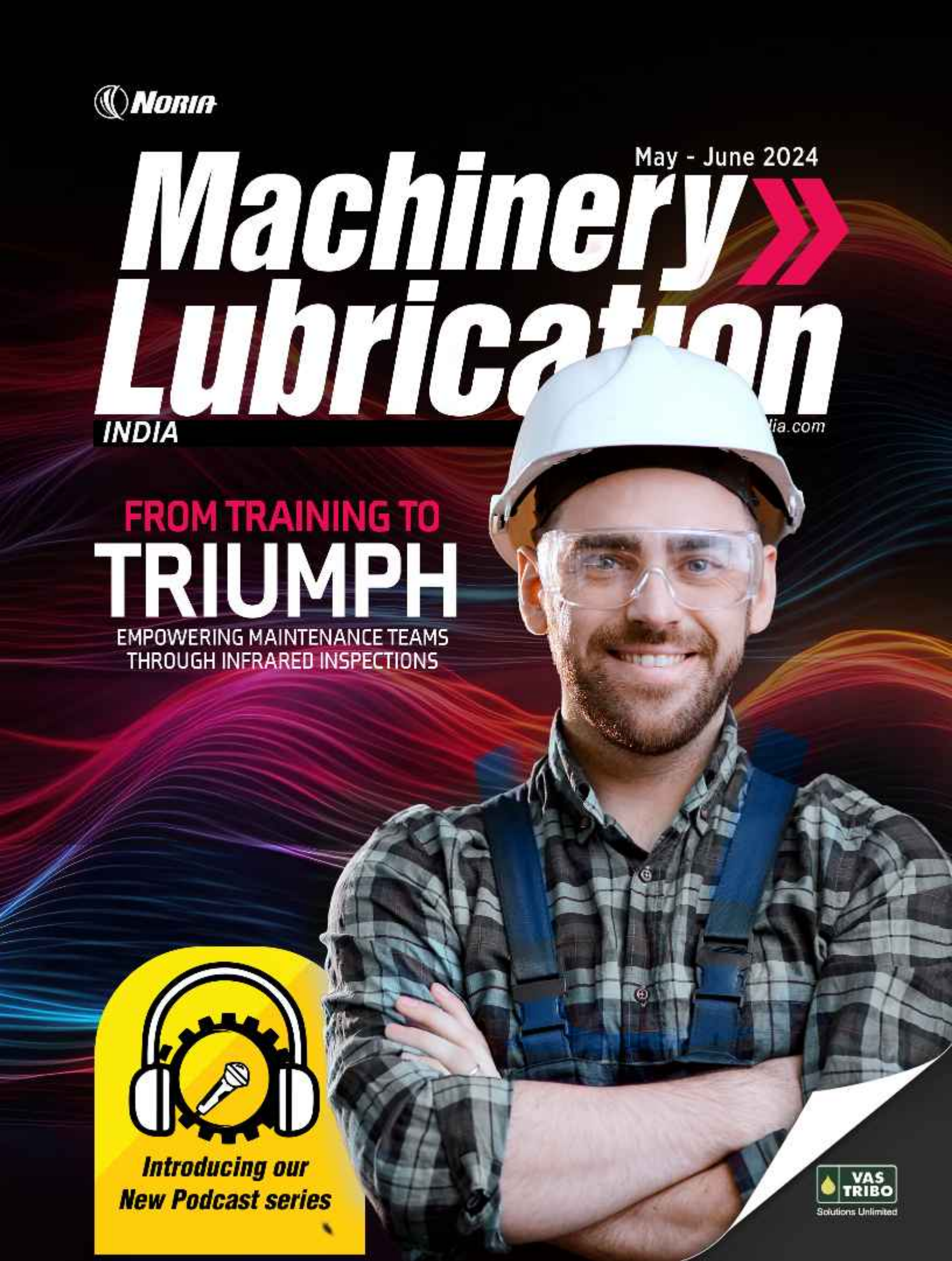
FROM TRAINING TO TRIUMPH

EMPOWERING MAINTENANCE TEAMS THROUGH INFRARED INSPECTIONS



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AS I SEE IT

COVER STORY

EDITORIAL FEATURES

Publisher's Note

In the fast-paced realm of industrial maintenance, there's an urgent need to shift perspectives on lubrication practices. These practices, often overlooked, have a significant impact on costs, productivity, and equipment reliability. Managers must integrate lubrication into broader organizational objectives to realize its full potential. A data-driven approach, leveraging data analytics and predictive maintenance, is essential for optimizing lubricant selection, application, and maintenance intervals. This proactive strategy minimizes downtime and maximizes equipment lifespan, reducing overall operating costs.

Investing in training is equally crucial. Enhancing the skills of maintenance teams fosters a culture of continuous improvement. Well-trained personnel can execute lubrication tasks optimally, boosting operational efficiency and equipment reliability. Embracing technological advancements, such as IoT sensors and lubrication management software, is imperative. These innovations enable proactive monitoring, optimization, and automation of lubrication processes, keeping organizations agile and efficient.

Performance tracking is a vital tool for assessing lubrication programs' effectiveness. Implementing key performance indicators (KPIs) and tracking systems allows managers to measure outcomes and identify areas for improvement, facilitating continuous optimization and enhancing equipment reliability and operational efficiency. Encouraging cross-functional collaboration and fostering a culture of continuous improvement are essential for success. Collaboration between departments ensures that lubrication practices align with overall business objectives, leading to sustained performance improvements across the organization.

Recognition and incentives play a pivotal role in motivating teams to excel in lubrication practices. By acknowledging and rewarding achievements in lubrication excellence, managers cultivate a sense of ownership and pride among employees, driving them to strive for continuous improvement and maintain high standards. The cover story advocates for practical strategies and engaging training methods to empower teams to achieve their goals, driving continuous improvement in equipment reliability and operational efficiency.

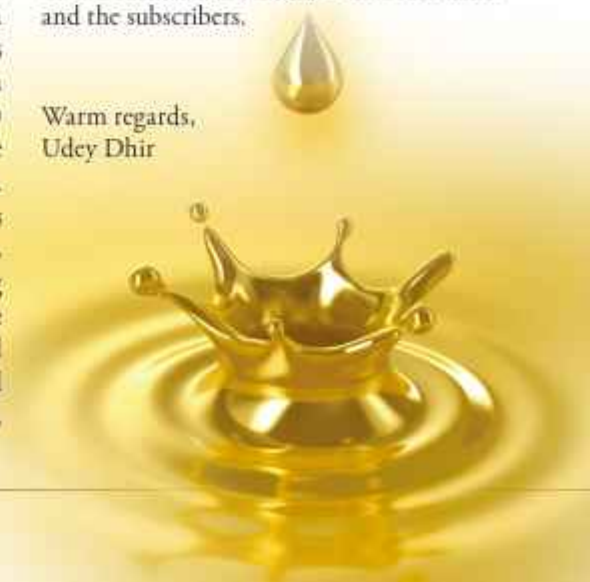
Breaking the decades-old status quo on maintenance, this issue explores achieving reliability through innovative lubrication management practices. It discusses how ASTM standards are adapting to monitor varnish effectively, offering insights into balancing traditional approaches with innovative solutions. This issue highlights the importance of formal training in machine maintenance, emphasizing MRO storeroom training to increase uptime through efficient spare parts management. Additionally, it delves into the eight pillars of a prosperous maintenance culture, providing practical strategies for overcoming challenges and driving success. This issue also addresses varnish challenges and showcases the use of soluble varnish removal technology to resolve them effectively, aligning with the theme of embracing innovation for enhanced reliability and performance.

Furthermore, we are excited to announce the launch of a brand-new podcast section, encouraging readers to watch some exciting video content.

In conclusion, the exploration of innovative maintenance practices signals a shift towards reliability and efficiency, akin to the transformative potential highlighted by Goldman Sachs Research during the world's largest election. By embracing advancements in lubrication management and staying ahead of the curve, organizations can navigate the evolving industrial landscape with confidence, ensuring sustainable growth and success.

We look forward to your support and feedback to enable us to improve the content and layout of Machinery Lubrication India. We welcome readers to participate by sending their feedback & contributing articles and case studies. We look forward to the continued patronage of the advertisers and the subscribers.

Warm regards,
Udey Dhir



BREAKING THE DECADES-OLD STATUS QUO ON MAINTENANCE:

ACHIEVING RELIABILITY THROUGH LUBRICATION MANAGEMENT

What is your preventative maintenance program designed to do? What are the objectives of your daily maintenance activities? Is it to maintain the machines toward higher reliability, or is it to maintain the status quo? If you're trying to achieve something higher, keep in mind: if you do what you've always done, you'll get what you've always gotten.

For better or worse, machine reliability is joined at the hip with lubrication, whether from a design or maintenance perspective. Proper lubrication ensures that machines run smoothly to minimize the negative impacts of friction and wear. But this isn't one of those things you can just set and forget.

While lubrication is important, it can be fickle over time if it's not properly maintained. What begins as the healthy lifeblood of the machine can turn into the murderous poison within and lead to premature machine failure and unexpected downtime.

Today, maintenance and reliability have become revolutionized by lubrication management systems (LMS) that help take the guesswork out of best-practice lubrication. And this doesn't just apply to the tangible lubricant, but rather lubrication, as a whole, and includes all facets of the process that influence the lubricant to perform at its optimum level. Understanding this concept is a core function in proper maintenance.

Holistically, there are 40 factors that should be considered for achieving machinery lubrication excellence. Some of these factors include choosing the optimal lubricants to use across a facility and how to properly receive and store them before use. And as this knowledge applies to day-to-day maintenance and the details associated with lubrication routes in a facility, you must ensure you perform three key processes properly: lubricant application, contamination control, and condition monitoring.

Before the Use of a Proper Lubrication Management System (The Status Quo)

Let's take a typical process — pump asset train, for example — which includes two or three lubricated components: the electric motor, the pump, and the coupling. The status quo activities may include a periodic reminder to "add grease" or "inspect oil level" listed in a physical checklist.

This leaves the quality of the work dependent upon the technician's level of training and availability, along with any exisiting practices already in place, to communicate any relevant information. Similarly, the pump and electric motor status quo often lack necessary modifications to allow for proper inspections or to protect from the surrounding contaminants.

By default, there is little standing in the way of:

- **Contaminant Ingression** – Airborne contaminants entering the machine ac-

cumulate, cause friction, and degrade the lubricant.

- **Lubricant Misapplication** (amount) – Both under-greasing and over-greasing lead to energy losses and heat generation due to lubricant starvation or viscous drag.
- **Lubricant Misapplication** (type) – One of the most common mistakes made in lubrication is applying the wrong lubricant, often due to the lack of proper lubricant identification and labeling.
- **Inadequate Inspections** (Inspection 2.0) – Without proper training and on-the-job guidance, more than 90% of inspectable conditions go unnoticed.

Correcting these practices and breaking the status quo requires change. Managing this change requires diligence and time but can be made easier with the right tools and processes. Machine reliability relies on best practices of lubrication performed daily through proper management systems. For many professionals who have been successful in managing these changes, the benefits are abundant and include cost reductions, reduced carbon footprint, and predictable machine operation, along with better job satisfaction for the workforce.

Lubricant Application

Effective lubrication is not just about using the right type of lubricant — it's also about applying it in the right quantity and frequency. An LMS manages each lubricated asset in a cloud-based database and establishes precise lubrication schedules based on equipment usage and manufacturer recommendations.

For example, installing an automated lubrication system, a subset control of the LMS, can deliver the exact amount of lubricant needed and eliminates the risk of over-lubrication, which can lead to energy wastage and component damage. But even standard tasks with a grease gun or a top up container must be carefully guided by best-practice procedures and documented in an LMS. Otherwise, with the status quo, mistakes made with these basic tasks are common and can lead to significant failure modes.

Contamination Control

Contaminants like dirt, moisture, and particles are notorious for compromising machinery performance. The LMS should prioritize contamination control through means of modification considerations, procedures, and condition monitoring. They often incorporate optimized selection of filtration, sealing, and breathers to prevent contaminant ingression and

Machinery Lubrication

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Machinery Lubrication India Volume 21 - Issue 3, May-June 2024 is published bi-monthly by VAS Tribology Solutions Pvt. Ltd. Operation Office:213, Ashiana Centre, Adityapur, Jamshedpur-831013, India.

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support contaminant removal from lubricated components. Using proper LMS tools, such as LubePM, can help guide which hardware to select for optimizing these needs.

Additionally, daily lubrication PM's performed by technicians must be well-defined and managed to ensure these critical hardware items are performing as expected. The LMS tools, often accessible through a mobile device app, further help the technician know what to monitor and accurately report the status. This proactive approach allows for timely corrective actions to prevent equipment damage and unplanned downtime.

Inspections

The LMS emphasizes routine detailed inspections as a cornerstone of condition monitoring and overall effective maintenance. These systems facilitate the setup of regular inspection schedules, during which technicians can assess equipment condition through a series of specific questions and answering prompts. This helps support on-the-job training with example images, videos, etc., and also aides in the collection of data

to complement other condition-monitoring technologies.

Lubricant Analysis

Regular lubricant analysis involves assessing factors like viscosity, contaminants, and the presence of wear particles. By monitoring these parameters, maintenance teams can identify early signs of lubricant degradation or component wear. The first step for lubricant analysis, oil sampling, must be done carefully, or it will compromise the value of the condition-monitoring technique, just like with inspections.

The LMS helps manage these activities by employing step-by-step procedures that reference best practices. Collecting a representative oil sample also requires a properly identified sampling point and sampling valves, which is recommended and defined within an LMS like LubePM. When done correctly, lubricant analysis empowers users to take preventive maintenance measures, such as scheduled lubricant replacement, before more severe issues arise.

Creating a New Status Quo

Industrial machines can no longer be expected to withstand rough operating conditions with a reactive mindset. There is no more room for that in today's competitive industry. Since the beginning of machine design, lubrication has always been foundational to reliability. But it cannot be taken for granted.

A Lubrication Management System (LMS) is a dedicated tool that enables lubrication excellence in conjunction with the more holistic maintenance management of a CMMS or EAM. But it takes firm initiative to transcend traditional maintenance practices that have been locked into the status quo of maintenance culture for the last several decades. By deploying modernized tools such as LubePM to manage

the entire lubrication program, much more efficient and streamlined work flows, combined with on-the-job job skills development, can be achieved. Take charge of your lubrication program with a systematic approach of an LMS.

INNOVATIONS IN LUBRICATION | GEAR TALK:

Episode 1

Innovation in Lubrication

The "Gear Talk" podcast inaugural episode features Bennett Fitch, the Chief Strategy Officer at Noria, discussing innovation and lubrication programs. The conversation explores why innovation is crucial in lubrication programs, despite some resistance to change. They emphasize the importance of empowering individuals with the right tools and information to optimize lubrication practices. Fitch highlights the need for a balance between traditional methods and leveraging technology, such as AI and big data, to enhance lubrication programs. The discussion emphasizes the role of education, training, and management systems in driving innovation and improving reliability in industrial machinery. Overall, the podcast underscores the significance of embracing innovation to enhance efficiency, reduce costs, and maximize equipment lifespan in lubrication management.

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Dive into Our Podcast Now!

Cody Jackson | EffectivePDM

FROM TRAINING TO TRIUMPH

EMPOWERING MAINTENANCE TEAMS THROUGH INFRARED INSPECTIONS

Maintenance teams face multiple challenges in today's manufacturing facilities such as a lack of skill development, expensive maintenance, electrical safety risks, unplanned downtime, and outdated training programs. In this article, we're going to cover how an effectively trained maintenance team that executes electrical infrared inspections can overcome them.

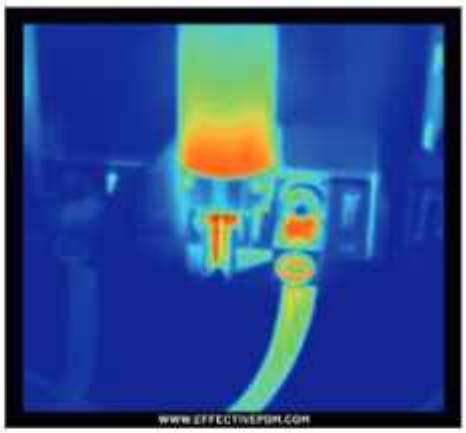
Foundational Understanding

First, let's all get on the same page: electrical systems run everything. They are the backbone of every facility and are often over looked once installed. I'm sure we've all heard the following saying, "If it ain't broke, don't fix it."

Unfortunately, that saying doesn't apply in the current times of industrial automation, reliability, safety, and compliance. Electrical systems are the most important and the most dangerous utility. That's why we focus on electrical systems in our companies. If you can maintain your electrical system (including electric motors) using a predictive maintenance program, you can achieve incredible benefits.

But what is a "predictive maintenance program?" A predictive maintenance (PdM) program is an advanced form of planned maintenance that monitors asset conditions in real time using one or several inspection strategies, tools, and procedures. PdM is a maintenance type designed to predict asset failure based on the current condition of the equipment to estimate when maintenance should be performed. There are five common types of PdM inspection techniques:

- **IR** - Infrared Thermography
- **ULT** - Ultrasound (Airborne and Structure-borne)
- **MCA** - Motor Circuit Analysis
- **VIB** - Vibration Analysis
- **FA** - Fluid Analysis



Stacking Skills

What's the significance of incorporating infrared (IR) inspections into the skill development of maintenance teams? The answer came from an unlikely (non-maintenance and reliability) source: a book by the creator of the Dilbert cartoon, *How to Fail at Almost Everything and Still Win Big*, by Scott Adams. In the book, Adams defines "The Success Formula" in which"every skill you acquire can double your odds of success." The formula looks like this:

Good + Good > Excellent

In other words, you're better off being good at a couple of complementary skills than being an expert at only one. When applied to maintenance teams, the formula can look like this:

Maintenance Skills + Electrical Skills + Infrared Skills = Enhanced Maintenance Team

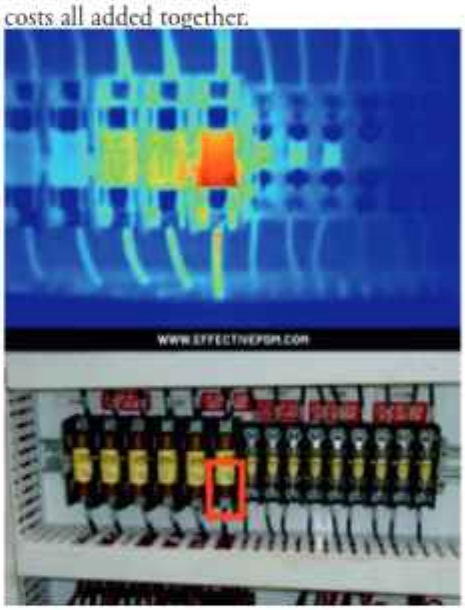
Adding the skills of infrared inspections to electrical maintenance creates the foundation of a great skill-stack for every maintenance team. The benefits of stacking maintenance, electrical, and infrared skills could include:

- Faster troubleshooting
- Better understanding of asset failure
- Find previously hidden problems
- A more capable team

Essentially, stacking infrared inspections skills on top of existing maintenance skills produces a confident and capable team. And history has shown that nothing can stop an effective maintenance team.

Not Wasting Big $$$

How do infrared inspections contribute to cost avoidance and more efficient cost management in maintenance operations? Fundamentally, predictive maintenance costs less than reactive maintenance and here's why. With reactive maintenance, an electrical component runs to failure. At failure, there are replacement costs, possible emergency parts and labor, downtime, possible lost product waste, and potential safety costs all added together.

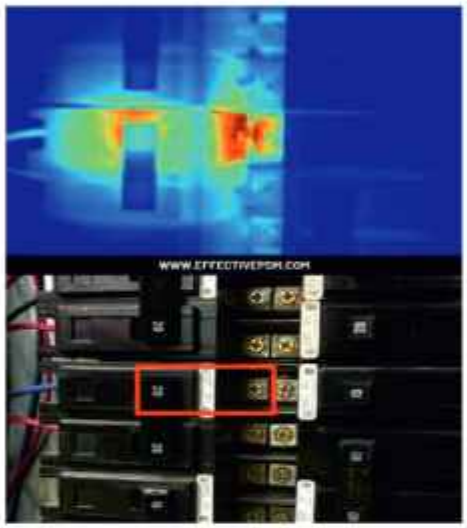


When comparing reactive to preventative maintenance (time-based maintenance), there's partial electrical component replacement costs, scheduled downtime for parts and labor costs, and non-problem component replacement waste. When comparing preventative maintenance to predictive maintenance (condition-based), there are partial replacement costs, scheduled downtime, and problem-only replacement —resulting in the least expensive form of maintenance.

According to a 2019 Hartford Steam Boiler study, infrared inspections have a 5:1 cost-avoidance, conservatively based on parts and labor versus reactive maintenance. The cost-avoidance when tracked can be even more impactful.

Some numbers we tracked over six electrical infrared inspections from one of our customers resulted in:

- 20:1 repair to replace ratio (parts and labor only)
- 65:1 total infrared cost avoidance (parts and labor, lost production time, lost product)
- $44,937.00 total IR + repairs cost before failure
- $2,269,120.00 total avoided cost of failure



Cost-avoidance can get serious quickly when implementing infrared inspections.

When talking about more efficient cost management for maintenance teams, infrared inspections help with that too. We've established that reactive maintenance is more expensive than predictive maintenance. If a maintenance team wanted to start a PdM program, infrared has the lowest barrier to entry.

One inspection tool can pinpoint problems from high voltage on down to 24-volt systems and across thousands of electrical assets. Infrared thermography is also easy to learn and (with effective training) easy to apply. Starting your PdM program with electrical IR inspections allows you to pick off the low hanging fruit and produces results quickly.

The initial investment in tools and training is minimal compared with other technologies like vibration and motor circuit analysis. As soon as a maintenance team starts using infrared, they'll be finding small problems early and making in expensive corrections. Ultimately, they'll be saving their company money.

Ensuring Electrical Safety

How do infrared inspections mitigate electrical safety risks in manufacturing facilities? Infrared inspections and electrical safety tie together with these three words: normal operating condition. The *NFPA 70E Standard for Electrical Safety in the Workplace* tells us that electrical equipment should not be running unless a "normal operating condition" exists. To meet that criteria, electrical equipment must:

1. Be properly installed
2. Be properly maintained
3. Be used in accordance with manufacturer's instructions
4. Have doors closed and secured
5. Have all covers closed and secured
6. Have no evidence of impending failure

Infrared inspection programs help solve for the "no evidence of impending failure" part better than any other maintenance type.

More proof that infrared inspections mitigate electrical safety risks was recently published inside the 2023 *NFPA 70B Standard for Electrical Equipment Maintenance*. In Section *7.2.1.1 Infrared Thermographic Inspection of Electrical Connections*, "Infrared thermographic inspection of electrical connections and terminations shall be performed in accordance with Section 7.4." Why would the new standard make annual electrical infrared inspections mandatory? Here's a great answer from the previous version (2019):

4.2.1 "A well-administered EPM program reduces accidents, saves lives, and minimizes costly breakdowns and unplanned shutdowns of production equipment. Impending troubles can be identified — and solutions applied — before they become major problems requiring more expensive, time-consuming solutions."

Source: 2023 NFPA 70B Standard for Electrical Equipment Maintenance

How much safer would your team members and facilities be by eliminating these hazards? By training your maintenance team to implement infrared inspections at your facility, you'll help mitigate electrical safety risks.

Maintaining Uptime

What are some practical strategies and best practices to drive operational efficiency and achieve excellence by leveraging infrared inspections in maintenance practices? To move from reactive maintenance to proactive maintenance, you've got to stop "firefighting".

If "firefighting" is reactive maintenance, why not eliminate the fire before it starts? Here's the typical fire-starting steps:
Spark > Tinder > Kindling > Firewood > Big Fire

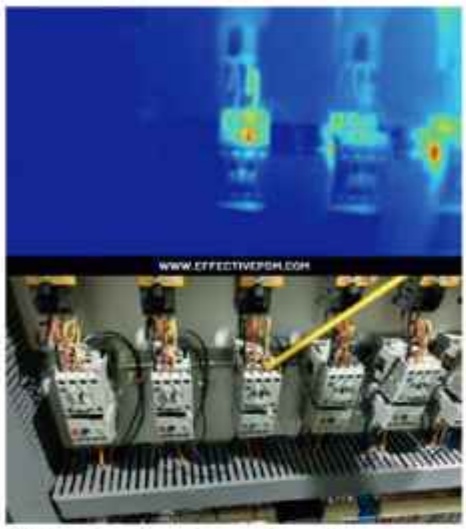
If a spark doesn't have tinder, a fire won't even start. Eliminate the tinder. Here are some examples of "tinder":

- Loose (high resistance) wire connections in control panels
- Overloaded circuit breakers in panels
- Obstructions blocking electrical equipment
- Missing circuit breaker filler plates in panels
- Loose (high resistance) fuse clips in control panels

This is all "tinder" that can be eliminated using infrared inspections so your team can stop "firefighting" which is reactive maintenance.

Another best practice to drive operational efficiency is for your maintenance team to start bringing their IR imagers along for troubleshooting situations. During the day-to-day maintenance calls, observing the same problems using infrared will:

- Show them a new perspective
- Find any excess heat
- Catch obvious IR issues on the spot



Ultimately, there's no point to have an expensive predictive maintenance tool just sit on the shelf.

Another tactic that leads to maintenance excellence is to create a list of critical assets to inspect regularly and break the total asset list up into manageable chunks. To do this, you'll need:

- A complete asset list of your facility
- Knowledge of what's critical to operation
- Systematic way to plan an inspection route

In-house maintenance teams are at an advantage, they can inspect the whole electrical system when they want to and break the asset list up into manageable chunks to inspect throughout the year.

A final best practice that will drive operational efficiency is to remember that IR inspections are only effective when followed by timely repairs. A real-life example brings this point home. I tell it as a cautionary tale of "The $200,000 Fuse Clip." Check this out:

An inspector friend of mine completed an electrical infrared inspection on a main disconnect of a new restaurant down in Florida. He found that the main disconnect had a loose (high resistance) fuse clip that he reported as an anomaly. The restaurant owner received the report and never hired a contractor to fix it. Two weeks later, the new restaurant started serving customers and as the electrical load increased, the connection got worse and eventually started a fire. The restaurant owner lost $200,000 between renting a generator to finish an event starting the same night as the fire plus replacing the service. Now, he wants him to inspect the restaurant at least annually.

IR inspections are a snapshot in time and there's no way to tell exactly when an electrical component will fail. That fuse clip could have been corrected for minimal cost but instead turned into a $200k bill. By following these tactics and best practices, your maintenance team can harness infrared inspections to maintain uptime.

No Death-By-Power Point

How can we best approach training the next generation of maintenance teams? A seemingly non-obvious answer is that training should be like watching YouTube— educational, tactical, and a bit entertaining. The next generation does not need more tired voice over and death-by-PowerPoint training that plagues the corporate world.

Think about the last time you wanted to learn something. What did you do? I bet you didn't crack open a crusty old text book. No, you Googled something and watched a YouTube video.

Training a maintenance team today should follow these best practices:

- No elaborate theory and overview fluff
- Learn from practitioners, experts, and doers
- Training must achieve a transformation/result
- Must be mobile-first training (for online courses)

The next step to best approach training the next generation is to provide a step-by-step system or play book they can implement immediately. Information is unlimited, the future of maintenance training is providing a system to utilize that information in the best way possible. You can apply this information directly using:

- Standard Operating Procedures (SOPs)
- Guides (video or written)
- Templates
- Cheat sheets

Templates, cheat sheets, and SOPs can all be managed with mobile-first CMMS. Most now even incorporate artificial intelligence A.I. into SOP management.

Lastly, IR is straight forward but not easy, good training is essential. Unfortunately, executing an infrared inspection is not as simple as "buy an IR imager, point, and shoot." There's more nuance that has to do with the art of thermography versus the science of it. A huge part of being a good thermographer is being able to accurately gather data that leads to great reporting.

When it comes to effective training, you'll want to learn how to inspect facility electrical system assets and identify electrical infrared and visual problems. Often, an "on-the-job" style training is best. The next time you get to train a maintenance team member, adapt to where we are today, not to where training was 30+ years ago. And please, no more death-by-PowerPoint training!

Conclusion

It's no secret that maintenance needs a rebrand and maintenance teams have an uphill battle. Incorporating infrared inspections into the skills development of maintenance teams will help fight that battle. By stacking skills, not wasting big money, ensuring electrical safety, maintaining uptime, and dropping the death-by-PowerPoint training, your maintenance team will be empowered to succeed by implementing infrared inspections taking them from training to triumph.

Challenge your company to implement one tactic from this article and get after it!

ASTM STANDARDS ARE EVOLVING TO EFFECTIVELY MONITOR VARNISH

Varnish is defined as the matter that precipitates from a lubricant and collects on surfaces. If this material accumulates on components, such as servo valves, or within oil systems, it can lead to maintenance and reliability headaches.

With the introduction of Group II and Group III oils in the early 2000s, varnish deposits became increasingly severe. It was discovered that these oil groups couldn't retain varnish solutions in the capacities of older-generation-formulated products.

While progress has been made in learning how to test oil to show its varnish potential, challenges and information gaps still exist. ASTM D02 Sub committees C and CS96 members are furthering the knowledge base about this important topic.

The Relationship Between MPC, RPVOT, and RULER

One promising area of research centers around the relationship between the ASTM tests used to characterize parameters of an oil's varnish formation tendency. These tests include:

- ASTM D7843 (MPC)
- ASTM D2272 (RPVOT)
- ASTM D6971 (RULER).

Each of these provides data focused on monitoring different aspects of an oil's degradation by products. It was discovered that trending each test independently does not provide a highly reliable forecast of expected overall oil performance as it relates to varnish formation and collection.

Utilizing ASTM D7873 (dry TOST) can determine the relationships between these tests. The dry TOST test is a method that accelerates oil aging and is believed to produce aged oils similar in chemistry to how the oils would age in service.

During one study, samples were removed after three, six, nine, and 12 weeks of exposure to the test conditions. RPVOT, MPC, and RULER tests were then run on each test sample. The study found that some oils with strong RPVOT performance produced more varnish deposits than oils with low RPVOT measurements. Conversely, some oils with strong antioxidant protection had a greater tendency to leave varnish deposits than oils with less oxidation protection. Both findings are nonintuitive.

The shape of the RPVOT test degradation curve over the period represented by the four aged samples also differed between different turbine oil brands. Some oils had an initial rapid test drop before assuming a gentle degradation rate. Other samples assumed a gentle degradation rate during the entire test period. This information may present one explanation of why some oils believed to be high performing formed more varnish than expected.

The relationship between these test methods is an active ASTM work item that will result in a revision to ASTM D7873 with new industry guidance that will provide users with a tool for selecting turbine oils.

Phosphate Esters

Fire-resistant triaryl phosphate ester-based fluids are used extensively in control oil systems but are currently outside the scope of the D7843 (MPC) test. However, because they are known to degrade, oxidize, and form varnish deposits, they will benefit from MPC testing.

Further research into these mechanisms has been performed, and ASTM agreed the MPC test method would be amended to include fire-resistant oils in the next revision of the standard test method. Proper monitoring of the phosphate ester oil varnish deposits being produced will require the collection of additional information beyond the current requirements of the MPC test.

In addition to an overall rating, the membrane patch color was found to have distinctive components related specifically to both varnish and thermolysis. When thermolysis occurs, certain matter originates from the micro-dieseling events that take place within the oil system. To trend the additional matter formed from thermolysis, the MPC test will soon report:

- The overall color measurement.
- The weight of the as-found patch deposit.
- The colors of "A" and "B" component deposits.

The "A" and "B" color components measured by the proposed test revision are used to determine if the overall MPC color is primarily carbon-based (micro-dieseling) or varnish-based (oxidation). A deeper understanding of the source of the material captured on the MPC patch will aid the user in:

- Performing root-cause investigations following a servo valve failure.
- Determining when remedial corrective action is required.

Trending the Effects of Micro-Dieseling

Turbine electrohydraulic control (EHC) oil systems won't operate optimally without exceptionally clean oil (as defined by the ISO cleanliness criteria). Other testing has demonstrated that, in addition to material originating from oxidation reactions, this oil type tends to produce a significant volume of particles that are smaller than the 4-micron limitation of the ISO cleanliness test but larger than the 0.45-micron patch that is used to collect deposits in the MPC test.

These particles, when abundantly present in the operating oil system, can lead to particulate etching and failure of the servo values. The extent of the presence of these extremely small particles should also be used to develop a new condemning criterion to replace the oil that other available testing would likely miss.

Summary

There is still much to learn about the formation of varnish and its impact on oil and machine health. Updates to formulations, particularly in Group II, Group III, and phosphate esters, have resulted in unexpected varnish accumulations. Oil varnish trending needs to be a routine part of condition monitoring programs. In some cases, particularly with phosphate esters, recent studies have found that varnish plus additional oil artifacts generated during operation should be trended.

With this new information and data, advances are being incorporated by ASTM to improve existing standards methods to keep up with the different types of varnish created because of the evolving oil formulations and the increasing understanding of new varnish mechanisms. Additional information on varnish studies and how they are being incorporated into ASTM standards may be found in a recently published ASTM STP Document: STP 1634 Standard Guides and Practices that Support the Lubricant Condition Monitoring Industry.

ASTM's D02 committee provides the condition monitoring industry with a voice and place to improve the profession and technology. The D02 C and CS96 subcommittees manage and author new and in-service lubricant condition monitoring standards. The subcommittee's primary responsibility is to develop standards that promote knowledge and innovation while ensuring that appropriate testing is being performed and that resulting data is correctly implemented.

ASTM International, a global volunteer-driven standards organization, serves a significant role in today's condition monitoring industry. ASTM is known for laboratory test methods that provide instruction used to obtain consistent and reliable data. In addition to test methods, ASTM products include Guides and Practices that provide useful "how to" recommendations, some of which include test acceptance and action-level criteria that can be used to enhance the effectiveness of both common maintenance practices and in the use of condition monitoring test data. ASTM is a source of research and innovation that has and will continue to shape the future of the condition monitoring industry. One of the more significant topics of condition monitoring discussions in recent years has been related to varnish.

Acknowledgments:

Special thanks to Greg Livingstone, Fluitec International, and Dr. M. Hobbs, EPT Clean Oil.

BALANCING TRADITION WITH INNOVATION

The Crucial Role of Formal Training in Machine Maintenance

Anyone familiar with Noria knows our emphasis on training. But what many folksdon't realize is that many of the same people teaching our courses spend a large amount of time in facilities. Some of this time is spent benchmarking reliability programs (with an emphasis on lubrication), and the rest with mechanics, maintenance engineers, and lube techs.

If I have learned anything over my years of doing these projects, it's to never discount the depth and value of the knowledge these people have about their equipment. (Yes, this includes operators since they'd typically spend the most amount of time with the equipment). We commonly refer to this type of experience and information as "tribal knowledge".

To elaborate, tribal knowledge, which is also referred to as institutional knowledge, includes:

1. Practical Insights: Tribal knowledge often holds valuable insights that aren't found in manuals or formal training. Maintenance technicians with years of experience share real-world lessons, including shortcuts, best practices, and workarounds that can significantly enhance machine upkeep.

2. Customized Solutions: Every machine has its unique quirks and characteristics. Tribal knowledge offers personalized solutions for specific equipment within a particular facility. Technicians who have spent time working on those machines understand their idiosyncrasies and can provide tailor-made solutions.
3. Rapid Troubleshooting: When a machine encounters an issue, tribal knowledge allows maintenance personnel to quickly diagnose problems. Experience-based insights help identify common root causes and streamline troubleshooting processes, minimizing downtime, and improving operational efficiency.
4. Historical Context: Tribal knowledge provides historical context for the equipment. Knowing the maintenance history, past failures, and repairs can aid in predicting potential future issues. This foresight allows maintenance teams to proactively address concerns before they escalate.
5. Cost Savings: Leveraging tribal knowledge reduces the reliance on external consultants or extensive research, leading to cost savings. The expertise shared among team members empowers them to handle routine maintenance tasks and minor repairs without the need for outside assistance.
6. Continuous Improvement: Tribal knowledge encourages a culture of continuous improvement. Technicians learn from each other's experiences, mistakes, and successes, fostering an environment where the team collectively strives to optimize maintenance processes and minimize downtime.
7. Enhanced Collaboration: Sharing tribal knowledge fosters collaboration among maintenance team members. The exchange of insights, tips, and techniques

creates a sense of camaraderie, boosting team work and overall job satisfaction.

With all these advantages around tribal knowledge, we sometimes can find ourselves questioning why we would want to take valuable time and money to even have formal trainings. This is where the automatic reliance on tribal knowledge can really hurt us. We can't just rely on the old-timers to show us how it's always been done.

Formal training offers benefits not found in our traditional OJT and can be trusted as an alternative to tribal knowledge:

1. Structured Curriculum: Formal reliability training provides a structured curriculum designed by experts in the field. This curriculum covers a wide range of topics systematically, ensuring that participants receive a comprehensive education in machine maintenance and reliability practices.
2. Standardized Knowledge: Formal training imparts standardized knowledge to all participants. This consistency ensures that all team members have access to the same accurate and up-to-date information, reducing the risk of misinformation or outdated practices.
3. Industry Best Practices: Training programs often incorporate industry best-practices and the latest advancements in machine maintenance and reliability. Participants learn techniques and methods that have been proven effective across various industrial sectors.
4. Theoretical Foundations: Formal training dives into the theoretical foundations of reliability engineering. Participants gain a deeper understanding of the principles underlying maintenance strategies, enabling them to apply critical thinking and problem-solving skills to complex scenarios.
5. Hands-On Experience: Many formal training programs include practical exercises, simulations, and hands-on experiences. These activities allow participants to apply theoretical concepts in a controlled environment, fostering skill development and boosting confidence.
6. Certification and Recognition: Completing formal training programs often leads to certifications that hold industry-wide recognition. These certifications validate participants' expertise and enhance their credibility when working on complex machinery or in diverse industrial settings.
7. Professional Development: Formal training is an investment in professional development. Participants not only acquire technical skills but also develop soft skills such as communication, teamwork, and project management. These skills are essential for thriving in a modern industrial environment.

But one of the most important things for me, when it comes to the why of formal training, is I get to know why my actions are important and how each action I take affects everything else down the road.

The Final Verdict

Tribal knowledge undoubtedly stands as a valuable resource in the realm of machine maintenance and reliability, serving as a repository of practical wisdom distilled from years of hands-on experience. Its strengths lie in the provision of pragmatic insights and customized solutions that often prove highly effective in addressing specific maintenance challenges.

Moreover, the ability to swiftly diagnose problems and draw upon historical context can lead to reduced downtime, resulting in operational cost savings. Additionally, the collaborative and knowledge-sharing aspects of tribal knowledge cultivate a positive team culture, fostering camaraderie among team members.

However, when evaluating the role of tribal knowledge in the broader context of modern industrial practices, its limitations come to the forefront. One significant drawback is the inconsistency that often characterizes tribal knowledge. This inconsistency can stem from variations in experience, expertise, and approaches among different team members, potentially leading to confusion and errors in maintenance processes.

But let's face it: it's not perfect.

Sometimes, the advice can be different from one person to another, which can lead to confusion and errors in work processes. It might not cover all the latest ideas and technologies, so it could fall behind the times. Plus, much of tribal knowledge depends on the expertise and availability of certain experts. So, when these old "tribal leaders" leave, things can sometimes get tricky.

Finally, tribal (or institutional) knowledge doesn't come with the backing of official certificates or qualifications. Many professionals in the reliability and lubrication industries may think that these certifications are unnecessary or excessive. But they help to demonstrate a level of competency and help people with having a common language and accepted standards in the tasks that they are performing. This leads to less confusion and more connectedness in a facility.

So, to wrap things up, while tribal knowledge is handy it's not always the best approach to handle machine maintenance. A better, more effective way is to combine it with formal training.

This gives a technician the best of both worlds — the experience and wisdom of the old-timers along with the latest knowledge, training, and technologies —making a team more complete and better equipped at keeping machines running smoothly, efficiently, and avoiding major breakdowns in all the processes going on in a facility.

MRO STOREROOM TRAINING: INCREASING UPTIME THROUGH SPARE PARTS MANAGEMENT

Throughout my many years of involvement with maintenance, repair, and operations (MRO) storeroom programs, one major fact stands out from the rest – MRO storeroom associates receive significantly less training than associates in other departments across the organization.

Often, MRO storerooms are seen as an expense, not an investment, and those who oversee these storerooms have difficulty securing the funding necessary to properly staff their department and make improvements that would better the department's efficiency and benefit the entire organization.

Those incharge of approving the facility's budget are okay with **cycle-counting** out thousands of dollars worth of spare parts, misguidedly believing it's just part of doing business. As long as the assets are repaired and put back into production, they are content to sweep larger underlying problems under the rug. This mentality can have costly repercussions for the entire organization.

But, by recognizing the impact an MRO storeroom can have and taking steps to ensure its efficiency and advancement, an organization can reduce its costs, increase its uptime, and guarantee the success of its associates.

Keys to MRO Storeroom Success

The MRO storeroom associate is key to ensuring parts are readily available for an organization's maintenance program. It's common for these organizations to have MRO associates work closely with the receiving department to ensure the items being received match what was ordered and are not damaged.

While this is a good practice, unfortunately, I have found during my facility visits that many times, these associates are not trained properly in this process. Oftentimes, the only training they receive is how to:

- Use the current system to look up and issue parts.
- Put stock away.
- Process a return.
- Complete any necessary 5S activities.

5S

A Japanese-based set of principles designed to eliminate waste and foster a workplace culture of efficiency.
Source: Reliable Plant

However, to be successful, associates must also know:

- What the part is supposed to look like.
- How to review the parts for damage.
- How to store parts properly.
- What special storage needs each part has.
- How to perform preventive maintenance (PM).
- How to conduct cycle counts.

When asked why these organizations don't provide this crucial training, I'm meet with the typical answer, "We don't have the time." This leaves the responsibility of completing these tasks to the purchasing/receiving department, which is often short on time.

Developing a Training Program

It's important for organizations to develop a world-class training program for all MRO storeroom associates to guarantee the health of all maintenance parts and materials used to support the maintenance of critical facility assets.

These training programs also develop a sense of pride and responsibility in the MRO associates, who become better equipped to understand and assist the maintenance technicians with any of their needs and requests. MRO and plant maintenance must partner together to ensure the facility experiences minimal downtime and produces a quality product for its customers.

Understanding the Inventory System

Training needs to begin with understanding how the organization's specific inventory system operates. During this time, associates should spend time at the receiving dock to gain knowledge of how the receiving process works and how purchase orders are updated in the system after they have been received.

Performing Inspections

Next, associates should learn the inspection process. This includes:

- Visually inspecting for any damage to the parts.
- Reviewing labels and tags for specific part numbers.
- Verifying the parts were properly shipped and stored.

It is also a good idea for the receiving associates to train the MRO associates on how to locate, review, and understand the different parts of the purchase order, such as:

- Item numbers
- Quantities
- Order dates
- Expected delivery dates
- Vendor information

This information is extremely useful for answering any questions the maintenance team may have about a particular part.

Operating Heavy Equipment

Finally, all MRO associates must be trained on how to operate heavy equipment, such as:

- Lift trucks
- Tuggers
- Carts
- Other electric transportation vehicles

Many times, I have found that if an organization does provide this training, it's only for one or two MRO associates. This tactic ends up causing delays in getting the necessary parts to the maintenance team, which hinders their ability to fix downed equipment in a timely manner.

Organizing an MRO Storeroom

Once received, the MRO associates must understand how to appropriately put each parta way in the storeroom, carefully considering any unique requirements they may have. For example, ball screws should be stored either completely vertically or horizontally

on V-blocks and at a specific temperature to prevent bending.

If questions arise concerning how to properly store a specific item, many vendors and suppliers are more than happy to visit the storeroom and help train the associates.

The ABCs of MRO Storerooms

The MRO associate should understand how to conduct cycle counts of parts and be aware of what the top movers are in the storeroom. Most organizations use the ABC method to determine what items need to be counted.

"A" items typically make up 80% of the total inventory value, but only 20% of the SKUs carried.

"B" items typically make up 15% of the total inventory value, but only 30% of the SKUs carried.

"C" items typically make up 5% of the total inventory value and are 50% of the SKUs carried.

ABC Method

"An inventory management technique that determines the value of inventory items based on their importance to the business. ABC ranks items on demand, cost, and risk data, and inventory managers group items into classes based on those criteria."

Source: NetSuite

This classification method is a good starting point. Many organizations will regularly count the top 25 to 50 SKUs moving through their system. This ensures the parts in the highest demand are always kept in stock and that reviews of the minimum and maximum number of products on hand are conducted at regular intervals. This information is then provided to a manager who reviews the results and makes any necessary changes to keep the parts on hand at an optimal level.

Spare Parts Preventive Maintenance

MRO associates must also understand how to perform preventive maintenance on the spare parts. This includes:

- Turning the shafts on motors per manufacturer guidelines to redistribute grease and prevent false brinelling.
- Ensuring that belts are properly stored to prevent premature failure and that they are issuing the oldest belts first and rotating newer stock to the back.
- Working bearings to prevent brinelling.
- Checking that hydraulic cylinders are stored vertically to prevent actuator seal damage.

While organizations can outsource PM duties to a third party, it is still important for store room associates to understand these requirements so they can do their part to ensure these items are stored correctly as soon as they are received and put into inventory.

Assigning Responsibility

All MRO storeroom associates should be assigned an area where they are responsible for conducting 5S activities and providing upkeep for the items in that area. This could include:

- Conducting cycle counts.
- Inspecting for damage and improper storage.
- Performing preventive maintenance.
- Ensuring all parts are correctly labeled and in the right location.

This practice also fosters a sense of pride by having associates become "experts" in their area. As a bonus, many times, the associates can help identify needed corrections in another associate's area that may have been missed by providing a fresh pair of eyes.

Assigned areas can be rotated on a quarterly basis to help the associates become familiar with all areas of the storeroom.

MRO Storeroom Classes

Finally, it is important to provide the opportunity for associates to attend formal MRO storeroom classes. These classes cover:

- Ways to set up and maintain a storeroom.
- How to stock parts in the right quantities.
- Preventive maintenance programs.
- Purchasing procedures.
- The roles and responsibilities required to properly maintain a storeroom.

Whether they are a new employee or a manager, all storeroom associates can benefit from attending MRO classes, which provide excellent knowledge that leads to tangible results for the entire organization, such as increased wrench time, reduced defects, and decreased spending.

Conclusion

It's crucial for MRO storeroom associates to have a training plan just like other departments across the facility to be set up for success. The storeroom is one of the most important departments in the entire facility, but until it is given the necessary training and financial investment, the benefits it can provide won't be experienced. A great MRO associate is an invaluable asset to any facility.

8 PILLARS TO A PROSPEROUS MAINTENANCE CULTURE

It ain't just about the oil. In recent years, it has become increasingly clear to me that applied tribology is more about training and behavioral science than about engineering and material science.

I would guess that for every bearing that failed due to a problem lubricant (wrong selection, poor quality, etc.) there are ten others that fail due to problem lubrication (neglect, procedural, timing, etc.). No amount of expertise in lubrication and machine reliability will overcome the destructive after-

math caused by rotten maintenance culture. In fact, most companies seem to have a maintenance culture that is in urgent need of an intervention strategy. I recently wrote a column on a 12-step program for recovering addicts of lubrication neglect.

Although similar, this column discusses culture and behavioral foundation issues that seem to be at the core of lubrication neglect and other maintenance performance malfunctions. It borrows much from management science and leadership principles.

Over the years, I've engaged in hundreds of conversations on this topic with individuals from many companies and countries. Some come from organizations infected with culture problems, while others represent businesses that have emerged from a successful transformation.

Then there are those organizations which achieved transformation but transgressed to their bad habits and past addictive practices.

Drawing upon my years of learning on the subject, I have compiled "Eight Pillars to a Prosperous Maintenance Culture." Because of the central theme of this magazine, I've put these pillars into a lubrication context:

1. **Unwavering Management Commitment** - Have you ever wondered why lubrication neglect isn't keeping your company's CEO awake at night? Maybe he doesn't know how it's impacting the company's bottom line and his bonus. You have to be interested in lubrication for managers to lead, incite needed change and succeed at it. Managers who are purposeful and choose to both in-

spire and support lubrication initiatives have the unique opportunity to build charged-up and prosperous maintenance teams.

2. **The Right People** - We've heard the saying that employees are a company's most important asset. This is true, but only when it is the right people in the right jobs. Incompetent or poorly matched people working in maintenance positions can present sizeable operational risks rather than be productive assets. Select, nurture and inspire the right people to build a prosperous maintenance culture.

3. **Proactive and Planning** - The Whack-A-Mole approach to maintenance employee's workday is destructive and costly. Conversely, companies which proactively stabilize machine health and deploy a regiment of planning and scheduling activities will strengthen positive maintenance culture. Planning and scheduling includes utilizing well-organized work plans with modernized and documented procedures.

4. **Continuous Learning** - A prosperous business culture is a learning culture. Learning not only builds intellectual capital but also fosters a behavioral desire to do the right things right every time. It also builds team loyalty and dedication to achieving business goals. Certification instills pride and is the capstone to each learning stage by providing visible recognition of skill competency.

5. **Measurement** - When you measure, you are communicating what is important. So too, those things that are not measured are assumed to be unimportant. Beware of what you don't measure. People subconsciously work the metric. They know how they are being evaluated and respond in their work behavior accordingly. Measurement should come in many forms and at many different levels, including lagging indicators (what just happened), leading indicators (what's going to happen), macro indicators (the forest) and micro indicators (the trees).

6. **Investment** - Companies who are lean to the extreme harm their maintenance culture. The sense that "there is always enough time and money to fix a problem but never enough time or money to prevent it" is on the minds of many who work in the lubrication and maintenance field. Buying cheap oil, cheap filters and cheap people instead of buying proper tools, lubrication accessories, software and instruments is at the core of the problem. Too often companies, especially publicly traded companies, are driven by the desire to see how much money they can make between now and next Tuesday. Investment is a long-term strategy that cultivates a productive maintenance culture.

7. **Rewarding** - Many companies are inflicted with problem entitlement cultures. This occurs when employees collectively think they are entitled to be paid a premium regardless of the fruitfulness of their labor (building shareholder value). There needs to be a connection, or balance, between value given and value received. After all, you can't eat what you don't kill. To the other extreme, many companies fail to properly reward and recognize employees who have excelled in creating value. Time and again we see lube techs at the low end of the pay scale. Sadly, these companies enter the cycle of despair by hiring low-skilled workers (remember investment, No. 6 above) and pay them accordingly. And remember, there are many non monetary types of rewards. Companies which fail to celebrate "when they don't have broken machines to fix" lose out on this culture-strengthening opportunity.

8. **Empowerment** - Maintenance workers are more than just arms and legs performing a mindless task. They are productive knowledge-workers who not only can carry out the job plan but also can create, innovate and improve the quality and efficiency of the work performed. Remember, empowerment amplifies a company's intellectual capital by stimulating the minds of it s employees. When employees can act on their thoughts and opinions, they are the most productive. Unfortunately, for many companies there is a fineline that separates a change agent from an insubordinate worker.

At the root of maintenance culture problems is often a culprit called "denial".When confronted with lubrication issues, companies tend to move away from the denial problem in stages. Following are some words and thoughts from management that characterize these stages:

- **Stage One** - Denial . Ignore it. Pretend you don't have a problem. Hope it will-go away.
- **Stage Two** - Rationalization. It's for others. We're doing fine. We have a good program.
- **Stage Three** - Lip Service. Let's create a study group to see what we might do. Who else is doing it? Let's do a survey.
- **Stage Four** - Panic. Urgent, we're behind! We've got to catch up! We've got-to change everything - now!

Maintenance culture transformation is no easy task. Take ownership of your lubrication program by beginning the process of dismantling bad maintenance culture and replacing it with the pillars described above. Until you fix the culture issue, you cannot rise to the lofty state of lubrication excellence.

RESOLVING VARNISH CHALLENGES
USING SOLUBLE VARNISH REMOVAL TECHNOLOGY

Abstract
Varnish is an organic residue produced by the irreversible chemical degradation of lubricants, and it leads to numerous equipment problems, including:

- Filter plugging
- Restricted oil flow
- Poor heat transfer
- Valve sticking
- Fail-to-start conditions
- Costly unit trips

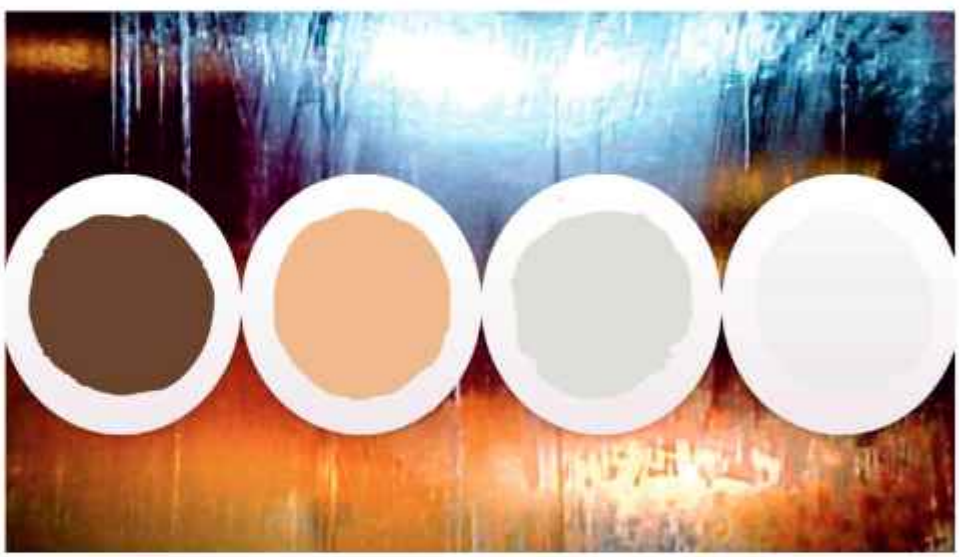
Varnish has traditionally been defined as an insoluble deposit, but it also exists in a soluble state, and the conversion between soluble and insoluble is a physical equilibrium process dependent upon temperature. The soluble varnish becomes insoluble by reducing the lube oil temperature; therefore, it is critical to remove soluble varnish from lube oil to permanently resolve varnish-related issues.

Due to the prevalence and costly nature of varnish-related failures, strategies have been developed to mitigate the effects of varnishing. The most important aspect is to routinely measure the varnish, develop a trend, and use suitable technologies to remove it from the lube oil system.

This paper describes a technical evaluation of the effectiveness of ion charge bonding technologies in removing soluble varnish and the technology's potentially negative effects on lube oil additives.

The evaluation conducted onsite field tests on a gas turbine and was followed by a laboratory assessment. To measure the effectiveness of the technology, lube oil samples were tested for:

- MPC
- RULER
- TAN
- Particle Count
- Other primary oil parameters



Introduction
Varnish is widely accepted as one of the industry's major lubrication challenges. During rotating equipment operation, friction generates heat which degrades the oil and produces degraded by-products – varnish. As varnish accumulates, the rotating equipment's performance suffers immensely. Furthermore, with enough time, varnish deposits can thermally cure on surfaces, creating a solid coating that is difficult to remove and increases the risk of failure.

At Saudi Aramco, lube oil degradation and varnish are the leading causes of lubrication failure in our critical rotating machines, which can have devastating consequences. In oil and gas companies, gas turbine shutdowns due to varnish formations can cost up to $150,000 per incident.

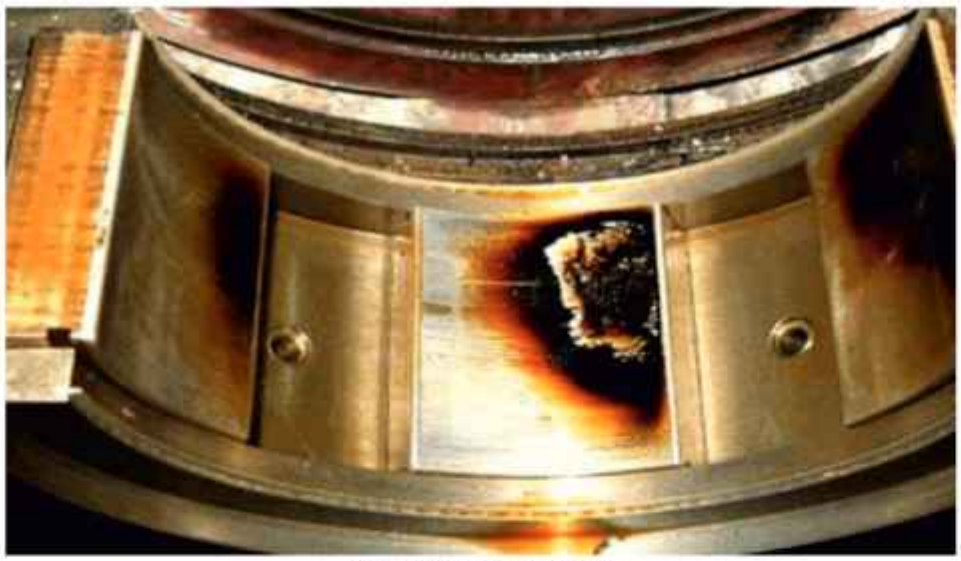


Figure 1.Varnish in bearing.

Therefore, removing varnish from lube oils is essential for preventing catastrophic failure, major operational losses, and expensive equipment repairs. In response to this need, a variety of varnish removal technologies have been developed and are now readily available. Many of these systems are not only adept at removing both soluble and insoluble varnish, but at improving heat dissipation rates and reducing system temperatures, preventing future varnish formation.

Varnish Formation

Under normal operating conditions, lube oils are subjected to oxidation, but as modern equipment continues to demand more from their lube oils, thermal stress is increasing. This equipment is subjected to micro-dieseling and static electricity discharge, which accelerate the lube oil's oxidation process. This oxidation degradation produces polar molecules from non-polar mineral oils. These polar species represent the starting point of the varnish life cycle.

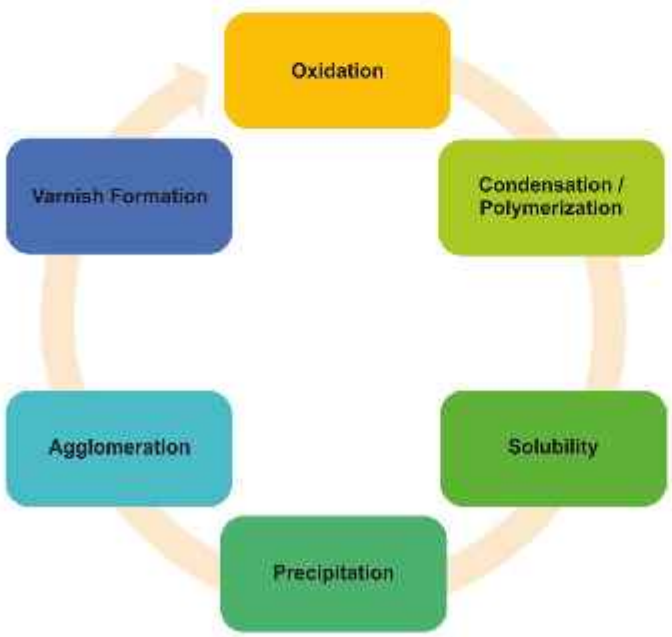


Figure 2. Varnish formation cycle.

Currently, the industry is trending toward using highly refined lube oils, which have higher oxidation and thermal stability, but low solvency characteristics compared to conventional lube oils. The polar oxidative by-products become larger due to polymerization. As the polar oxidative by-product comes out of the solution, they agglomerate and collect on bi-polar metal surfaces, which attract polar oxidative molecules and form a sticky deposit. Varnish typically forms in relatively cool zones with low flow and clearances, like valve spools and oil reservoirs, because they have relatively low solubility.

The major causes of varnish formation are:

- Static electricity discharge from mechanical filters
- Shared reservoir for hydraulic and lube oil circuit
- Hot spot in the system
- Additive depletion
- Implosion of air bubbles (micro-dieseling)
- Low-flow hydraulic circuits with temperature differentials

Varnish can impact equipment operation in several ways:

- Accelerates the oil degradation process.
- Reduces clearance in spools and bearings due to deposit formation. Deposits cause valve sticking and equipment malfunctions.
- Attracts contaminants and increases bearing wear.
- Reduces the performance of heat exchangers.
- Causes filter plugging.
- Reduces heat dissipation and increases oil and application temperatures.

Saturation, Equilibrium, and the Varnish Life Cycle

Varnish's solubility in lube oil is temperature dependent, and the lube oil has a finite ability to dissolve soluble varnish at any given temperature. The oil's saturation point in-

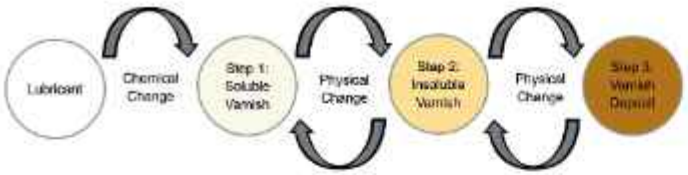


Figure 3. Varnish formation cycle.

creases with raised temperatures and decreases with lower temperatures. Lubricant saturation and thermal symmetries play key roles in the varnish life cycle.

During service, lubricants chemically degrade in an irreversible manner, producing soluble varnish, which accumulates in the solution (Step 1).

As soluble varnish builds up, the lubricant eventually reaches its saturation point. Beyond this point, any additional vanish produced will be insoluble. Continue degradation of a saturated lubricant produces insoluble varnish particles (Step2). These particles eventually agglomerate and produce deposits (Step 3).

Phase changes between soluble and insoluble varnish are physical in nature, therefore, they are reversible. Because the levels of varnish are dependent on temperature, once the varnish is deposited, conditions can be altered to positively shift the equilibrium and return the deposits to a dissolved soluble state. This ability to manipulate the equilibrium is key to completely removing varnish and mitigating the risks associated with it.

The majority of lubricant breakdown events occur in the hottest areas of asystem, known as "hot spots". The high temperatures in these hot spots warm the lubricant and increase its capacity to dissolve soluble varnish. As the lubricant varnish solution cools in other areas, the oil's saturation point decreases. Although the lubricant can accommodate the present soluble varnish levels when warm, these levels often exceed the lubricant's capacity in cooler areas.

When a fluid's concentration of soluble varnish exceeds its saturation point, the lubricant becomes supersaturated; soluble varnish will convert to insoluble varnish and deposits until it drops to levels that can be accommodated at that specific temperature. If nothing is done to address the levels of soluble varnish present at lubricant operating temperatures, the varnish will continue to precipitate and deposit in cooler regions.

Varnish Removal Technologies

Soft contaminants within the oil's equilibrium state tend to be submicron in size and are often both soluble and insoluble. They can be difficult to extract due to the high operating temperature of many in-service lubricants, which can cause them to change into a soluble state.

There are currently several filtration and separation technologies on the market that can intervene with the formation of varnish. By continually removing harmful degradation by-products, the concentration of varnish precursors is reduced, providing a cleaner working oil.

Balance Charge Agglomeration

The balance charge agglomeration (BCA) technology divides the fluid into two streams and charges the contaminant particles with opposite charges – positive(+) and negative (-). These charge particulates are recombined and mixed under a turbulent flow to form larger, neutral particles, which can be removed with traditional mechanical filtration devices.

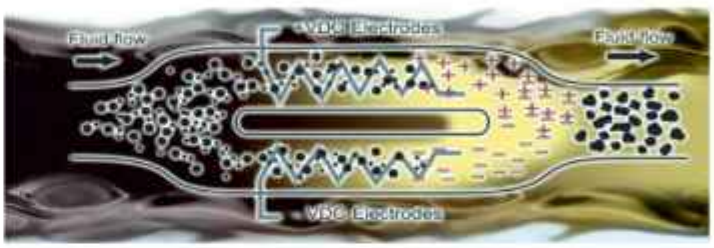


Figure 4. BCA technology.

Electrostatic Liquid Cleaner

The electrostatic liquid cleaner (ELC) system operates on the basic principle that opposite charges attract. With the help of a constant electric field, a positively charged particle is drawn toward a negative electrode within the system, and particles with an inherent negative charge are drawn toward a grounded plate. Polar contaminants (molecules having a non-uniform charge distribution – a main component of varnish) are drawn to the area of the greatest field strength of the collector media.

Electrostatic Separation Process

The electrostatic separation process (ESP) is the physical and/or chemical binding of atoms, molecules, or particles to a surface. The filtration process is comprised of adsorption and chemisorption. The media is designed to remove certain chemistries from the fluid without impacting healthy additive components.

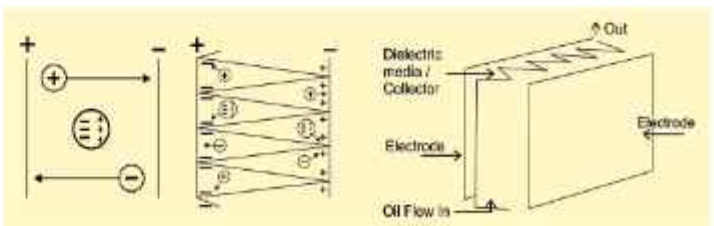


Figure 5. ELC Technology

This technology is advantageous because it removes selected degradation products regardless of if they are in suspension or in solution. Because of its chemical structure, varnish molecules are believed to be attracted to the adsorbent through weak molecular forces such as Van der Waals (or dispersion) and hydrogen bonding.

Varnish Removal by Adsorption

Adsorption is the selective physical and/or chemical binding of atoms, molecules, and particles to a surface – or adsorbent – such as activated carbon or silica gel. It is not the same as absorption: absorption is not selective and takes material into the absorbent material like a sponge does with water.

A major distinction between classical adsorption and filtration systems as a processing element is that the performance of the adsorber typically depends on temperature, flow rate, concentration, and other operating conditions, while filters are less sensitive to such conditions.

Some high-quality oil filters utilize cellulose, which can be used as an adsorbent. It has a high surface area, and due to its chemical nature, the fibers are well-suited to pick up oxygenated organic molecules such as varnish.

Chemical Cleaning

Chemical cleaning involves using chemicals to clean the lube oil system internally. The equipment is switched off, and the lube oil is drained out of the system. Certain chemicals are then used to flush the system to remove any varnish deposits from the internal surfaces. This is considered an effective method for removing internal varnish deposits, however, because the equipment has to be offline during cleaning, it can usually only be done during Test and Inspection (T&I) or planned outages.

Principle of Soluble Varnish Removal Technology

The soluble varnish removal technology will be connected to the lube oil tank in the form of a "kidney loop". The hot oil is drawn from the lowest point of the system tank to the soluble varnish removal technology through a transfer pump on the unit.

This filtration medium is a composite consisting of a cellulose fiber matrix and other materials that give it a high-void volume and open-fiber matrix. The resin-bonded, open-fiber matrix provides high permeability, which is necessary for the fluid to contact the large fiber surface area and for the varnish precursors to be absorbed. These specially formulated binder resins give the filter media a high affinity for the polar varnish precursors, resulting in high removal efficiency and retention of the material suspended in the fluid phase.

Selective ion exchange resins are mixed and formulated to absorb varnish within their porous structure. This absorptive nature is due to the polar attraction between ion exchange resignation and varnish contamination. There are large amounts of surface area by volume, making this process highly effective.

Soluble varnish removal systems use a specialized in charge bonding media that contains billions of sites capable of adsorbing soluble varnish. This adsorption relies on a preferential interaction between the varnish molecules and the sites present within the media.

Soluble varnish removal systems interrupt the varnish life cycle at its earliest stage and prevent soluble varnish from accumulating in the lubricant and forming harmful varnish particles and/or deposits. Since the soluble contaminants that they remove are prevalent at operating temperatures, these systems are also suited for continuous use during turbine operation.

When the soluble varnish is continuously removed, the levels present remain well below the lubricant's saturation point. This means that the risk of having varnish deposits in cooler areas or during shutdowns is effectively eliminated.

While the competing particulate removal systems are unable to remove both the soluble and insoluble varnish, soluble varnish removal

Figure 6. Soluble Varnish Removal Technology.

systems exploit the equilibrium that exists between these two phases to remove all varnish. This includes not only the varnish present in the lubricant but also the varnish which may have previously been deposited on equipment surfaces.

Piloting Methodology

This soluble varnish removal technology with a flow rate of 7.5 gallons perminute (GPM) was evaluated in collaboration with Saudi Aramco, where it was piloted on a M58-CGTG-07 Gas Turbine lubricant reservoir. The reservoir capacity was 1700 USG, and the machine was running with Gas Turbine Oil 32. The turbine was selected due to its high MPC (varnish potential) – a value of 35– which was confirmed by a sample analysis report, seen in Figure 7.

The soluble varnish removal system was installed on the lube oil reservoir for a period of roughly three months. Samples were taken from the device's outlet to test its effectiveness.

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Evaluation Methods

The evaluation of the soluble varnish removal technology was carried out both in the lab and field to assess its effectiveness at removing varnish from the in-service lube oil.

SOP087	ASTMD 1500	ASTMD445		ASTMD664		ASTMD2272
		WATER	Viscosity_40	pH	TAN	RBOT
Appearance	Color	0% Vol	cSt		mg/KOH/g	minutes
1.1	3.0	0.00	32.92	5.1	0.09	741

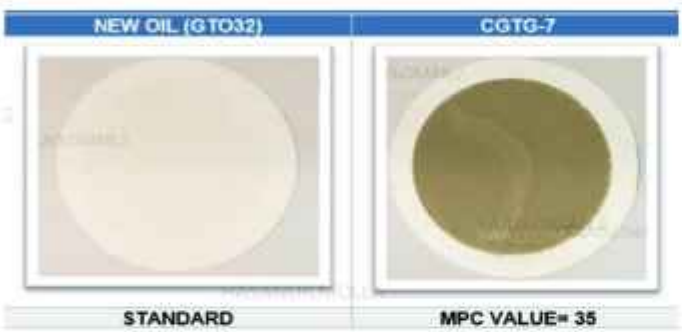


Figure 7. CGTG-07 LCM analysis report before soluble varnish removal usage.

The following analyses were performed to assess the condition of the gas turbine oils in service at CGTG-07.

- Varnish Potential by Membrane Patch Colorimetry (MPC): ASTM D7843.
- Acid Number (AN): ASTM D664.
- Oxidation by Fourier Transform Infrared (FTIR) Spectroscopy: ASTM E2412.
- RULER Antioxidant Additive Testing: ASTM D6971.
- Dissolved Metals: ASTM D5185.
- ISO Particle Count: ISO 11500 and ISO 4406.

Laboratory-scale soluble varnish removal columns were then prepared to assess the effectiveness of the fluid treatment using ion charge bonding media. A portion of each provided oil sample was then passed through the separate columns for 24 hours at a rate of 20 mL/minute and a temperature of 40°C. Following soluble varnish removal treatment, the analyses listed above were repeated, and their results were used to assess soluble varnish removal effectiveness in a lab.

Lab Evaluation Result

In total, Saudi Aramco submitted one fresh and one used Gas Turbine Oil 32 sample collected from the CGTG-07 Gas Turbine to the lab to determine the condition of the in-service lube oil and assess the effectiveness of the soluble varnish removal technology.

Sample	MPC ΔE	Patch Photo	AN (mg KOH/g)	ASTM Color	Additives	
					Amine (%)	Phenol (%)
M58-A193B	13.7		0.09	6.1	97	41
Post ICB™ RO	1.7		0.01	3.9	97	41
Change	-88%	N/A	-89%	-36%	-0%	-0%

Figure 8. Lab evaluation of ion charge bonding.

The results of the lab assessment are shown below:

The used oil's MPC suggested that varnish would become a serious problem in the near future. Fortunately, ion charge bonding efficiently removed the accumulated varnish, and the oil's MPC ΔE decreased by 88% following lab-scale soluble varnish removal treatment. With these dramatically reduced MPC values, the risks associated with varnishing were mitigated. In addition, since the soluble and insoluble varnishes deposited within a system exist in equilibrium with one another, the removal of soluble varnish would prompt previously deposited varnish to re-dissolve. Once re-dissolved, the soluble varnish removal technology would remove this varnish as well. These findings were corroborated by color and acid number analyses, which showed a 36% and 89% decrease in varnish precursor levels, respectively, and the fluid's acid number was brought down to better-than-new oil levels. These results highlight that the filter media not only already-present varnish, but also key varnish feedstocks.

Since varnish removal filtration occurs continuously, these varnish precursors can be removed as they form, completely preventing varnish problems. Finally, because the filter media is engineered to leave desirable additives untouched, no additive loss was observed with the in-service Gas Turbine Oil 32.

Field Evaluation

The final sample taken before completing the trial revealed that:

- The acid number, moisture content, and viscosity levels were all within the desired target range.
- The fluid's ISO particle count had decreased from 20/18/12 to 15/12/9.
- The MPC ΔE was now <15, indicating a low level of degradation by-products within the fluid.
- While silicon levels were above target and phosphorus levels were below, all

other dissolved metals were within the target range.

- The fluid's color level was above target.
- 100% of the oil's amine and 100% of the oil's phenol antioxidants remained similar to samples tested during installation, indicating there was no impact to the additives system in the lube oil.

Sample Date	AN (mgKOH/g)	SAN	H2O (ppm)	Viscosity (cSt) 40 °C	100 °C	ISO (particles / ml) 4µm	6µ	14µm	ISO Code 4/6/14µm	Resistivity (G ohm-cm)	Chloride (ppm)	Mineral Oil Cont.(%)	Air Release (min)
Target	0.08	N/A	< 200	34.5	N/A	480	120	8	16/14/10	N/A	< 50	N/A	N/A
10-Feb-22	0.09		11.2	.34.7	N/A	4897	709	3	19/17/9	N/A	N/A	N/A	N/A
14-Jun-22	0.10		21	33.9	N/A	9238	2249	25	20/18/12	N/A	N/A	N/A	N/A
25-Jul-22	0.06		28	33.0	N/A	2228	167	6	18/15/10	N/A	N/A	N/A	N/A
29-Aug-22	0.06		20	34.3	N/A	1073	327	4	17/16/9	N/A	N/A	N/A	N/A
20-Sep-22	0.07		23	33.9	N/A	276	38	5	15/12/9	N/A	N/A	N/A	N/A

Sample Date	Demulsibility data (mL) Oil	Water	Emulsion	Time (mins)	Membrane Patch Colorimetry (MPC) Hold Time (hr)	Patch Wt (mg)	MPC ΔE
Target	40	40	<3	<15	68 - 76	<2.0	<15.0
10-Feb-22	N/A	N/A	N/A	N/A	70	1.6	13.7
14-Jun-22	N/A	N/A	N/A	N/A	70	0.9	12.3
25-Jul-22	N/A	N/A	N/A	N/A	69	1.4	4.0
29-Aug-22	N/A	N/A	N/A	N/A	69	0.4	3.0
20-Sep-22	N/A	N/A	N/A	N/A	68	1.9	3.1

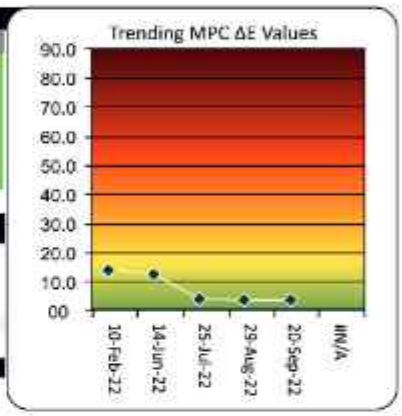


Figure 9. Sample results from start to end of trial.

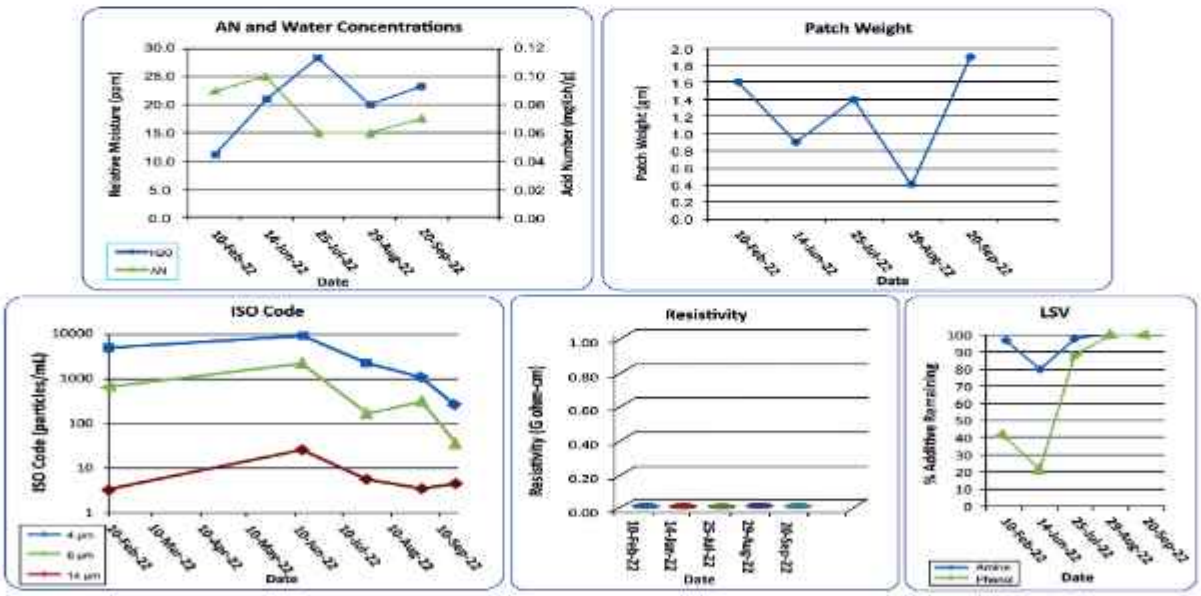


Figure 10. Trending of critical oil parameter during soluble varnish removal trial.

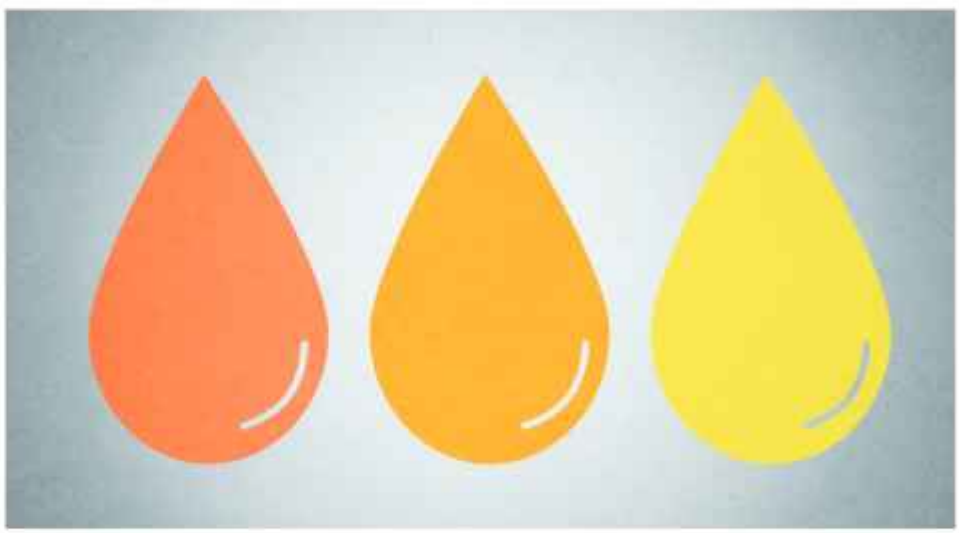
Note: This trial took place under controlled conditions. The results may vary depending on the unit condition and performance and the quality of the lube oil.

Conclusion

The application of a soluble varnish removal technology facilitated improvements to oil cleanliness by effectively removing soluble and insoluble varnish from the lube oil system. In addition to improving equipment reliability, it eliminated the need for immediate premature lube oil replacement, system flushing, and chemical cleaning.

THREE SIMPLE THINGS THAT ARE OFTEN **OVERLOOKED WHEN PERFORMING OIL ANALYSIS**

Oil analysis is a valuable tool for predictive and proactive maintenance and provides critical insights into the health and condition of machinery. Before embarking on an oil analysis program, there are a few straight forward points to keep in mind to ensure accurate and meaningful results. Let's explore these key considerations.



1. Providing Accurate Details

This information aids the laboratory in choosing the appropriate test and interpreting the results precisely including creating the baseline, caution limits, and critical limits. The process resembles how doctors diagnose patients — the more accurate the information you give your labs, the more precise the diagnosis you will get back. In the first topic, we'll classify our discussion into two main categories: registering for equipment and registering for lubricant samples.

Registering for Equipment

The registration process begins when maintenance teams decide to set up an oil analysis program for their machinery. Laboratories have to fill in specific asset details in their database. Here are the critical details that need to be provided:

- **Machine Identification Name and Number** : The designated name or label for the machine on which you intend to conduct the oil analysis should be one that's recognizable and commonly used by your team. While a site might have several machines that appear identical but are located in different places, the unique number associated with each machine is crucial to pinpoint the specific unit you've selected for testing.

- **Unit Type** : The unit type describes the general classification or category of a machine based on its primary function (such as an Engine, Turbine, Compressor, Gearbox, Motor, etc.). However, a more detailed description, like "high-pressure vane pump hydraulics," allows the laboratory to conduct a more targeted analysis using table of specific standards. If such specifics aren't provided, the lab will compare results with reference standards.

- **Manufacturer and Model of Machine** : Take "MITSUBISHI POWER M701J"as an example. Here, "Mitsubishi Power" represents the manufacturer

of the gas turbine, while "M701J" is its specific model. Typically, these details can be found on serial plates attached to the machine. Having this information aids in identifying the machine's metallurgy and the range of wear metals to expect.

- **Fluid Manufacturer, Type, and Grade** : Using 'SHELL TURBO T ISO 46' for illustration: 'Shell' is the name of the fluid manufacturer, 'TURBO T' is oil type, and 'ISO 46' defines its viscosity grade. This detail assists laboratory analysts to roughly classify the formulation components and specific properties of the oil based on the Technical Data Sheet (TDS). Each type of oil has its unique pattern of degradation.

- **Operating Condition** : The operating condition refers to the manner and environment in which a machine is used, encompassing various specific attributes such as the machine's working at high speed, exposure to shock load, continuous operation, or working in shifts. It would impact wear rates going forward and run-time exposures.

- **Work Environment and Ambient Exposures** : The working environment refers to the conditions which the machine is being surrounded by during its operation, such as in extreme cold environments, radiation-intensive areas, or high sulfur facilities. For instance, machines operating in a mining environment with excessive dust can typically result in elevated silicon levels.

- **Lubricant Application Knowledge** : This encompasses details such as total oil volume, operating oil temperature, the use of coolers or heaters for the oil, circulating systems, and splash systems, which allow lab analysts to better understand the overall application of the lubricant.

Sample Bottle Registration

Laboratories require you to submit updated details about your oil and machine every time you send an oil sample to the lab. This can be done either on a small paper form, through a label sticker attached to the sample bottles or by scanning a QR code to fill out a form via an app provided by certain labs. Below are the critical details that must be provided:

Machine Identification : The name and number should exactly match the registration for equipment. Oil analysis labs usually use machine names to link current results with historical data, forming a continuous trend. However, in factories where there are various machines and the staff changes frequently, issues may arise, such as calling a machine by a different name. Confusions such as "machine left vs. right" or "First machine from the bottom vs. First machine from the front" can arise. It's highly recommended to establish a procedure that clearly guides the team on proper sampling, machine names with pictures, and data entry, to ensure everyone is on the same page.

- **Sampling Point** : A single machine can have multiple components and various points for taking oil samples. Clearly identifying the sampling point ensures continuity with historical data from the same location, enabling consistent tracking over time.

- **Date Sampled** : This marks the day the oil sample was taken, revealing consistency interval for testing as planned.

- **Machine Runtime** : This represents the total operating time of the machine,- similar to car mileage. It helps analysts correlate machine usage with lab results.

- **Lubricant Runtime** : Unlike machine hours, this indicates how long the current oil has been in use. It helps the lab roughly determine whether the oil's degradation is consistent with its age or premature.

- **Hot / Cold Running Condition** : Specify whether the machine was inoperation or shut down when the sample was taken. Taking an oil sample after a prolonged shutdown might not be ideal, as sediments may have settled, resulting in a sample that doesn't truly represent the oil in actual machine operation.

- **Maintenance Action** : Maintenance actions refer to activities like oil changes, filter replacements, major overhauls, repairs, and oil top-ups. This action more or less directly affects the efficiency of oil. Furthermore, in case of a switch in the oil supplier, it is crucial to provide updated information regarding the fluid brand, type, and grade.

- **Report Abnormalities** : Reporting any noticeable abnormal symptoms of the machine and oil, such as stable foam in the sight glass, leakage, and bottom sediment, can provide additional beneficial information for interpretation.

- **Extra Test Request** : Request preferred exception tests (specialty test), such as analytical ferrography, which provides a more in-depth evaluation of wear particle identification.

2. Bottle Integrity

It is common to observe new customers using recycled water bottles to take samples of oil. Because these bottles could contain leftover water residue, the detection of water in these bottles might indicate sampling oil mixed with residual water contamination, rather than solely from oil sampling.

Even in actual working conditions, the presence of water might be in normal range. The best practice is to use the bottles provided by the lab, which adhere to a standard of cleanliness and ensure the most accurate results.

Bottle Storage (Before Delivery to Labs)

Typically, sample bottles are clear to easily spot sediment and the presence of free or emulsified water. After sampling oil, it's advisable to store the bottles at room temperature and away from sunlight. Ensure you do not store the samples for too long, though. It is best practice to send out the samples as soon as possible for current and accurate data.

Some articles explain how sunlight exposure can affect the MPC value (Membrane Patch Colorimetry) because if oil is left in the sun for a long time, it can darken and result in unusual MPC detection (especially in turbine oil). To prevent this issue, many labs provide non-translucent outer covers that can protect the sampling bottles from ultraviolet light exposure before they are delivered to the labs.

3. Sampling Conditions

While it's common knowledge that samples should be taken from representative areas and maintain oil sample hygiene, here are a few simple but important conditions to also consider:

Environmental Conditions : Before taking the sample, make sure the area around the sampling port is clean to prevent oil sample contamination.

Flush or "Purge" Before Sampling : It's important to flush the dead volume 5 to 10 times prior to sampling to ensure that the oil sampled is representative of the current state of the machine.

Sample at Operating Temperature : Taking the oil sample while the machine is in operation (if possible) ensures that the oil sample is closest to its working condition. This provides a more accurate representation of the oil's current state and performance.

Single-Use Sampling Tubes : If employing the drop-tube method, use the tube only once to prevent cross-contamination and ensure the most accurate representation of the current oil condition.

Consistency in Taking Oil Samples : Ensure that you are collecting the sample from the same location on the system and utilizing the same sampling procedure every single time. It is recommended to never fill a sample bottle more than 3/4 full.

Inspect Sample Before Sending to Lab : Check that the volume of the oil sample is sufficient for testing requirements. Conduct a visual inspection of the sample to ensure it is in a suitable condition for testing. Additionally, check for sediment, water, ferrous wear (using a magnet), and any changes in color (such as darkening or haziness) that may indicate maintenance concerns. Flag any issues to the maintenance team.

Conclusion

Oil analysis is a long-term investment with significant payback. The more accurately you gather asset data, the more valuable insights you derive. Future caretakers of the machinery benefit from the historical database of oil analysis reports, allowing them to make informed decisions and take necessary actions based on past trends.

DO'S AND DON'Ts OF SETTING CONTAMINATION CONTROL OBJECTIVES

It is pretty well understood, or at least widely stated, that what gets measured gets done. So it should come as no surprise that contamination control objectives should be implemented; they are our means of measuring the effectiveness of our equipment relubrication processes, not to mention how many of our other contamination control measures are going. When we set these objectives, though, we need to keep a few things in mind: consider this the Do's and Don'ts of setting contamination control objectives.

DO

Do set measurable and achievable goals.

Having solid goals that you can actually hit makes a huge difference, not just for the equipment but also for the entire reliability team. How frustrating would it be to have a goal that can never be achieved? Look at your process, operating conditions, lubricant demands, machine demands and criticality, and see what makes sense for your capabilities and reliability goals. "Pie in the sky" dreams are great, but we live in the real world, and we need real goals.

DON'T

Don't set a blanket statement and make it "the goal."

We can't just say, "I want clean oil in all of our equipment," and call it a day. We can't measure this in any meaningful way, and we don't even have a definition of "clean" to shoot for. ISO cleanliness codes are a simple way to start on this.

DO

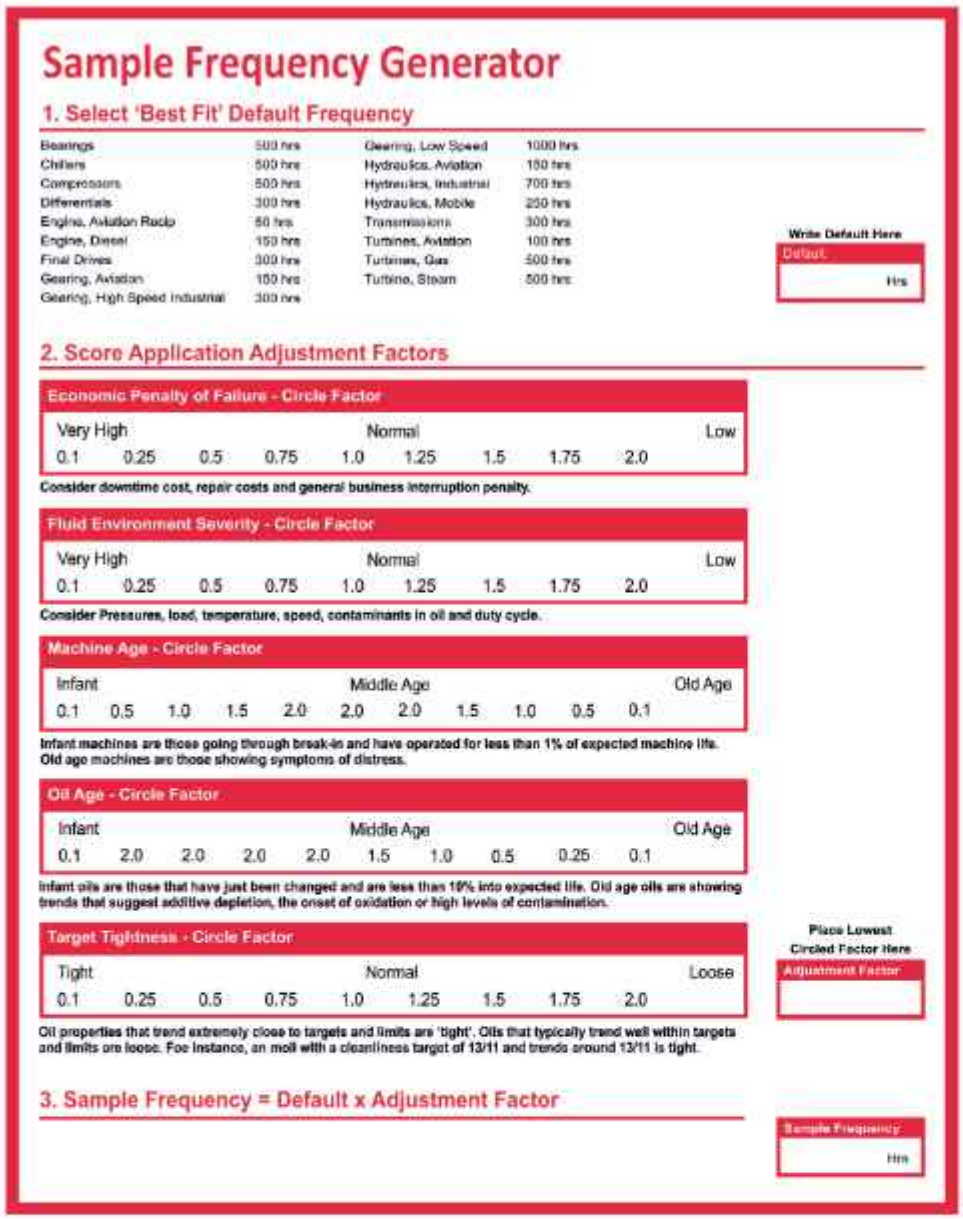
Do create a standard for how we are going to go about reaching the goals.

We need to have a set way of accomplishing something, and we need to all be on the same page (for both processes and procedures). When we are all doing these procedures, whether it is re-greasing a bearing or topping off a gearbox, we remove variables that will mess with the data that we are using to track our progress.

DON'T

Don't set standards and then forget about them.

If we have created standards, whether procedures or targets for oil cleanliness, we should



Sample Frequency Generator

1. Select 'Best Fit' Default Frequency

Bearings	500 hrs	Gearing, Low Speed	1000 hrs
Chillers	500 hrs	Hydraulics, Aviation	150 hrs
Compressors	500 hrs	Hydraulics, Industrial	700 hrs
Differentials	300 hrs	Hydraulics, Mobile	250 hrs
Engine, Aviation Recip	50 hrs	Transmissions	300 hrs
Engine, Diesel	150 hrs	Turbines, Aviation	100 hrs
Final Drives	300 hrs	Turbines, Gas	500 hrs
Gearing, Aviation	150 hrs	Turbine, Steam	500 hrs
Gearing, High Speed Industrial	300 hrs		

Write Default Here
Default
Hrs

2. Score Application Adjustment Factors

Economic Penalty of Failure - Circle Factor

Very High — Normal — Low

0.1 0.25 0.5 0.75 1.0 1.25 1.5 1.75 2.0

Consider downtime cost, repair costs and general business interruption penalty.

Fluid Environment Severity - Circle Factor

Very High — Normal — Low

0.1 0.25 0.5 0.75 1.0 1.25 1.5 1.75 2.0

Consider Pressures, load, temperature, speed, contaminants in oil and duty cycle.

Machine Age - Circle Factor

Infant — Middle Age — Old Age

0.1 0.5 1.0 1.5 2.0 2.0 2.0 1.5 1.0 0.5 0.1

Infant machines are those going through break-in and have operated for less than 1% of expected machine life. Old age machines are those showing symptoms of distress.

Oil Age - Circle Factor

Infant — Middle Age — Old Age

0.1 2.0 2.0 2.0 2.0 1.5 1.0 0.5 0.25 0.1

Infant oils are those that have just been changed and are less than 10% into expected life. Old age oils are showing trends that suggest additive depletion, the onset of oxidation or high levels of contamination.

Target Tightness - Circle Factor

Tight — Normal — Loose

0.1 0.25 0.5 0.75 1.0 1.25 1.5 1.75 2.0

Oil properties that trend extremely close to targets and limits are 'tight'. Oils that typically trend well within targets and limits are loose. For instance, an moil with a cleanliness target of 13/11 and trends around 13/11 is tight.

Place Lowest Circled Factor Here
Adjustment Factor

3. Sample Frequency = Default x Adjustment Factor

Sample Frequency
Hrs

have done so with a specific goal in mind, right? So why would we setthose things and then just let people completely forget about them? The standards should become a part of our everyday lives, integrated into how we complete tasks and do our jobs in general.

DO

Do modify your equipment and review your tools.

Machine modification can be a daunting task, but it doesn't have to be. Look at your reliability goals for that piece of equipment. Look at the aspects that might prevent you from reaching those goals, i.e.:

Does this machine need to breathe? Does it have clean and dry air to breathe? What do I need to do to make sure that it does have clean and dry air to breathe?

Are there tight targets for cleanliness? Do I have a way of getting clean oil into the machine? Would something like hydraulic quick connects help prevent unwanted contaminants from entering my machine?

Is this machine susceptible to water contamination? How is water/moisture getting into my machine? Am I using lip seals where I should be using labyrinth seals? Are there any early warning indicators, like bottom sediment and water bowls, or even moisture sensors, that can be installed?

DON'T

Don't buy every sensor on the planet and put it on your machine.

Sensors, quick connects and desiccant breathers are great tools, but not every piece of equipment warrants the investment. A non-critical piece of equipment may be more efficient if left to die on its own versus using every piece of technology available to extend its life.

There is no magic bullet when it comes to setting cleanliness targets or reliability goals for your facility, but doing proper contamination control doesn't have to be some daunting task. The first task should be to figure out your reliability goals for any given piece of equipment. Once that is figured out, you need to determine what cleanliness target will help you reach those goals. Here is a great calculator to help you out with cleanliness and dryness targets (remember, moisture is the second most damaging contaminant to your oil and machine).

Great! Now that we know how clean and dry we need to get our oil, how often do we actually sample it to make sure we are hitting our targets? We made a calculator (Figure 1) for that too!

Now, using these two calculators in tandem, along with your overall criticality, you should be able to easily determine what sensors or modifications should be performed to help you achieve your goals. If you are still having issues, or have questions about criticality and how to calculate that, send us a message, we will be happy to talk you through it (we might even have some tools available for that, too).

TASK-BASED TRAINING |

REGREASING AN ELECTRIC MOTOR

What is an Electric Motor?

An electric motor is a device that converts electrical energy into mechanical energy. It is a common type of motor used in various applications, ranging from industrial machinery and house hold appliances to electric vehicles and robotics.

The basic principle behind an electric motor involves the interaction of magnetic fields and electric currents. Typically, an electric motor consists of a stationary part called the stator and a rotating part known as the rotor. The stator contains a set of electromagnets that generate a magnetic field when an electric currentflows through them. The rotor, usually equipped with coils of wire, carries theelectric current.

When an electric current is applied to the motor, it creates a magnetic field in the stator. This magnetic field induces a force on the coils of wire in the rotor, causing them to interact with the magnetic field and generate a rotational motion. The rotor starts to spin, resulting in mechanical output.

Electric motors can be categorized into various types based on their construction and operational characteristics. Some common types include:

DC Motors : These motors operate using direct current (DC) and are commonly found in applications like electric vehicles, household appliances and small machinery.

AC Motors : These motors operate using alternating current (AC) and are widely used in industrial machinery, HVAC systems and household appliances. The most common type of AC motor is the induction motor.

Brushless DC Motors : These motors are similar to DC motors but do not use brushes and commutators for current switching. They offer improved efficiency, reduced maintenance and higher reliability.

Electric motors are crucial components in modern technology, providing the mechanical power required for a wide range of devices and systems. Their efficiency, control *lability* and versatility have made them indispensable in various industries.

Why Regrease an Electric Motor?

Regreasing an electric motor is important for several reasons:

Lubrication : Electric motors have moving parts, such as bearings and gears,that require proper lubrication to reduce friction and wear. Grease serves as a lubricant, creating a protective film between the moving parts, reducing friction and preventing metal-to-metal contact. Regular regreasing helps maintain optimal lubrication levels and ensures smooth operation, which can extend the motor's lifespan.

Heat Dissipation : Electric motors generate heat during operation due to the electrical and mechanical energy conversion processes. Adequate grease help dissipate this heat by acting as a thermal conductor. It absorbs and transfers heat away from the motor's components, preventing overheating and potential damage. By regreasing the motor, you ensure that the grease is fresh and capable of effectively dissipating heat.

Contaminant Protection : Electric motors are often exposed to various contaminants, such as dust, dirt, moisture and chemicals. Over time, these contaminants can enter the motor and mix with the existing grease, leading to the formation of abrasive particles or a breakdown of the lubricating properties. Regular regreasing allows for the removal of old grease along with any contaminants, providing a clean environment for fresh grease to be applied.

Noise Reduction : Properly lubricated motors tend to operate more quietly compared to poorly lubricated ones. By regreasing the motor, you can reduce the friction and associated noise generated by the moving parts.

This can beparticularly important in applications where noise reduction is crucial, such as in residential or office environments.

It is important to note that the regreasing frequency and procedure may vary depending on the motor type, application, and manufacturer's recommendations. Consulting the motor's user manual or seeking guidance from a qualified technician can help ensure proper regreasing and maintenance practices for your specific motor. It is important to follow the motor manufacturer's guidelines and recommendations for greasing intervals and procedures. Regular maintenance and periodic regreasing can help ensure the motor's optimal performance, longevity and reliability.

How to Properly Regrease an Electric Motor

1. Gather all the appropriate tools required to perform the procedure.
2. Verify that the grease gun's LIS code matches the recommended lubricant used in the electric motor bearing.
3. Clean the external surface and the area around it with a brush and a lint-free rag.
4. Remove the plug if fitted from each purge relief port and clean any hardened grease with a pipe cleaner.
5. Remove the dust cap if fitted from each, and clean off any grease with a lint-free rag.
6. Stoke the lever one or more times until clean grease discharges from the gun nozzle.
7. Wipe the discharge grease from the grease gun nozzle with a clean, lint-free rag.
8. Attach the grease gun nozzle to the grease fitting; do not hold the nozzle with your hand while applying.
9. Slowly at 3-5 seconds per stroke, apply 1/2 of the volume.
10. If you observe grease emerging from the bearing seals or purge relief port,discontinue greasing and record the amount added.
11. If you feel any abnormal back pressure, stop greasing and look for obstructions in the grease passages; use a pipe cleaner to remove the obstruction.
12. Gradually apply up to the maximum amount of grease to the bearing whileobserving the purge relief port.
13. Stop regreasing if you see grease emerging from the bearing seal or purge relief port.
14. Do not exceed the maximum calculated amount of grease for the bearing.
15. Disconnect the grease gun.
16. Repeat the steps for an outboard bearing grease fitting.
17. Record the volume of grease added for each bearing.
18. Clean the grease fitting and replace the grease cap.
19. If no cap is available, leave a dollop of fresh grease on the fitting.
20. Wipe up any grease from the grease gun nozzle and replace the cap.
21. If purge fitting is the plug type, allow the motor to run for 15 minutes to expel any excess grease.
22. Wipe up any grease purged by the relief port.
23. If fitted, replace the plugs on the purge port.
24. Collect and dispose of all consumables used during the procedure.

THE IMPORTANCE OF PROPER STORAGE AND HANDLING OF LUBRICANTS

As this issue of has been diving into all things tribology, let's take a minute to focus on some important aspects of the proper storage of lubricants . Lubricants play a crucial role in various industries, from automotive to manufacturing and beyond. They ensure the smooth operation of machinery and equipment, reduce friction, dissipate heat and prevent wear and tear.

However, to maintain their effectiveness and extend their shelf life, it is essential to store lubricants properly. In this article, we will explore the importance of proper lubricant storage and provide guidelines for ensuring longevity and efficiency.

Why Proper Lubricant Storage Matters

Prolonged Shelf Life

Lubricants, whether in the form of oils, greases, or other compounds, have a finite shelf life. Proper storage can help extend this shelf life, saving money and resources. Correctly stored lubricants maintain their original properties, ensuring consistent performance in critical applications.

This consistency is vital for machinery reliability and longevity. Proper storage minimizes the risk of contamination by moisture, dirt, or other contaminants, which can compromise the lubricant's performance and, consequently, the equipment it is meant to protect.

The first thing to focus on is the climate. Lubricants should be stored in a cool, dry place with a controlled temperature. Extreme temperatures can degrade the lubricant's quality. Ideal storage temperatures typically range between 50°F and 80°F (10°C to 27°C).

Lubricants should never be stored in direct sunlight or near heat sources, as this can accelerate oxidation and reduce the effectiveness of your lubricants. Just putting lubricants in a climate-controlled room is not proper storage we want to ensure that lubricant containers, whether drums, pails, or bottles, are tightly sealed. This prevents moisture, dust, and airborne contaminants from infiltrating the lubricant.

Ideally, we want to see some sort of filtra-

tion of new oils and then transfer them to a clean tank. If this is not possible, then we should always replace container caps or seals immediately after use to maintain product integrity.

Another thing we want to be aware of when it comes to lubricant storage is that we are not cross-contaminating lubricants — we want to see clearly labeled containers listing not only color but also shape, which provides multiple ways to verify the lubricant that is in the container.

Even small amounts of one lubricant mixing with another can alter their properties. Also, make sure to note the date the lubricant was received. This will help with the "first-in, first-out", regarding usage.

The Proper Handling of Lubricants

Now let's dive into the proper handling of lubricants. When handling lubricant containers, make sure to use clean tools and equipment to avoid introducing contaminants. A "top-up" container that can be filled without the removal of the lidis ideal.

As we discussed above, when it comes to usage of your lubricants the "first-in, first-out" rule of thumb prevents your lubricants from reaching the end of their shelf life before you use them. We need to make sure that we have a good wayto track the use of our lubricants, whether it be good old-fashioned pen and paper or on a computer-based tracker. Knowing the usage rate of your lubricants prevents you from possibly running out at a crucial time and also keeps you from over ordering.

Upon receiving new lubricants, examine them right away to ensure there was no damage or contaminants that were introduced during transit. A couple of tools to help keep contaminants like water and debris particles include desiccant breathers or filtration carts with quick-connect fittings through which you can addthe lubricants without exposing them to any contaminants in the environment.

Ensuring Consistency in Performance

This article has sought to shed light on the importance of this crucial practice and provide a comprehensive set of guidelines to help facilities master the art of lubricant management. Lubricants are not just substances in bottles or drums —they are the lifeblood of mechanical systems. Neglecting their storage can have profound repercussions, including a reduction to the consistency in performance.

A lubricant's role is to deliver consistent and efficient performance. If a lubricant's properties are compromised due to improper storage, machinery reliability is jeopardized. Consistency ensures that operations run smoothly, maintenance costs stay in check, and productivity remains unhindered.

Reduced Contamination

Lubricants are sensitive to contaminants like moisture, dirt, and impurities. The equipment they protect is reliant on their purity. Proper storage is the first line of defense against contamination, safeguarding both the lubricant's effectiveness and the machinery's longevity.

As we've explored through this article, temperature control, protection from heat and light, airtight containers, and avoiding cross-contamination are all vital facets of proper lubricant storage. Equally important are the principles of proper handling and usage tracking, which help organizations avoid waste, manage inventory, and reduce risks of running out or over stocking.

Environmental responsibility should be at the forefront of any organization's approach to lubricant storage. Developing a plan for the responsible disposal anda documented emergency-response strategy is a commitment to both the environment and the safety of employees.

In essence, proper lubricant storage and handling are the cornerstone of effective lubricant management. Neglecting these practices can lead to decreased lubricant effectiveness, equipment breakdowns, and even environmental hazards. By embracing and implementing these guidelines, industries can not only ensure the longevity and efficiency of their lubricants but also contribute to the overall success and sustainability of their operations.

After all, it's the meticulous care of these silent guardians that keeps the wheels of industry turning smoothly.

CASTROL AND BP ENLIST SHAH RUKH KHAN AS BRAND AMBASSADOR

Castrol, a renowned global lubricant brand under the BP Group, proudly announced its strategic partnership with Shah Rukh Khan, the iconic Bollywood superstar. This collaboration underscores Castrol's commitment to delivering top-notch lubricants.

Over the next two years, Shah Rukh Khan will be featured in digital, print, and TV campaigns, showcasing Castrol's extensive product range.

Mr. Sashi Mukundan, President of BP India and Senior Vice President of the BP group, expressed, "Our collaboration with Shah Rukh Khan signifies our dedication to innovation and excellence in the automotive sector. This partnership reflects our shared values of performance, reliability, and sustainability as we shape the future of mobility together."

Mr. Sandeep Sangwan, Managing Director of Castrol India Limited, echoed this sentiment, stating, "Our association with Shah Rukh Khan highlights Castrol's commitment to innovation and excellence, mirroring the actor's illustrious career. With Shah Rukh Khan onboard, we aim to enhance vehicle performance for generations to come."

Expressing his enthusiasm, Shah Rukh Khan remarked, "I am thrilled to partner with Castrol, a brand I've long admired for its dedication to performance. As a fellow automobile enthusiast, I believe Castrol's commitment aligns perfectly with my pursuit of excellence.

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