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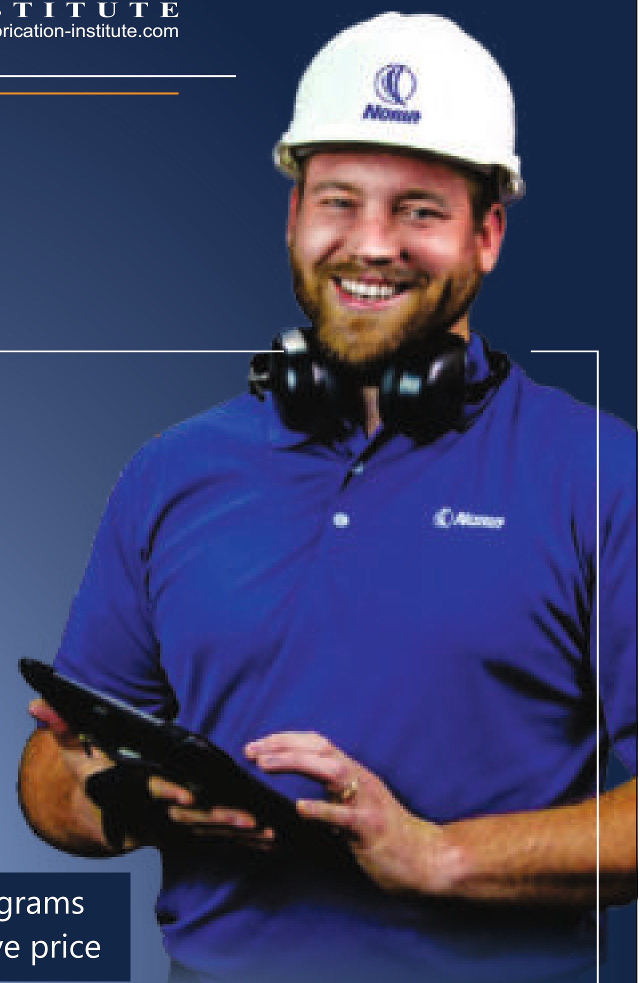

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MONITORING WIND TURBINE GEAR OILS WITH ONLINE SENSORS

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Publisher's Note

Machinery Lubrication India (MLI) magazine covers various advancements in lubrication industry and makes you a well-informed person.

The launch of Chandrayaan-3 mission encountered its share of challenges, yet ISRO scientists displayed unwavering perseverance and resilience, ultimately achieving success. A few leadership and management lessons from the successful launch of Chandrayaan-3 includes: There is no such thing as failure, learning from the past and adopting a proactive approach are vital, look life beyond the lens of pass or fail. Similarly, reliability engineers will encounter setbacks during their journey, but they must remain resilient and continue to progress.

"Any intelligent fool can make things bigger, more complex, and more violent. It takes a touch of genius—and a lot of courage—to move in the opposite direction.' —ALBERT EINSTEIN"

As rightly stated by Jim Fitch, CEO and a co-founder of Noria Corporation in one of his article, some lessons that we have learnt in lubrication and oil analysis are optimizing the state of lubrication. These are fundamental concepts that are largely underdeveloped and need to be understood as the foundation of any transformational strategy by users. Among these lessons learned include:

- Lubrication is heavily influenced by behavior science. Machines fail largely by human agency, i.e., things you do that you shouldn't and things you don't do that you should.
- Lubricant-induced machine failure is highly controllable. The greatest amount of this control lies with the user organization.
- Clean, dry and cool lubricants yield huge reliability returns (proactive maintenance).
- Lubricant starvation is a pervasive, yet largely unrecognized cause of premature machine failure. Moderate lubricant starvation is often difficult or impossible to detect.
- Skillful, daily one-minute inspections are very effective at early detection of many common lubrication problems. This sounds simple enough, but most routine inspections are horribly inadequate.
- Users typically only get about 10 percent of the available benefit from oil analysis. Many critical improvements relating to the quality of sampling, frequency of sampling, quality of the test slate and interpretation methodology often remain untouched.
- Education enriches the maintenance culture and is a strong impetus to change and improve the lubrication program.
- Procedure - based maintenance strengthens the awareness and importance of correctly performed tasks. Documenting best practice in work procedures conveys the need to do the right things right the first time and every time.
- Machine criticality and other risk factors should be used to properly establish maintenance priorities and focus resources. Knowing both the probability and consequences of machine failure is a much better way to optimize a program transformation.

The cover story takes a detailed look into how online sensors show their value in monitoring wind turbine gearbox (WTG). The oil cleanliness in a WTG is hugely affected by load, idle or standstill, and only sampling every six months makes trending even more inaccurate. With online sensors you can accurately monitor many times per hour and give immediate access to trending data. Some other topics covered in this edition includes: Why lubrication should be outside the CMMS, a history of oil analysis, how to inspect a desiccant breather, story of Elijah McCoy: A founding father to machinery lubrication, how to inspect a bullseye sight glass, lubrication standards manual—the need for documentation

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

Wes Cash | Noria Corporation

WHY LUBRICATION SHOULD BE OUTSIDE THE CMMS

"lubrication is a program and not simply a process or a task

Those tasked with managing industrial facilities are data-centric, and they desire to track and improve virtually every aspect of the plant. Think about your plant or the last plant you walked through; you likely saw scoreboards or dashboards showcasing key information related to safety, production, maintenance, environmental or other programs that are managed to ensure proper functionality of the machinery and staff.

For improvement to be possible, we must be able to measure; to measure, we must be able to observe. This is where many fall short in their lubrication program — there is no way to observe the program, as it can't be measured or improved. A great need exists in the industry for a method to manage the chaos associated with lubrication.

Let's begin by defining lubrication as a fundamental activity for equipment reliability. Regardless of the methodology of asset management you subscribe to, lubrication is one of the key elements required to achieve high levels of equipment reliability. This means lubrication is more than simply — a task as it is a collection of activities that must be correctly performed in order to achieve the desired result.

The definition of a program is "a set of related measures or activities with a particular long-term aim." This means lubrication is a program and not simply a process or a task; by definition, it is related to a long-term goal. This begs the question: Does anyone treat lubrication as a factor in their facility's long-term-goals?

Most would likely respond that there are long-term goals associated with-production, maintenance or safety and would quickly say that lubrication would be wrapped up inside of these. While lubrication is certainly involved with these aspects (as well as many more), it becomes difficult to truly measure the effectiveness of our lubrication program when it is buried inside other data sets. This is why lubrication needs to be managed and controlled separately from other programs within the facility.

A LUBRICATION MANAGEMENT SYSTEM

Perhaps the most common place where lubrication is considered to be managed is within the computerized maintenance management system (CMMS). These systems provide insight into

maintenance activities, help schedule work and often serve as the main metric gathering place to showcase improvements in maintenance. Since lubrication is often performed by maintenance technicians, it typically gets crammed into the CMMS, with little thought as to whether this is actually the best place for it or not.

There are many reasons why lubrication should exist outside of a CMMS system and reside in its own system a Lubrication Management System (LMS). A proper LMS will be able to provide all the necessary information required to understand what is happening in a lubrication program, as well as aid in the ability to track and assign work and plan for future events. The time to employ an LMS in each facility is now, and the benefits of doing so will compound for decades to come.

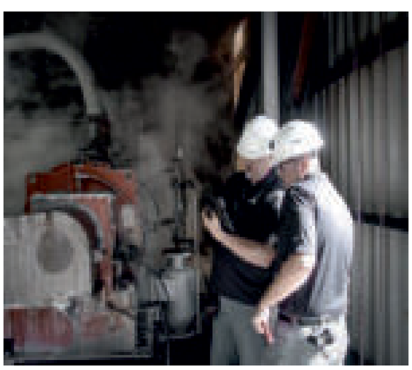
REASONS LUBRICATION SHOULD EXIST OUTSIDE THE CMMS

Lubrication work is different from maintenance and production work and virtually different from work that exists within the different systems utilized inside facilities to track them. While the CMMS is a powerful tool, there are several reasons that lubrication should exist outside the CMMS:

The number of tasks that are generated in a lubrication program

Lubrication has tasks that are to be completed daily (and sometimes even multiple times a day). A CMMS specializes in PMs that are due routinely but typically not at this level of periodicity. This results in far too many tasks, leading in turn to missed work from the CMMS. A related issue to the number of work orders or tasks that would be generated is the skewing of the dataset, which is often a critical metric in maintenance work order completion.

Imagine this scenario: You are a lube tech working in a facility, and the time has come for you to do your lubrication work in a specific area of the plant. This area includes dozens of small machines



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that must be greased; this is in addition to a few dozen machines that you weren't able to complete lubricating yesterday. The CMMS kicks out well over a couple of hundred work orders related to the lubrication activities. A manager logs in and sees a mountain of open work orders as well as a backlog of other work orders that are now overdue. The compliance metric is now in the red, and the decision has been made to close all open work orders to give us a chance to reset and start fresh. In that process, a critical PM was accidentally closed, and two weeks later, a catastrophic machine failure stopped production for 48 hours.

While the scenario above may sound far-fetched, these events happen at plants across the world every day. Extracting lubrication work into its own LMS allows the CMMS to focus on maintenance activities and provides visibility into the lubrication work. It simultaneously gives you the ability to improve both programs.

A lack of critical lubrication information

The critical information needed to accurately lubricate a piece of equipment is seldom found attached to the equipment in CMMS. This information could include the volume of lubricant, the type of lubricant, the proper procedure to lubricate the component and other pertinent data. Many work orders contain a simple statement like, "clean, inspect and lubricate the machine." And while being succinct is important, these instructions lead to inconsistent lubrication activities being performed.

A goal of any LMS would be to ensure that lubrication is performed as consistently as possible. To achieve this, you must have solid data for all aspects of lubricating the machine. This would include detailed instructions, pictures and all the information regarding the tools and consumables needed. This level of detail is seldom found in the CMMS and requires significant focus in order to collect and document. The LMS serves as a living receptacle for this information.

Hierarchy constraints

The hierarchy of CMMS constrains where lubrication tasks should be assigned. For many, the PM exists at the machine level, but realistically, the lubrication work occurs at the component/maintenance point level. A single machine could have hundreds of lube points, toward which the CMMS provides no specificity. The LMS treats the point individually, so you get a more microscopic view of the equipment to understand all the discrete tasks that must be performed.

Depending on what CMMS you utilize, you will be forced into a certain level of hierarchy which, in turn, determines how deep you can drill down into your data. While this may be fine in the maintenance world of determining the mean time between failures (MTBF) of a component or machine, it doesn't allow you to understand how many tasks are being performed, and you completely miss the detailed information that comes from looking at a machine from the aspect of an individual lube point.

Take the example of an electric motor: At the CMMS level, you might see it as a single component. If you have solid data, you will be aware of any differences in bearings between the drive end and the non-drive end. That, however, is where the level of detail stops. This same example in an LMS would be able to provide the individual lubricant volume for each point as well as an individual inspection result from each point. This allows managers to quickly determine if a problem exists on one side of the motor instead of trying to interpret a generic "the motor is getting hot" message.

Lubrication-centric metrics

Lubrication is a program, much like maintenance is a program. Most CMMS allow for the tracking of metrics related to maintenance but are not specific enough to provide metrics for lubrication. This is a Deming problem: If we can't observe it, we can't improve it. The CMMS is the data pool for most of the key maintenance KPIs and is reviewed constantly. With many of the issues listed above, you can understand that since lubrication can't be tracked effectively in a CMMS, there exists a lack of data to drive the lubrication program.

The lubrication program needs to have its long-term goal and key metrics identified and tracked. With the use of an LMS, you would be able to track each lubrication task individually, as well as a roll-up. Some key metrics like route compliance, contamination control compliance and lubricant consumption ratio become much easier to pull and analyze. Having this data readily available also gives you the ability to provide some predictive analytics to forecast lubricant needs in a timely manner. With the supply chain issues of late, being able to order well in advance helps minimize any emergency situations which may arise from not having the correct lubricant on hand.

Schrödinger's cat for lubrication

Lubricated programs may fall victim to the sociopsychological phenomenon known as Diffusion of Responsibility. This concept posits that an individual is less likely to take responsibility for an action (or inaction) when they are part of a group-instead of taking action, the individual assumes another member of the group has already done so or will do so in the future. For example, take a bearing on a conveyor. This bearing gets walked by every day by several operators, mechanics and supervisors. At this plant, lubrication is considered a"shared responsibility" between maintenance and operations. Each person that walks by this bearing notices that it is making some noise but figures someone else will be by with a grease gun in hand. So, this bearing runs until it fails due to a lack of lubrication. It would very easily happen the opposite way as well. For example, everyone walking by with a grease gun gives the bearing a shot of fresh grease and, in no time, the grease has blown the seal, and the bearing is on borrowed time until contamination and leakage cause a failure.

Without a mechanism to have accountability for tasking and ensuring that the task gets done, our equipment might be either over or under-lubricated. Much like Schrödinger's cat, the equipment is unobserved and, for all we know, could be in either state. Since the CMMS doesn't typically track to this level of accuracy (or when operations perform lubrication, they might not be using a CMMS), we don't have the ability to understand what is happening and by whom. Therefore, an LMS should be employed to shine a light on these scenarios.

ASSET MANAGEMENT BEST PRACTICES

The term Lubrication Management System exists in ICML's global standard ICML 55. This standard was written by dozens of experts in the fields of lubrication, maintenance and reliability scattered across the planet. Industry as a whole is focusing on key initiatives like reliability and sustainability. In order to achieve these initiatives, people are looking at standards such as ISO 55000 and, specifically for lubrication, ICML 55. These are key standards for asset management to focus on reliability, thus ensuring the sustainable operation of a plant. Asset management may involve the physical assets such as equipment, human resource assets such as people, and knowledge assets such as documentation and trainings. All of these must be analyzed, and a management-plan must be put in place.

Workforce turnover is a very large problem, and it doesn't just affect us here in the US because of retirement or attrition-it is a key item in the global industry as well. Industrial employers are looking for creative ways to attract, train and retain the best talent they can. In lubrication, an LMS can be a tool that allows employers to market themselves as leaders in the industry.

Put yourself in the shoes of someone interviewing for an industrial job, whether it be in lubrication, maintenance, operations or any other front-line position. In the back of your head, you're probably thinking about an industrial facility being noisy, hot, dirty, etc., and you likely conjure up thoughts of these jobs being mindless or pointless. During the interview process, you are shown a handheld device (not unlike the phone that you are accustomed to) that details your work and tells you everything you need to know regarding how to properly lubricate and inspect a physical asset. Furthermore, you can see how everything you put in that device adds to the reliability of the equipment you are tasked with maintaining. Your boss will be able to see all the effort you are putting in and reward you for that.

Being able to showcase that the work you are doing is meaningful and impactful is one of the key factors of job satisfaction and engagement. This is hard to do in lubrication without an LMS and often leads to people feeling like they are in a dead-end job and their effort isn't appreciated. For nearly three decades, it has been Noria's mission to address just that. We believe that lubrication is a catalyst to remarkable machinery reliability, and to do lubrication correctly, we have to empower the people that are performing these tasks daily.

There is no time like the present to get intentional with what you are doing in lubrication and reliability, and there are tools in the market to help achieve lubrication excellence. We need to stop relying on rigid CMMS structures that can't treat lubrication properly and look at an LMS that can provide the necessary information to elevate lubrication as a program, as a profession and as a pillar for world-class reliability.

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Steffen Nyman; Morten Henneberg

MONITORING WIND TURBINE GEAR OILS WITH ONLINE SENSORS

INTRODUCTION

We have known for decades that clean oil will improve system reliability and uptime, as well as prolong component and oil life in service . This is especially top of mind for wind turbine owners and operators. Oil analysis is used to predict failure and hinder un-scheduled downtime. However, the oil analysis mainly shows the status at the specific time of the sample, and it is difficult to ensure the sample is completely representative. The oil cleanliness in a wind turbine gearbox (WTG) is hugely affected by load, idle or standstill, and only sampling every six months makes trending even more inaccurate.

This is where online sensors show their value: they accurately monitor many times per hour and give immediate access to trending data. This article will evaluate oil cleanliness and the state of oil degradation/quality on 10 wind turbine gearboxes using online sensors.

MONITORING OIL USING ONLINE SENSORS

Online oil sensors give real-time data and help you predict a bad trend, which could lead to a serious situation. The best online condition monitoring systems consider oil degradation, water content and particle count as well as machine load. In this paper, we will focus on particle counts and oil degradation/quality measured by resistivity since water issues are quite rare in wind turbine gear oil. Obtaining the best possible installation point for the online sensors is vital to get the most representative data. Tests

Figure 1: Near-shore wind turbines

have shown that the offline/kidney loop oil filter circuit is ideal for online analysis due to the continuous homogeneous flow and suction from the bottom of the oil reservoir. Optimum conditions are there by present for the evaluation of particles, water and oil degradation.

OIL DEGRADATION SENSORS

The oil quality or state of degradation can be evaluated using sensors that measure resistivity, which correlates to oil aging by oxidation, acidity and water content. Resistivity is well-known in the power industry, where transformer oils have been monitored by resistivity for more than 50 years.
A reduction in resistivity indicates the oil is

Figure 2: Oil Quality sensor.

degraded or contaminated. Resistivity sensors can thus be used to assess the oil quality/degradation and recommend actions such as sweetening, filtration or a full oil change.

In gearboxes, degraded oil will often result in varnish and increased viscosity, which create problems like increased friction, poor cooling, etc. In addition, the oil may be difficult to pump during cold start-ups, which may lead to cavitation or even starvation. Oil degradation will reduce the oil's in-service life, which will result in premature oil changes, increased gearbox wear and even risk of a complete failure.

Figure 3:States of degraded oil.

Figure 3 shows progressive states of oil degradation, which can be detected by means of reduced resistivity (online Oil Quality sensor).

ONLINE PARTICLE COUNTING

Particles will be created during the operation of any machine, influenced by load, rotational speed, oil temperature, oil additives, etc. But if the oil is kept mostly free from contaminants, wear will be reduced to a minimum. Furthermore, it is much easier to discover an abnormal wear trend when the oil cleanliness is good, compared to seeing an increase in particle counts in a very contaminated oil.

BENEFITS OF ONLINE PARTICLE COUNTING

- Early warning: If the trend increases, a worn component can be replaced before larger issues arise, e.g., replacing a ball bearing before a total breakdown of the gearbox.
- Oil analysis and maintenance can be scheduled according to the online data, e.g., indicating a bad wear trend, which requires an in-depth oil analysis or onsite investigation.
- Instant data access and visible trends can support more precise decision-making in case of overhauls, as well as improved maintenance practices and intervals.

TRENDING DATA USING A WEB-BASED USER INTERFACE

The data in this study is collected using C.C. JENSEN's cloud solution (CJC®T2render), which receives data from the CJC® Condition Monitoring Unit (CMU). The CMU can incorporate multiple sensors, but in this study, we will focus on particle counts according to ISO 4406 as well as resistivity, indicating the oil quality and state of degradation.

From the sensors, the encrypted data are sent via a secure connection (4G, Wi-Fior Ethernet) to a cloud-based solution for further analysis. The data can be provided directly to a surveillance system (SCADA system) or followed on a web-based user interface.

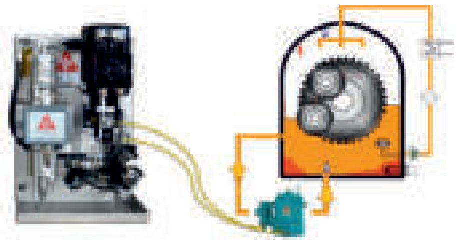


Figure 4:Condition Monitoring Unit with sensors,-connected to the CJC® offline filter, which is installed as a kidney loop on the gearbox.

Alarms are sent to the operator by email or text message when pre-set limits are-surpassed or when the individual system oil and equipment trend varies from normal operation. This reduces the complex and time-consuming interpretation of data from individual sensors from influencing each other.

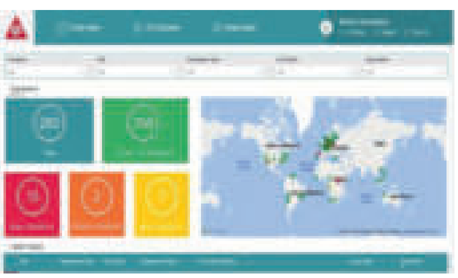


Figure 5: The web-based graphical user.

CASE STUDY - MONITORING PARTICLES AND OIL QUALITY/ DEGRADATION ON 10 WIND TURBINE GEARBOXES

This study looks at data taken from 10 WTGs installed in Europe, North America and South America, with rated power from 0.9 MW to 3 MW and a mix of on-shore, near-shore and off-shore installations.

Overview:

- 4 x Siemens, 3 MW (off-shore)
- 2 x Siemens, 2.3 MW (near-shore)
- 1 x Vestas V90, 2 MW (on-shore)
- 1 x GE, 1.6 MW (on-shore)
- 2 x NEG Micon, 0.9 MW (on-shore)

The 10 gearboxes were all fitted with a CJC® 3-micron offline/kidney loop oil filter for maintaining gear oil cleanliness. Some of the WTGs had the 3-micron offline filter (OEM fitted), and some had the filter retrofitted later in the WTG's life.

During the operation of a gearbox, any changes in load, start/stop, temperature, wind gusts or other stress factors will create particles visible to the online particle counter.

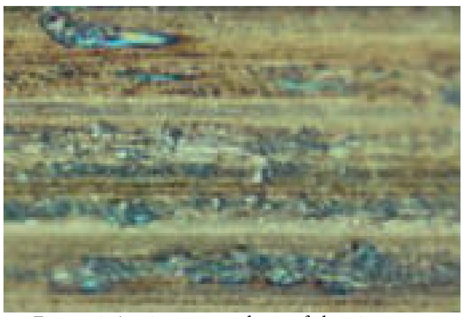


Figure 6: A microscope photo of abrasive wear.

Smaller particles, up to 10 microns in size, are seen during normal abrasive wear (4 and 6-micron counts in the ISO 4406 codes), while particles larger than 10 microns indicate severe wear, fatigue or adhesion (14-micron and larger in the ISO 4406 codes).

It is, therefore, of the utmost importance to ensure that additional particles created during stress/load changes are removed as quickly as possible to limit the time in which they can damage gears, pumps, bearings, etc. anywhere with an ultra-thin oil film clearances less than 3 microns. A particle wedge between moving surfaces creates hundreds of new particles, sending the wear in an increasingly vicious spiral.

An increase in the number of 14-micron and larger particles indicates an "out of normal" operation, with possible severe abrasion, adhesion or fatigue propagation. Testing of particle distribution in used oil (Figures 6-9) shows that normal abrasive wear results in exponentially distributed particles with close to no particles of size 14 µm or above.Microscope inspection of the worn surface support

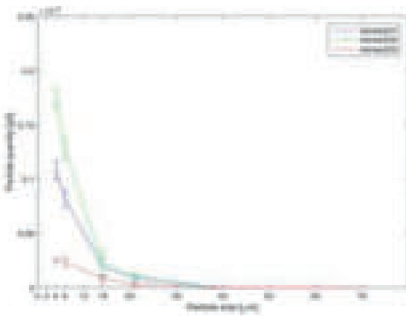


Figure 7: Particle distribution curve for abrasive wear, measured with an online particle counter

wear scars below 5 µm.

When fatigue wear modes are investigated, the distribution curve changes and particles larger than 14 µm are detected in greater quantities. This is also supported by the visual surface damages that range from 50 µm to 100+ µm in diameter.

It is essential that the oil filters can keep up

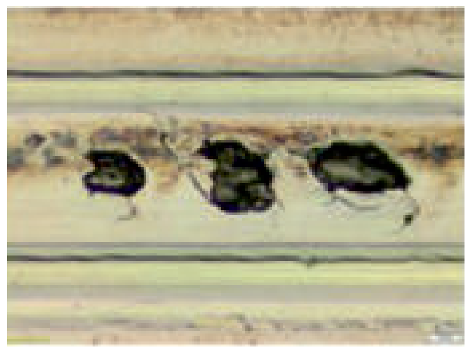


Figure 8: A microscope photo of severe wear.

with the particles generated during operation. If the filters cannot, then the oil will get progressively more contaminated, resulting in reduced component and oil life.

The particle counts on WTG oils with a 3-micron CJC® offline filter installed are typically ISO 15/13/10 according to ISO 4406 (see test results Figure 10).

Particle counters typically use optical light extinction sensors, as do the online sensors in this study. The particle counts detect particles bigger or equal to 4 microns, bigger or equal to 6 microns and bigger or equal to 14 microns. The counts are converted into ISO codes/classes according to the ISO 4406 table (see Figure 11).

The online particle counters used in this study are Oil Contamination Monitors (OCMs), which measure the particle counts for five minutes, averages them, and converts them into ISO codes; the cycle then repeats.

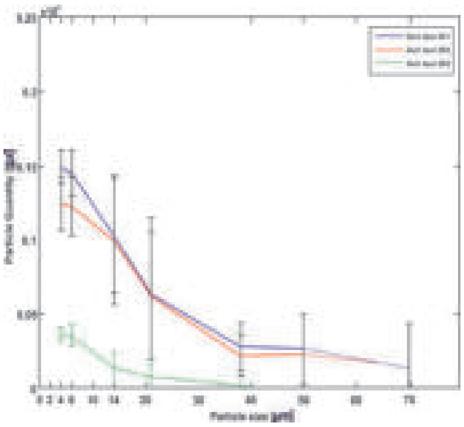


Figure 9: Particle distribution curve during abnormal wear generation (fatigue wear) measured with an online particle sensor.

It is possible to see the ISO code trend as raw data or to smoothen data out overa 24-hour period.

Table 3: Purity classes in accordance with ISO 4406		
Number of particles per 100 ml		
Over	Up to	Purity class
8,000,000	16,000,000	24
4,000,000	8,000,000	23
2,000,000	4,000,000	22
1,000,000	2,000,000	21
500,000	1,000,000	20
250,000	500,000	19
130,000	250,000	18
64,000	130,000	17
32,000	64,000	16
16,000	32,000	15
8,000	16,000	14
4,000	8,000	13
2,000	4,000	12
1,000	2,000	11
500	1,000	10
250	500	9
130	250	8
64	130	7
32	64	6
16	32	5
8	16	4
4	8	3
2	4	2
1	2	1

Figure 11:4406 conversion table.

Looking at raw data over a long period, say-four years, will impair the opportunity to see a trend, but averaging the ISO code raw data into 24 hours enables us to see the trend more easily.

ANALYSIS RESULTS		Current sample	11 previous samples not shown		
LAB NUMBER		2966908	2783652	2634838	2590081
SAMPLE RATING		✓	✓	✓	✓
Date tested		03.11.2015	07.04.2015	13.10.2014	03.03.2014
Date of sample taken		26.10.2015	30.03.2015	07.10.2014	21.02.2014
Date of last oil change		21.05.2008	-	-	-
Top-up since change		-	-	-	-
Operating time since change		-	-	-	-
Total operating time		120940	115940	111806	106467
Oil changed		-	-	no	no
ADDITIONAL TESTS					
AN / NN	mgKOH/g	0.92	0.89	0.94	1.07
Cleanliness class	ISO 4406 (1999)	15/13/10	15/13/10	18/17/14	15/13/11
A: >4µm = ISO >4µm	Particles/100ml	18379	21297	236423	20047
B: >6µm = ISO >6µm	Particles/100ml	4810	6879	85784	4174
C: >14µm = ISO >14µm	Particles/100ml	556	856	9522	1552
D: >21µm	Particles/100ml	140	182	2267	300
E: >38µm	Particles/100ml	0	39	151	0
F: >70µm	Particles/100ml	0	0	0	0
Cleanliness class	SAE AS 4059	5A	5A	5A	5A

Figure 10: Typical particle counts on WTGs with 3-micron CJC® offline filters (bottle sampling).

APPLYING THE BOX PLOT

A box plot model can be used to average the ISO codes over four years. Here the meridian is indicated by the redline, and 50 percent of all data are in the blue box, while 99.3 percent of all data are within the whiskers indicated by black lines.

Red points indicate outliers — measurements larger/smaller than 99.3 percent of the data. Applying the box plot model to ISO codes (4, 6 and 14-micron particles) for the10 WTGs in this study:

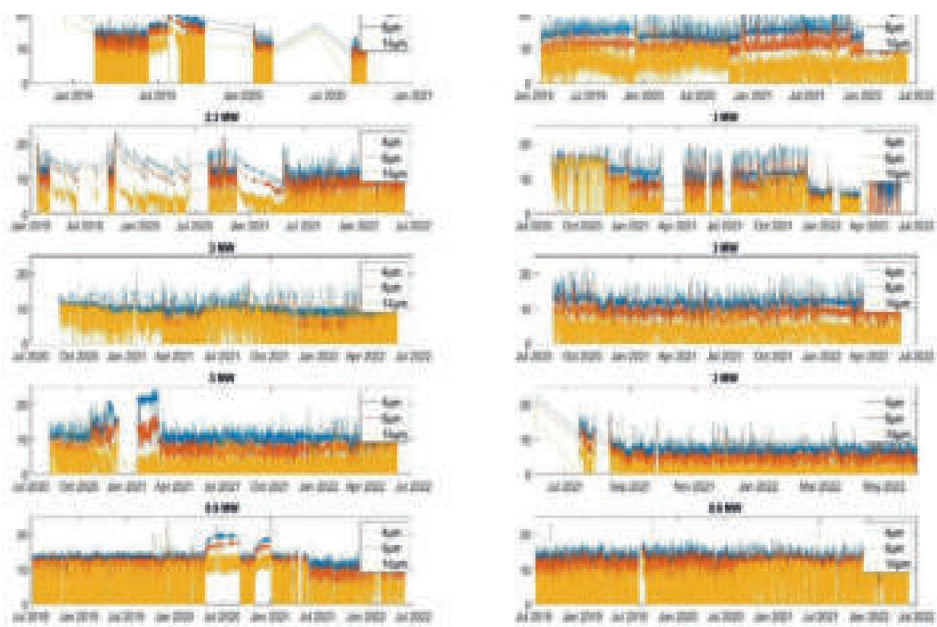


Figure 12: Raw data of ISO codes for 10 WTGs between 2018 – 2022.

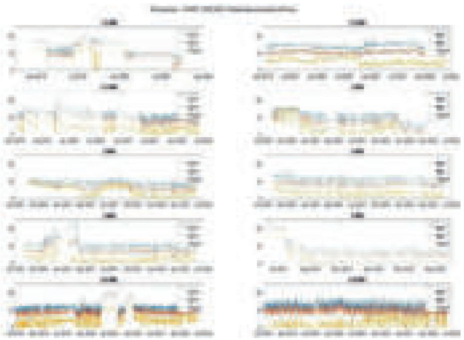


Figure 13: Average 24-hour ISO codes for 10 WTGs between 2018 – 2022

The wind turbine gear oils in this study are, in general, all super clean, with very few particles larger than 14 microns, meaning no indication of abnormal wear. The "normal" ISO codes for these 10 healthy WTGs sums up to be:

50 percent of the data are in the box from ISO code 10/7/1 up to ISO 14/11/6.

(ISO code 6 equals only 32-64 particles in 100 mL oil.)

99.3 percent of the data are within the whiskers from ISO code 4/1/0 to 20/14/15.

Alternatively, this can be written as: ISO 12/9/5 +/-2 (50 % of data) and ISO12/9/5 +/- 8 (99.3 % of data).

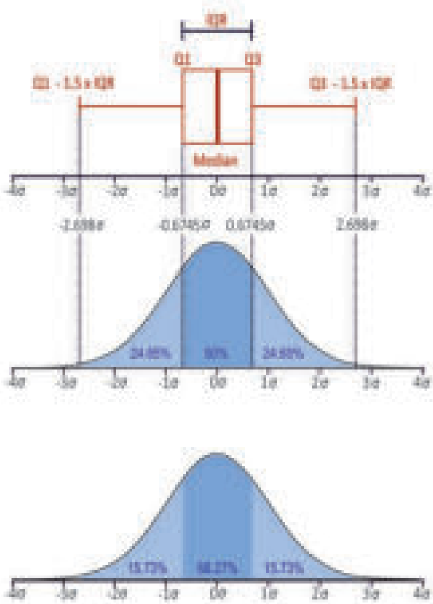


Figure 14: Box plot model explained.

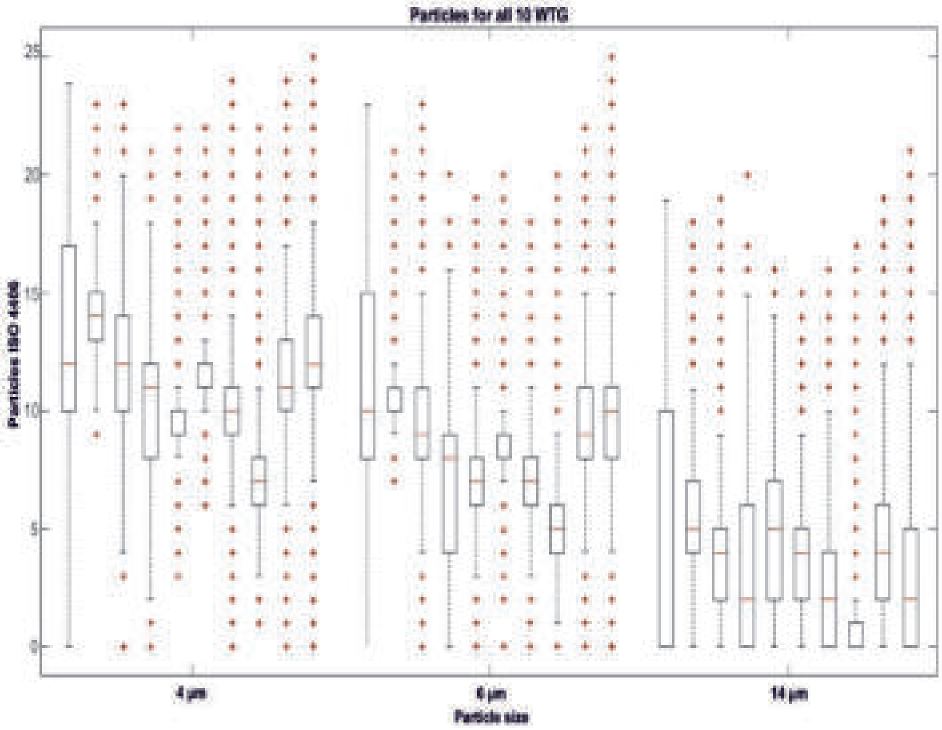


Figure 15: Box plot of ISO codes for the 10 WTGs, separated into 4, 6 and 14-micron.

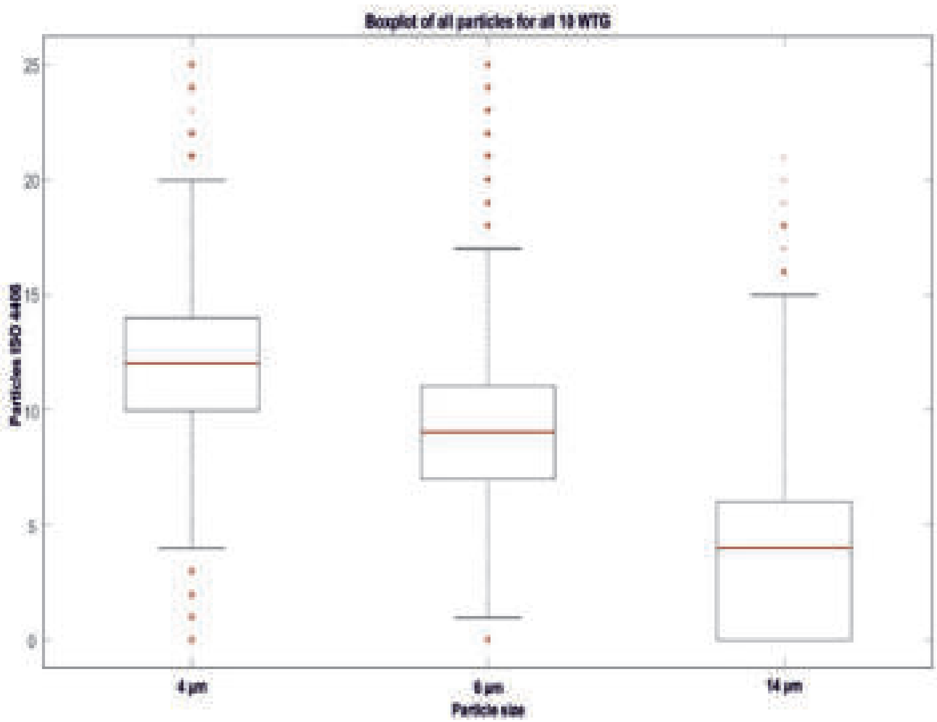


Figure 16: Average oil cleanliness ISO code for the 10 WTGs (4, 6 and 14-micron).

Evaluating the 10 Wind Turbine Gear Oils in Terms of Oil Degradation. The same 10 wind turbine gearboxes were also fitted with online oil quality sensors, CJC® Oil Quality Monitors (OQMs), to evaluate the degradation state of the oils by means of resistivity.

All WTGs were using fully synthetic PAO-based oils, ISO VG 320, from well-known oil manufacturers (Castrol, Mobil, Fuchs and AMSOIL), which were anonymized in this study as oil types 1 to 5. The in-service life varies from three to more than 13 years, with two of the oils having an unknown age.

WTGs 4 to 8 are using the same oil type - type 4- but with different in-service lives. WTGs 3 and 9 are also using the same oil-type - type 3 - but at different ages.

The oil degradation/quality is monitored online every five minutes by the OQM sensors (resistivity). In the following illustration, the online data during the three years (2019-2022) are smoothened out over 24-hour periods:

Applying the box plot model to the resistivity data on the 10 WTGs reveals a drop for oil type 3 comparing the six-year-old to the 13+ years in service oils (WTGs number 3 and 9), but doesn't show a severe drop in resistivity, so both oils are well maintained and don't need to be replaced.

The five WTGs (numbers 4 to 8), which were using the same oil type (4), showed an even clearer picture of oil degradation/quality between the three-year-old and nine years in service oils.

Unfortunately, the age of the oil type 4 was unknown on WTG number 8, but since the resistivity has decreased so much, it is likely that the oil has been in service for many years, possibly more than 12 years. If not, then the oil has been poorly maintained and very contaminated most of its life prior to the offline filter installation.

CONCLUSION

The uptime of wind turbines depends on an efficient gearbox with clean oil. An offline oil filter (kidney loop) is operating continuously and should be able to remove the majority of newly generated particles. The CJC® offline oil filter has a very stable and consistent filtration efficiency and is able to keep up with particle generation, maintaining the WTG

WTG no.	WTG output	Oil type (anonymous)	In-service life [years]
1	1.6 MW	Type 1	Unknown
2	2.3 MW	Type 2	5+
3	2.3 MW	Type 3	6+
4	3.6 MW	Type 4	3+
5	3.6 MW	Type 4	3+
6	3.6 MW	Type 4	9+
7	3.6 MW	Type 4	9+
8	2.0 MW	Type 4	unknown
9	0.9 MW	Type 3	13+
10	0.9 MW	Type 5	10+

Figure 17: Oil types used in the 10 WTGs.

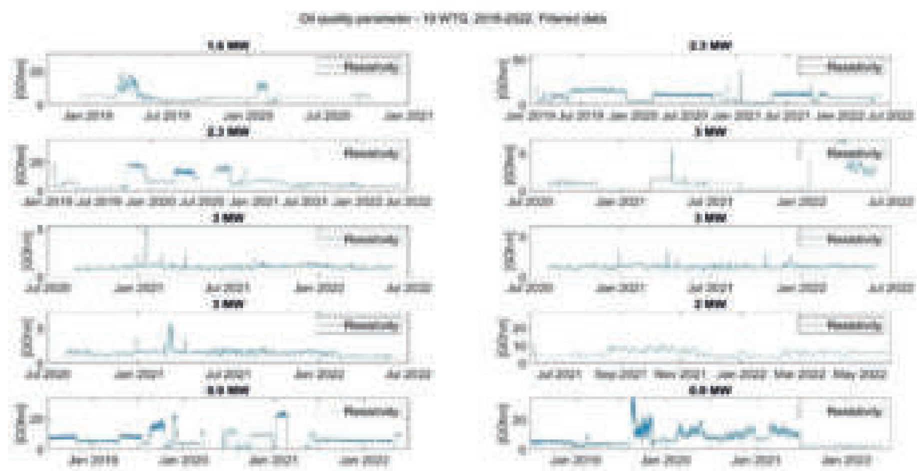


Figure 18: Trend for oil degradation/quality (resistivity) for the 10 WTGs during2019-2022.

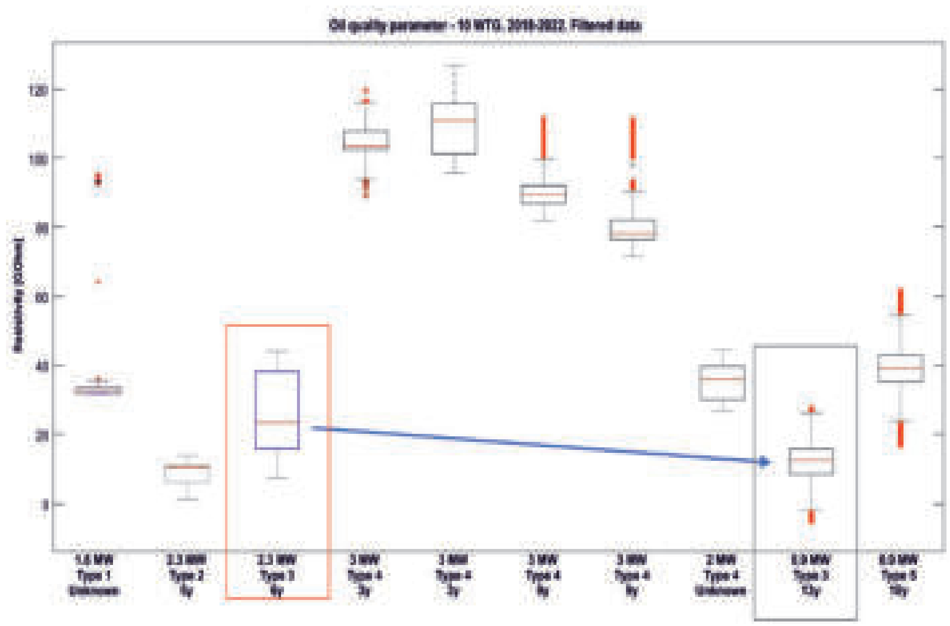


Figure 19: Comparing oil degradation/quality (resistivity) between WTGsnumber 3 and 9 with the same oil type, but different in-service life.

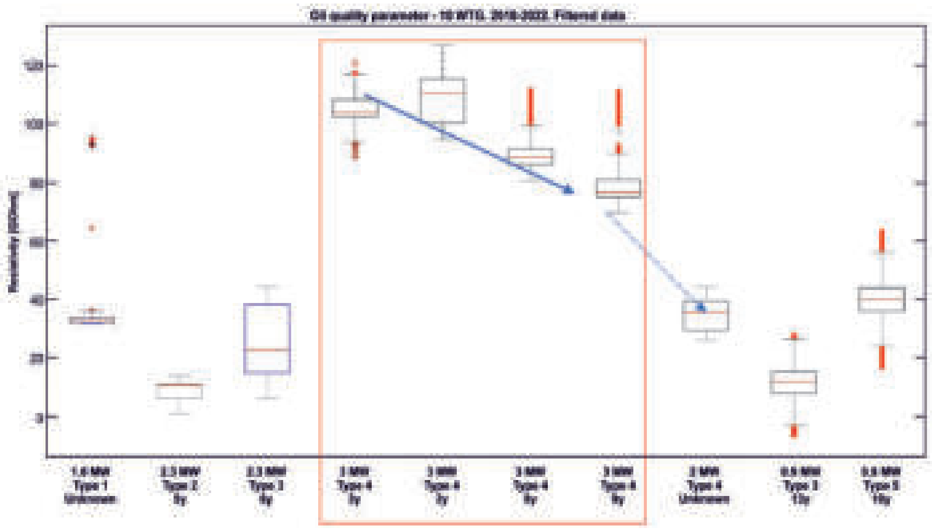


Figure 20:Comparing oil degradation/quality (resistivity) between WTGsnumber 4 to 7 (8) with the same oil type but different in-service life

oil clean, dry and varnish-free. This has been proven for decades in more than 135,000 wind turbines worldwide, utilizing CJC® offline oil filters on gearboxes.

LEARNING POINTS FROM THE STUDY

Regarding oil cleanliness in terms of particle counting:

- Healthy wind turbine gearboxes with well-filtered oil operate at around ISO 12/9/5 (+/-2)
- Trending on small (4-6 µm) particles will give in sights to:
- Abnormal abrasive wear
- Abnormal operation of the filtration system and possible faults
- Trending on larger (14-40 µm) particles can give insight to:
- Severe abrasion/fatigue/adhesive wear

In terms of oil degradation/quality monitored by resistivity, the study shows:

- The state of oil degradation and aging can be trended
- Different oil types/brands have different levels of resistivity, so a sudden change could indicate wrong oil has been added
- Monitoring the oil resistivity trend can give insights to:
- Stability of the oil quality and state of degradation (possibly reduce oilsampling intervals)
- Remaining useful life of the oil in service

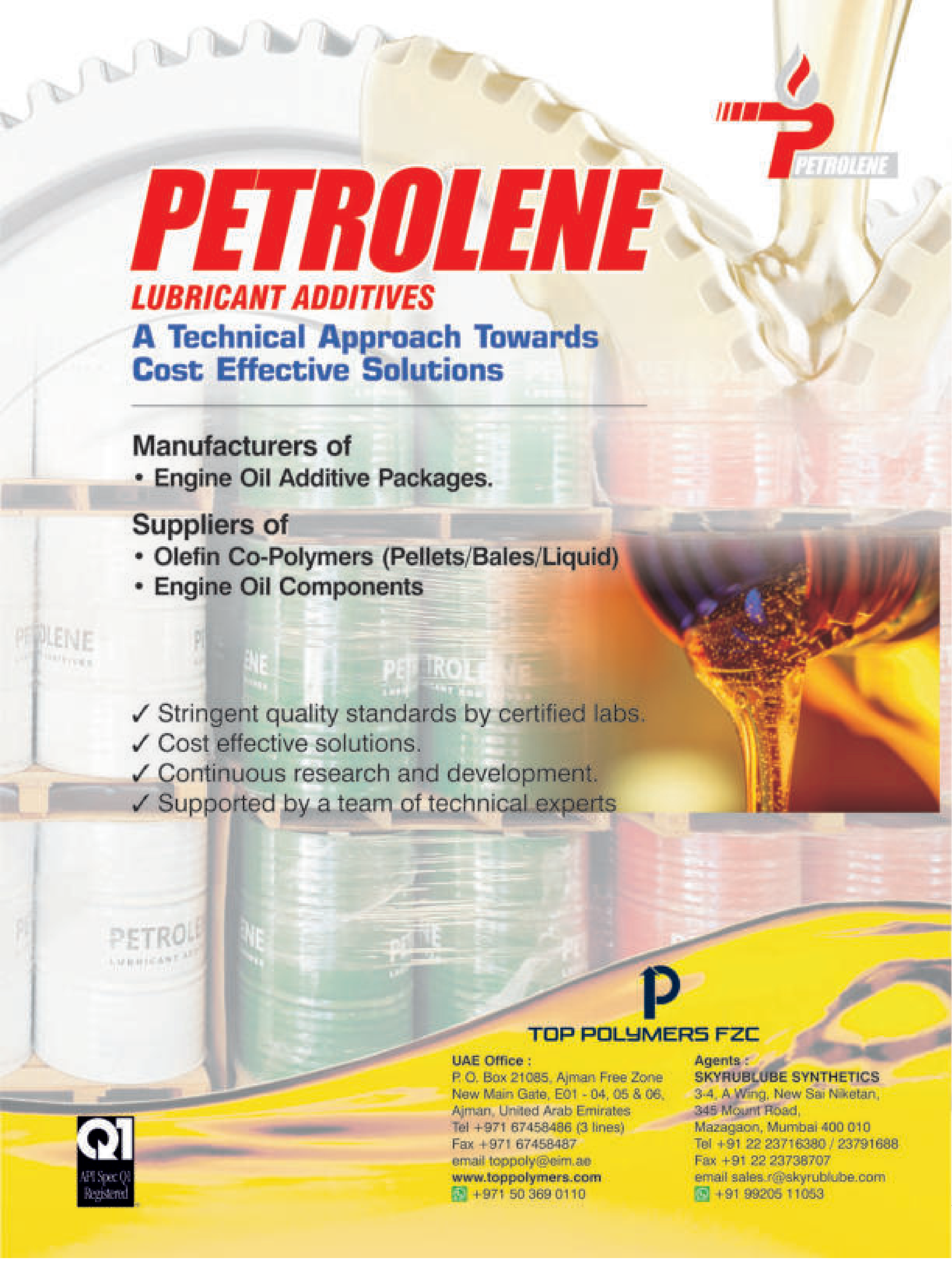
If you want to improve the power factor of your wind turbine, it is best done by keeping the oil clean using a combination of good air breathers, in-line oil filtersand offline/kidney loop depth filters while monitoring and trending the oil cleanliness and state of degradation/quality.

BENEFITS WHEN IMPROVING CLEANLINESS AND MONITORING THE OIL FOR PARTICLES AND OIL DEGRADATION/ QUALITY:

- Increased operational reliability due to less component wear and better oil conditions
- Extended oil and machine component life due to less degradation
- Reduced oil consumption, resulting in savings and lower environmental impact (CO_2 reduction)
- Less downtime, since problems can be foreseen and maintenance scheduled according to the data trend and wear situation
- Detection of abnormal operation, helping to find root causes more easily
- Detection of changes in oil quality, e.g., wrong oil added, which could causefoaming or short oil life
- Detection of abnormal wear. Replacing worn components proactively before a major breakdown occurs will yield large savings

Offline oil filters and online monitoring equipment do include initial costs but will result in large savings on the maintenance budget, plus an increase in the uptime and power factor for the wind turbine - offering a competitive advantage.

Online monitoring also adds additional safety and makes data trends readily available for interpretation.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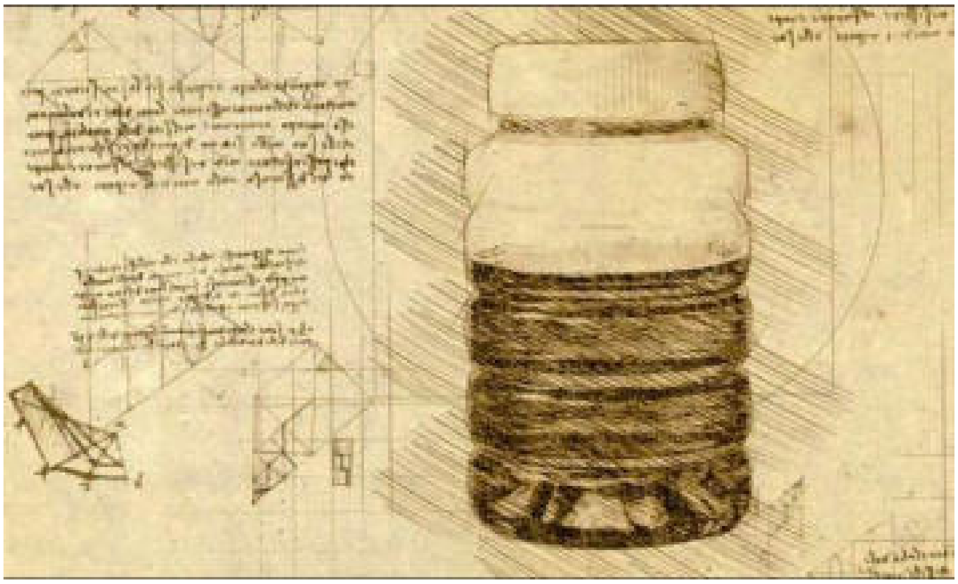
A HISTORY OF OIL ANALYSIS

In this issue we will look at the inception and rise of oil analysis. Specifically, we will be looking at the development and implementation of elemental spectroscopy, ferrography and infrared spectroscopy.



Lubricants have been inspected and monitored for perhaps as long as they've been in use. But until the second half of the 20th century, inspection and monitoring was limited to temperature, pressure and the occasional check for oil color and viscosity. There are also references to blotter spot testing of in-service lubricants in the late 19th century.

Prior to the widespread use of routine oil analysis for condition monitoring, there were numerous methods to examine the physical, chemical and performance properties of new lubricants. These properties included viscosity, flash point, pour point, density, total in solubles and water contamination. These early tests were promoted by oil companies as a way to characterize the basic properties of different lubricants and to ensure the quality of their product. These tests also served the purpose of legally defending the lubricant manufacturer in the event of machine failure.

Figure 1: Blotter spot testing: one of the earliest forms of oil analysis.

Between 1946 and 1948, the Denver and RIO Grande Railroad began using elemental spectroscopy to test lubricants for the abnormal presence of wear metals, namely aluminum, copper, iron and lead. This practice was implemented with the interest of avoiding accidents and reducing mechanical failure. The focus on wear metals can be credited for a paradigm shift regarding lubricant testing, shifting the focus (although not entirely) from testing lubricant health andperformance to monitoring machine health. This effort aimed at reliability was successful, and other railroad companies soon implemented similar practices.

EARLY USE OF ELEMENTAL SPECTROSCOPY

Early elemental analysis done by the railway industry utilized atomic absorption spectroscopy. It was a slow, tedious bench testingmethod performed one metal at a time. Because of this, wear metal analysis remained largely confined to the railway industry until the late 1950s, when Dr. Walter Baird, president of Baird Automatic, Inc., invented the semiautomatic atomic emission spectrometer (AES). This device, commonly referred to as the Baird Spectrometer, offered quick, multi-elemental analysis of fluids, reducing the amount of time required for testing from hours to minutes.

Figure 2: An early Baird elemental spectrometer.

The initial scope of his new spectrometer was railroads and large industrial plants. These were organizations that would most benefit from speedy oil analysis. But automated spectrometers made it possible for a commercial market for the new technology to emerge. In the 1960s, Edward Forgeron, a physicist and sales manager at Baird Atomic, Inc., saw the potential of the technology. He envisioned a laboratory equipped with AES that could receive and test samples from various user organizations around the country. Analysts, Inc., in Oakland, California, became the first lab to offer AES for in-service lubrication analysis inthe United States.

CONTINUED DEVELOPMENT

In the late 1960s, United States military aircraft were experiencing failures due to rolling element bearing fatigue. The particle detection technology used by the military at the time were ferromagnetic chip detectors and elementals pectroscopy. Neither of these methods was effective at detecting small particles associated with the early onset of bearing wear - they could only provide an alert to advanced impending or precipitous bearing failure conditions.

To remediate this problem, at least in part, the U.S. military contracted Vernon Westcott, founder of the Trans-Sonic Corporation, to develop an alternate technology. In the early 1970s, Westcott introduced the ferrograph as a new laboratory instrument to visually detect and analyze particles of all sizes. Initially, the ferrograph was used by universities, including Oklahoma State University and the University of Swansea (Wales).

In the early 1980s, more widespread acceptance of the ferrograph was seen, especially by the military. For instance, ferrography was used by the British to predict helicopter transmission failures during the Falklands War. Ferrography also gained popularity in

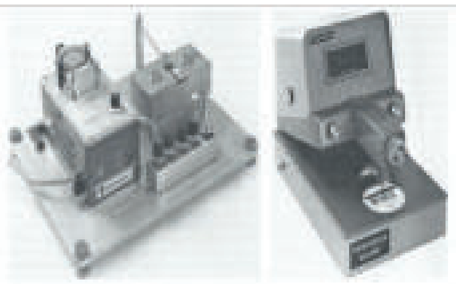


Figure 3:Early ferrography maker and reader. (Ref. Trans-Sonics)

the private sector. In 1982, the first International Conference on Advances in Ferrography was held.

Westcott and his colleagues continued to research and develop better methods of using ferrography, eventually developing analytical ferrography followed by direct-reading ferrography. The latter was an especially helpful development, as it revealed the ratio of small to large particles, allowing wear to be more easily quantified.

Figure 4: Vernon Westcott.

Around the same time, there were other advances in used oil analysis. For instance, Fourier transform infrared spectroscopy (FTIR) began to enter the oil laboratory scene. This type of spectrometer provided quantitative and qualitative information on oil chemistry and certain contaminants, not wear metals. Unlike an atomic spectrometer that looks at atoms, FTIR spectrometers are molecular. They can detect abnormal changes in base oil and additive chemistry, including oxidation, nitration and sulfation. Water, soot, fuel dilution and antifreeze can also be detected.

As new instrument technology began to flood the field of oil analysis (and other applications in analytical chemistry), the cost of performing quality analysis began to fall. In the 1990s, pattern recognition through the use of particle imaging software also became available, allowing for computer-enabled wear debris characterization. Charge-coupled devices (CCDs) also found use inparticle counters and other instruments.

Figure 5: Early tabel model of an infrared spectrometer. (Ref. Lubrication V.55,Texaco)

Around the turn of the century, online and onsite testing began to become more prevalent, largely due to advances in sensor technology and the availability of smaller, more portable instruments. As the first decade of the 21st century progressed, so too did oil analysis technology. The end of the decade saw the introduction of semi-portable and affordably priced analyzers as well as handheld IR spectrometers. As we enter into the third decade of the century, attention is being focused on artificial intelligence and the Industrial Internet of Things (IIoT).

Tune in to future issues for more history, including explorations of oil analysis as condition monitoring field, the evolution of sampling methods and tests elections, the spread of oil analysis labs through out North America and the development of many other technologies, including viscometry, particle counting titration, gas chromatography, flash-point testing, blotter spot chromatography, grease analysis and more.

TASK-BASED TRAINING
INSPECTING A DESICCANT BREATHER

WHAT IS A DESICCANT BREATHER?

Desiccant breathers are used to dehumidify incoming air and the headspace of equipment, while also restricting the ingression of small particulates.

WHY USE A DESICCANT BREATHER?

Many machine failure modes are associated with contaminants that breathers help to control. Most equipment comes equipped with a breather that is not sufficient. These OEM breathers will do little to nothing to reduce the ingress of particles and moisture, and they need to be replaced with something better.

WHY INSPECT A DESICCANT BREATHER?

These breathers eventually go bad — they aren't intended to last forever. They become saturated with moisture and lose their effectiveness; they can become clogged, restricting air flow and preventing the machine from breathing. If we're doing inspections well, we can have early warning signs of impending machine problems.

WHAT ARE SOME OF THE STYLES OF BREATHERS?

The OEM breather will likely look something like Figure 1: These do very little in terms of contaminant restriction — they do nothing for moisture and only prevent the ingression of very large particles; we are more concerned with fine particles.

Figure 1: A typical OEM breather.

Next, we have passive-style breathers (See Figure 2). In this sense, passive means the breather is open and breathing at all times: it will allow air in and out, and it is cleaning and dehumidifying the entire time.

Figure 2: A passive breather.

Next are check valve breathers (See Figure 3). Unlike the passive, open-all-the-time breathers, these breathers feature check valves that keep the breather sealed until it needs to breathe. This style of breather also comes equipped with a pressure gauge that indicates if the breather is clogged.

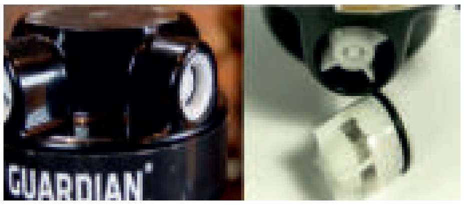


Figure 3 :Check valves.

WHERE ARE BREATHERS INSTALLED?

Desiccant breathers are for headspace management, so they're used on sumps and reservoirs. Criticality is also a factor when selecting where breathers are installed. A less critical piece of equipment, one that is relatively cheap and replaceable, may be fine to operate with the OEM breather. For more critical pieces of equipment that are smaller, passive breathers should work. For large critical equipment, a large check valve breather is recommended.

HOW DO BREATHERS FUNCTION?

Breathers move air into or out of the machine, cleaning it of particulates and moisture during the process. Depending on the style of breather, air will enter either from the bottom up or the top down. For a more complete understanding of the functionality of your breather, you can refer to the manual; there, information should be available regarding your breather's flow direction.

WHEN SHOULD BREATHERS BE CHANGED?

The first and most obvious indicator that a breather needs to be replaced is a change in the color of the breather media. During its

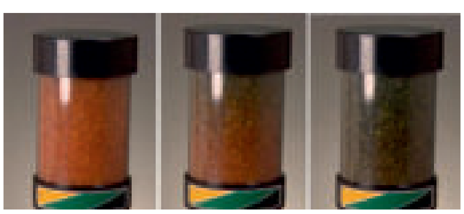


Figure 4: Color changes over the course of a desiccant breather's service life.

service, the media will change from one color

Figure 5: Breather with damaged threading.

Figure 6: A cracked breather casing.

or to another. The desiccant media of most breathers is visible, often accompanied by a color scale indicating the remaining useful life of the breather.

Additionally, you can refer to the installation date. Color change is indicative only of moisture removal; because they also handle particulates, breathers can become clogged an issue undetectable through color inspection: this is where the pressure gauge comes in handy.

Another obvious indication that a filter needs to be changed is signs of damage. Any indication that the filter is damaged (worn threads, cracked casing) should prompt swift replacement.

WHO PERFORMS INSPECTION TASKS?

The role of inspector is dependent on your industry and the way in which you developed or structured your maintenance program. Large-scale programs will have dedicated lubrication teams; in this scenario, the job is the responsibility of the lube tech(s). On a smaller scale, the general maintenance team would claim responsibility.

INSPECTING A DESICCANT BREATHER

Step 1: Clean the outside of the breather with a lint-free industrial towel.
Step 2: Inspect the outside of the breather for any damage. Ensure the entire assembly is tightly attached to the connection.
Step 3: Report any abnormal conditions.
Step 4: Check the vacuum service indicator. Locate the danger zone (red) and the normal zone (green). If the indicator has reached the red zone, the particle filter is clogged, and the breather must be changed. If the breather is not clogged, it may continue to work, depending on the desiccant condition.
Step 5: Observe the desiccant for color changes. The color may vary depending on the manufacturer. Refer to the visual color-change label attached to the breather for specific indications about the desiccant saturation.

Figure 7:Pressure gauge indicating suitable breather flow.

Step 6: Determine and report if the breather must be changed. Additionally, report any further abnormalities. Finally, collect all the tools used, and dispose of any consumables used for the procedure.

KEY TAKEAWAYS

- Ensure the correct breather size. Premature color change can be for indication of a breather that is too small. Conversely, if the breather is lasting too long, you may begin to experience functionality issues.
- Check breather operations regularly.
- Watch for oil misting.
- Know the direction of your breather's exhaust flow.

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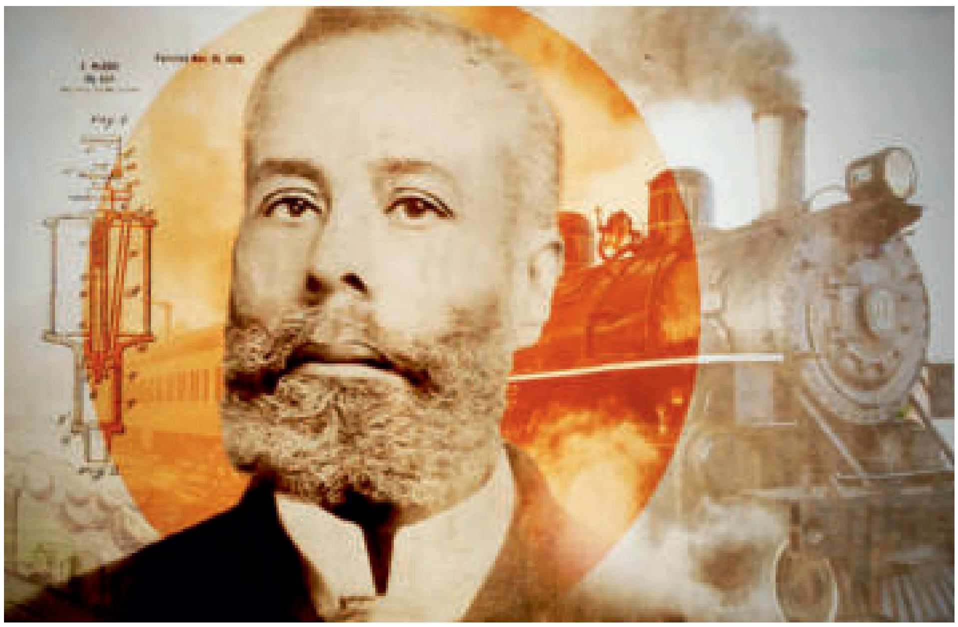
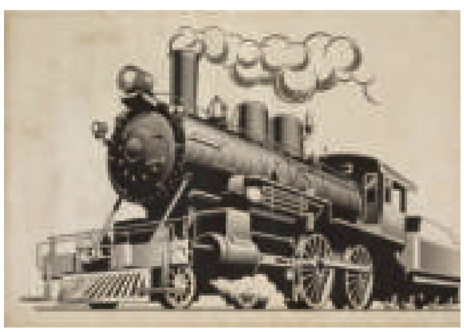
ELIJAH MCCOY: A FOUNDING FATHER TO MACHINERY LUBRICATION, AND THE REAL MCCOY

Machinery lubrication has been an essential aspect of industrial production over the course of each of the four industrial revolutions. For nearly all industries, lubricants such as oils and greases help reduce friction and wear on mechanical parts, which, in turn, increases the efficiency and life span of the machinery. One of the most important contributions to the field of machinery lubrication was made by Elijah McCoy, an inventor who developed the first automatic lubricator for steam engines.

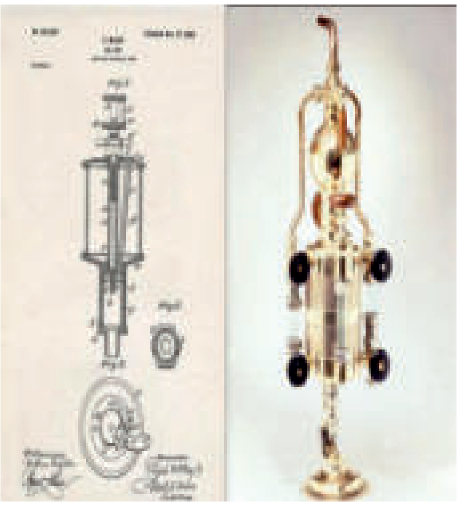


McCoy was born in the mid-19th century to African American parents who, through the assistance of the Underground Railroad, had fled from Kentucky to Ontario, Canada, to escape slavery. As a young boy, McCoy was enamored and inspired by the sophistication of contemporary mechanical designs. At the age of 15, he was sent to Scotland, where he studied to become a mechanical engineer at the University of Edinburgh.

Upon completing his education, McCoy returned to his family, who, by this time, had relocated to Michigan. Due to institutionalized racism, he struggled to find a mechanical engineering job worthy of his education and abilities. Instead, he took on jobs in the rail industry, like shoveling coal in the boiler rooms and oil in gtrain wheel bearings and other moving parts. This latter task significantly extended transport delivery times. During the first industrial revolution (before McCoy's invention), lubrication was done manually a time-consuming and often unreliable process: Engineers would have to stop the machinery to lubricate the moving parts, which reduced productivity and increased the risk of equipment failure. This is where McCoy saw room for improvement; he believed that there had to be a better way to lubricate machinery, and he set out to find a solution.



In 1872, McCoy patented his invention, an automatic lubricator for steam engines, which was referred to as the lubricating cup, the oil-drip cup or simply "the lubricator." The device used a small reservoir and a wick to deliver a steady flow of oil to the moving parts of the engine. The wick was designed to release the oil at a controlled rate, ensuring that the parts were always lubricated without the need for manual intervention.



McCoy's lubricator was an instant success and was quickly adopted by major industries such as railroads, mining and steel production, where it became standard equipment on steam engines and other machinery during the second industrial revolution - a time when mass production, production efficiencies and other technological advance ments were taking off. The success of McCoy's design prompted imitation, but of the many people who attempted to replicate his design, none were successful. The prevalence of low-quality imitation automatic lubricators led buyers to demand McCoy's original design, thus the expression "the real McCoy" a common saying that means a genuine or real thing.

In addition to the lubricator, McCoy also patented other inventions, such as a folding ironing table, a lawn sprinkler and a self-regulating engine governor. He was granted a total of 57 patents during his lifetime, making him one of the most prolific inventors of his time.

FROM THE REAL McCoy TO REAL AUTOMATION

Today, more than 150 years after the invention of McCoy's lubricator, machinery across the world and in all industrial plants still benefits from automatic lubrication. Nevertheless, manual lubrication practices are common, and machines are at constant risk

due to the mismanagement of these manual activities. Those who have been trained in manual lubrication best practices, such as using a grease gun to properly relubricate grease-lubricated bearings, know it is critical to not over-grease or under-grease bearings. Incorrect relubrication practices can lead to overheating, premature lubricant degradation, loss of wear protection, energy losses and, ultimately, premature machine failure. Cost considerations and the need for in-person inspections mean many tasks are still better off being performed manually, but as technology advances, we're forced to continually reevaluate this tactic and consider more automatic approaches.

Like McCoy's lubricator invention, more advanced automatic lubrication technologies have been developed and used for mechanical machines. These systems, which increase productivity and reduce the risk of equipment failure, have several benefits over manual lubrication, such as:

- **Centralized lubrication systems** - Uses a single pump and distribution lines to lubricate multiple points on a machine.
- **Progressive lubrication systems** - Uses a series of metering valves to dispense lubricant to specific points on a machine.
- **Single-line lubrication systems** - Uses a single pump and distribution line to lubricate multiple points on a machine.
- Dual-line lubrication systems - Uses two pumps and distribution lines to lubricate multiple points on a machine.
- **Automatic greasers (also known as single-point lubricators)** - Applies grease slowly over a period of months through various means of a pressurized reservoir, typically a mechanical pump on a plunger.

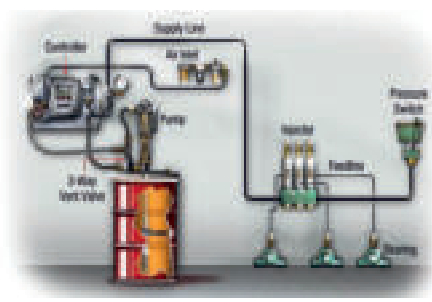


Image: Features of modern lubricator systems.

In many ways, McCoy was a visionary, far ahead of his time. Although his lubricator was introduced during the second industrial revolution, it wasn't until the third industrial revolution (during the mid-20th century) that automation advanced to the next level. With the integration of computers, logic processors, electronic systems, communications networks and information technology, humans were further removed from manual intervention, and machine reliability was greatly improved. As with other industrial practices over the last several decades, the technology behind automatic lubrication systems continued to improve. Once automatic lubrication systems became mainstream, they began seeing use in a wide range of industries like manufacturing, construction, mining, transportation and many more. There is hardly any industrial equipment today that isn't a candidate for automatic lubrication — conveyors, pumps, compressors, gearboxes, bearings, etc. There are different types of automatic lubrication systems, like time-based systems, pressure-based systems and condition-based systems (the most advanced), and they use various technologies to control and automate the dispensing of lubricant.

FROM REAL AUTOMATION TO CONDITION-BASED LUBRICATION AND INDUSTRY 4.0

Condition-based lubrication is a type of automatic lubrication system that uses sensors to monitor the condition of machinery as a health check on the lubricant or the machine. Based on the condition, the lubricant can be applied as needed. Much like McCoy's innovative motives with the lubricator, the approach of condition-based lubrication is based on the principle of "right lubricant, right place, right time" and aims to further minimize the risk of lubricant overuse and equipment failure.

Monitoring for conditions can be accomplished in many ways. Our own human senses can monitor machine conditions, and we still rely on those today. Beyond our senses, there are many other sensor technologies that can be deployed. Some are hard-mounted near moving machine components; others are part of a handheld instrument for route-based collection by a technician. These sensors monitor operating conditions such as vibration, ultra sound, temperature and more.

Oil analysis, although part of laboratory instrumentation, also uses sensors to analyze the sample of lubricant. The many instruments employed by the lab can monitor detailed attributes of the lubricant to alert us of failure modes of the machine, such as with wear debris monitoring (predictive maintenance). They can also detect something about the lubricant or in the lubricant that could lead to a machine failure, focusing on the root cause (proactive maintenance).

With condition-based lubrication systems, condition monitoring and lubrication systems can be amalgamated. These systems use the data from the sensors to determine the correct lubricant and lubrication schedule for the machinery. They can also generate alerts or alarms if a problem is detected, allowing maintenance personnel to take action before equipment failure occurs.

The most advanced condition-based lubrication systems are connected to a cloud-based central monitoring system, such as a Lubrication Management System (LMS). Analyzing machine condition data simultaneously across several machines in the plant allows for smart automation of follow-up activities. This is an essential part of establishing equipment reliability and is a core theme of the fourth industrial revolution (or Industry 4.0) that we live in today.

CONCLUSION

Elijah McCoy's invention of the automatic lubricator was a significant breakthrough in the field of machinery lubrication. Not only that, his engineering contributions and legacy continue to be celebrated and remembered as he pioneered a new way of thinking about lubrication in the 19th century and-beyond. It all started when he saw a need to create efficiencies in the railway industry that was held back by the manual approaches to lubricating numerous lubrication points.

Today, there are thousands of lubrication points across a typical industrial plant. Automation within lubrication activities is a must. Not only can this help reduce wasted maintenance activities, but when lubrication is done right, it can help to extend the lifespan of machinery and increase overall equipment reliability. It also helps to minimize the risk of lubricant overuse and environmental pollution by using the right amount of lubricant at the right time.

If you work in an industrial environment with lubrication activities, think to yourself: where does "the Real McCoy" exist today? In other words, what modern lubrication approaches still need to be implemented to create your reliable plant?

In honor of McCoy's legacy of practical and tireless innovation, the International Council for Machinery Lubrication (ICML) will soon add the Elijah McCoy Award for Lubrication Champions to its long-standing industry awards program. This latest offering will recognize individuals who improve machine reliability and maintenance quality through leadership, education, and individual contributions to the development, implementation, and management of best-in-class machinery lubrication programs. ICML will announce its criteria and start accepting nominations in mid-2023.
www.lubecouncil.org

TASK-BASED TRAINING
INSPECTING A BULLSEYE-SIGHT GLASS

WHAT IS A BULLSEYE SIGHT GLASS?

A bullseye sight glass is a transparent window at the oil level, typically made of glass or durable plastic, that allows users to observe oil conditions inside a piece of machinery.

WHY USE A BULLSEYE SIGHT GLASS?

First and foremost, a bullseye sight glass can be used to confirm that the oil is at the correct level inside the machine. The sight glass also allows for observation of the oil condition. There are a few things that become very obvious when usinga bullseye sight glass: you can see foam, emulsified water, the formation of varnish and more.

WHY INSPECT A BULLSEYE SIGHT GLASS?

Bullseye sight glasses need to be inspected periodically to see if the oil level fluctuates over time.

We can see if the level has risen:

Figure 1: Sight glass indicating oil level is too high.

If it has fallen:

Figure 2: Sight glass indicating oil level is too low.

Or if it has maintained a consistent level:

Figure 3: Sight glass indicating oil is at the appropriate level.

When inspecting bullseye sight glasses, we're also looking for the conditions mentioned earlier — we can see staining, varnish formation, foaming or cloudiness in the oil, giving us an early warning of impending machine or lubrication failure.

Figure 4: Sight glass revealing cloudy oil.

WHAT ARE SOME OF THE STYLES OF BULLSEYE SIGHT GLASSES?

OEM 2D bullseye sight glasses are the most commonly seen sight glass. They typically feature a flat glass pane and brass covering. While they do provide a window into the machine, the view typically isn't very good.

3D bullseye sight glasses stick out from the machine, allow for a better view of the lubricant and a more accurate appraisal of oil condition and level. The 3D sight glass allows visual inspections to be performed quickly by anyone walking by the machine.

Figure 5: A typical OEM bullseye sight glass.

Figure 6: A 3D bullseye sight glass.

Larger 3D bullseye sight glasses are also available that come equipped with different condition monitoring inspection points, like magnets, corrosion probes and sample valves. These additional inspection tools allow for more in-depth condition monitoring, but the bulk of the inspection can still be performed with the 3D bullseye.

Figure 7: A large 3D bullseye sight glass with inspection points.

WHERE ARE BULLSEYE SIGHT GLASSES INSTALLED?

Anywhere from the smallest horsepower motors and pumps to machines with several-hundred-gallon tanks - essentially, anywhere on a machine that has an oil-level plug or port is a great application. Things that are splash-lubricated can especially benefit from bullseye sight glasses.

WHEN DO THEY NEED TO BE CHANGED?

This depends on the type of sight glass.

The glass pane on most OEM 2D sight glasses can't be changed. Over time, this glass will become stained, which can give you a false reading of the oil level and condition. If a sight glass is stained, it needs to be replaced.

Figure 8: A stained OEM 2D sight glass.

3D sight glasses are typically made out of hard plastics and, in an industrial setting, are some what prone to being cracked or damaged in some way, in which case, they will need to be replaced. Those working around the protruding sightglass also must be aware not to impact it — since these glasses are at the oil level, a break can cause immediate oil leakage.

WHO INSPECTS THEM?

Typically, this task falls to the lube techs or maintenance techs, but with a 3D sight glass, anyone passing by can easily take on the role of inspector — if they see that the oil is at the right level and in good condition, they can move right along; if they see something is wrong with the oil or sight glass, they can report it, and the problem can be addressed quickly.

INSPECTING A BULLSEYE SIGHT GLASS

Step 1: Clean the surface of the bullseye sight glass with a lint-free industrial towel.

Step 2: Use a flashlight or laser pointer to illuminate the fluid in the sight glass - this will aid in the inspection process.

Step 3: Check the oil level; it should be at the middle of the sight glass. If the oilis below the middle of the sight glass, look for leaks and report. If the oil level is above the middle of the sight glass, look for water or process fluid ingression or for excessive top-ups.

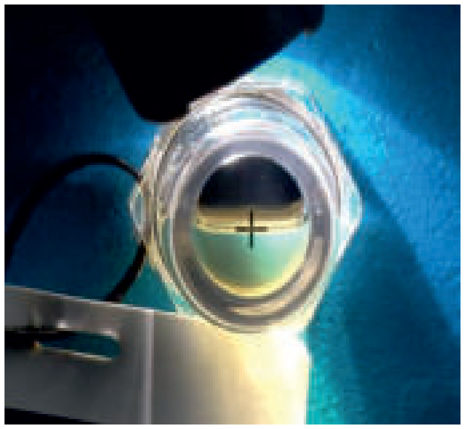


Figure 9: Using a flashlight to illuminate the oil inside the bullseye sight glass.

Step 4: Look for particulates and the presence of foam. Also check the lubricant color for signs of undesirable darkening or a cloudy appearance.

Step 5: Report any abnormalities, including:

- Color
- Temperature
- Leakage
- Vibration
- Noise
- Cloudy appearances

Figure 10: Foamy oil visible through a sight glass.

KEY TAKEAWAYS

- There are many types of bullseye sight glasses with different features and functionalities.
- Bullseye sight glasses allow for quick visual inspections and can reveal issues like improper oil level or the presence of foam, emulsified water or particulates.
- Bullseye sight glasses are prone to staining over time and must be replaced-when this happens.

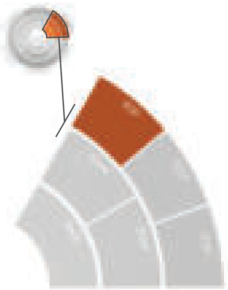
Travis Richardson | Noria Corporation

Factor: R1P

Hot Tips

Efficient & Effective Quality Control

More about this
ASCEND™ Factor



Factor:
R1P—Quality Control Process

Level:
Platform(P)

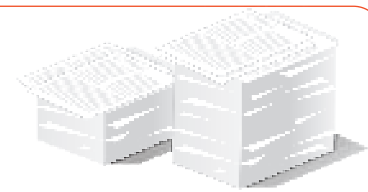
Stage:
Lubricant Reception And Storage

About:
The quality control process for new lubricants should be formed in collaboration with the lubricant suppliers and should establish a methodology with which lubricant characteristics can be inspected and evaluated.

Learn More:
noria.com/ascend/

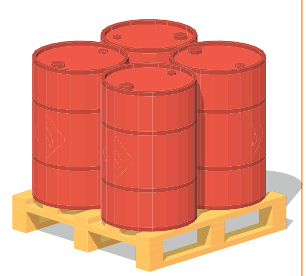
An effective quality control process ensures that incoming lubricants are inspected, evaluated and deemed fit for service. Incoming lubricants are a pathway for contaminants, and failure to prevent contaminated lubricants from entering machines can hinder an entire lubrication program. Here are some tips for implementing efficient and effective quality control practices:

1. **Ensure that every drum** of oil received is labeled correctly; six out of every 100 drums are mislabeled or improperly labeled.



2. **Ensure that all of the grease** tubes received do not have any base oil bleeding from the package. Greases that have no base oil are not properly lubricating their assigned application. Remember, the base oil and additives are what lubricate. Thickeners just hold the lubricant in place.

3. **5S every detail of your lubrication program,** especially the lubricant reception area. Immediately take the lubricant to the properly marked lubricant storage area. Any world-class lube room has a specific area for every little thing, especially for drum storage. As we always say, 5S the lube room to the extreme. Make storage of lubricants and parts easy, where anyone off the street could walk in and know exactly where every tool and container goes.

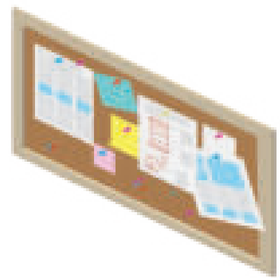


4.

Take a proper sample from each drum of oil that goes into critical equipment. Coinciding with tip number one, drums of oil are frequently mislabeled. If we are talking about a world-class lubrication program, then sampling new drums is simply a no-brainer. The two primary reasons to sample new drums are to check for the correct oil and get a good particle count of that new oil. New oil is not clean oil, and if the plant has cleanliness and dryness targets (an essential part of being a world-class plant), then we need to know how dirty that new oil is and how much moisture is in that oil. After figuring that out, we can determine how much the lubricant needs to be filtered and dehydrated before being put into service.

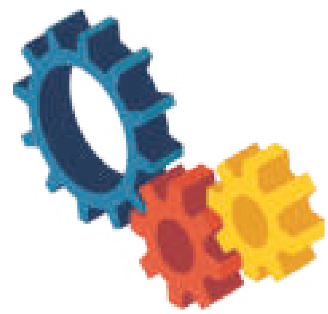
5.

Have written procedures posted conspicuously on the walls, in the digital receiving system and pretty much anywhere else that you could possibly put a document where it will be viewed often in the receiving area. When personnel see the procedure constantly, it becomes second nature. Psychologically, there is something to constant reinforcement of change. When you walk through the door at work, and everyone is talking about the new way to do things, and everyone is on board with the new way, then that becomes the way.



6.

Speaking of "the new way," effective quality control starts with culture, and culture starts with morale. If the workplace's morale is low, personnel will be more resistant to change. If the morale is high, they will be more receptive to change. For example, if morale is low, then employees are more likely to have a "don't care" attitude. A demoralized workplace is one of the most depressing environments to be in, and it becomes contagious; on the other hand, so does a positive workplace.



7.

Trust and verify. Trust that your technicians are doing the correct procedures and taking precautions when it comes to receiving new lubricants. However, always verify that they are upholding the standards set by the facility on receiving new lubricants. After all, a lube program is only as strong as the foundation allows it to be.

About the Author

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Mobil Serv

ENHANCING PERFORMANCE WITH SUPERIOR LUBRICATION SOLUTIONS

The manufacturing industry hinges on precision and efficiency for successful uninterrupted business. Here, the machine tools segment plays a critical role in ensuring continuity of operations by facilitating the use of advanced machining equipment. As India doubles down on its goal of becoming a preferred manufacturing destination, the emphasis on the success of the machine tools segment reigns strong. This is especially relevant today as the India machine tools market that reached a capacity of USD 1.4 billion in 2022, is expected to reach USD 2.5 billion by 2028 – exhibiting a growth rate (CAGR) of 9.4% during 2023-2028.

With growth in near sight, the machine tools segment requires attention towards minimizing downtime and ensuring smooth operations. Here, superior lubrication solutions are playing a pivotal role in supporting the sector maximise its potential. As a legacy industry leader, Mobil™ has been prioritizing its solutions for the machine tools segment to help businesses improve productivity and play their part in contributing to India's growth story.

SOLUTIONS FOR GUARANTEED PERFORMANCE

To cater to specific needs of the machine tools segment, Mobil has been driving innovation and research to develop reliable lubrication solutions. Here, the Mobilcut™ Series has emerged as a trusted choice for the machine tools segment. Mobilcut is the trademark for Mobil's line of high-performance water miscible metal removal fluids. Formulated with leading edge base oils, additives, and emulsifiers, products under the Mobilcut Series provide dependable performance in a wide array of metal removal processes. The products are designed to work in a variety of hard and soft water qualities and offer low foam potential and long-term corrosion protection for machine and components. Low maintenance and inherently stable, the Mobilcut products are designed for the modern machine shop where long service life, excellent machining performance and health and environmental concerns are important factors for increased productivity. These products are supplied in concentrated form and require mixing with water at the point of use.

PRECISION IN DELIVERY

A part of this series, the Mobilcut™ 231 and Mobilcut™ 251, deserve special mention. These advanced metalworking fluids have redefined the way manufacturers approach machining operations, enhancing performance, extending tool life, and elevating overall operational efficiency.

The Mobilcut 231 has been designed to excel in a wide range of machining processes. From milling and turning to drilling and grinding, Mobilcut 231 is a versatile metalworking fluid that reimagines what's possible in the machine tools segment. Engineered with state-of-the-art technology, Mobilcut 231 boasts properties that minimize the risk of tool wear, increase sump life and is ideal for emulsion hardness up to 700 ppm. Further, Mobilcut 231's superior lubricating qualities ensure reduced friction between cutting tools and workpieces, resulting in smoother operations and reduced energy consumption. This not only translates to enhanced precision but also contributes to cost savings. Manufacturers leveraging Mobilcut 231 can achieve environmental protection, finer surface finishes, and minimal top-up, ultimately elevating the quality of end products.

Similarly, the Mobilcut 251 has been tailored to optimize high-speed machining processes. It is a versatile semi-synthetic lubrication suitable for moderate to heavy, turning, milling, drilling, tapping, reaming, and grinding applications of aluminum and steel alloys. This high-performance metal working fluid showcases remarkable performance. Mobilcut 251's exceptional production capabilities help customers push their limits and deliver results that exceed expectations.

Mobilcut231 and Mobilcut 251 are today making their mark in the machine tools segment. These cutting-edge metalworking fluids transcend traditional boundaries, enabling manufacturers to achieve levels of precision, efficiency, and performance that were once considered unreachable. Both products epitomize cutting-edge technology and are redefining machining operations, enhancing tool life, and elevating overall productivity.

Moving ahead, as the machine tools segment charts its journey towards enhanced growth, use of superior lubrication solutions that are developed through thorough research and innovation and in tandem with the most advanced technology trends will be critical. Bringing its century-old legacy to the country, Mobil remains prepared to partner with businesses in the sector and aid their journey towards greater productivity, performance and profitability – while being mindful of maintaining efficiencies necessary for successful long-term operations.

DISCLAIMER:

For more information, visit www.mobil.in/business

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Wes Cash | Noria Corporation

LUBRICATION STANDARDS MANUAL - THE NEED FOR DOCUMENTATION

Everyone remembers their first car. The feeling of freedom coupled with a light tinge of fear going down the road is an experience that is hard to forget. Equally hard to forget is when that first car requires maintenance or repairs. In my case, the car was a 1983 Jeep Wagoneer, and there was no shortage of repairs that had to be made.

One day my dad brought me a Chilton's manual for that particular vehicle. It was filled with how-to's, diagrams and troubleshooting guides. It made the jobs significantly easier to perform but also provided much-needed specifications on items such as torque, tolerances and other specs to make the vehicle operate better and more reliably. Chilton has shifted primarily to an online platform now, but I still have that physical manual.

The idea of having a manual serve to enhance understanding and performance is not a new concept, but it's one that isn't employed as much in the industrial space as it should be especially as it relates to lubrication. Most facilities may have operating manuals for a piece of equipment that have some instructions related to lubrication, but many do not go into the level of detail required to ensure the reliable operation of the equipment. Nor do many facilities have a set of standards that relate to the lubrication activities required to sustain the program. This is why having a lubrication standards manual is a key component of a lubrication program.

A standards manual should be a living document that outline seach aspect of the lubrication program and then provides guidance for how activities should be performed. The idea is that it will serve as a repository of information that can be called upon when needed and as a way to keep the programin a consistent state. With employee turnover or changing priorities, the standards manual becomes a time capsule of how work should be done and managed and even who does the work.

While this is a good practice to get into for a single facility, it is often beneficial to es-

tablish a corporate-wide standards manual that will help provide consistency across a fleet of facilities. This also provides a conduit to mine the plants to find which programs are more established and record those practices to share with everyone else. It's incredible how often you see two plants owned by the same company with a huge difference in their lubrication programs. When done correctly, a corporate standards manual will bring the stakeholders from the different plants together to create a document that will be shared with their peersto elevate everyone's program.

Documentation is a requirement for most ISO-certified companies. For instance, ISO 9000 and ISO 55000 both have documentation requirements that you can compare your activities against. Lubrication should not be any different. The standards manual can serve as an internal audit tool used to create consistency in activities. On a set periodicity, current practices can be compared to the written manual, gaps can be identified, and corrective actions can be taken to remediate any issues. The inverse is also true: if what is being done in the field is a better practice than what is documented, the standards manual should be updated to reflect it. This keeps the manual current, making it a truly living document.

The first world wide lubrication-centric standard for lubrication programs, a document called ICML 55, was written by over forty subject matter experts in lubrication and reliability and launched by the ICML. Within its text, it calls for documented standards. It states, "The organization shall create, execute and maintain a lubrication manual that clearly specifies the aspects associated withthe execution, management and continual improvement of the organization's lubrication policy, strategy objectives, and plans."

While documentation alone won't improve field practices, it does start the process of improvement. Some view the standards manual development as an exercise to put the goal of how the lubrication program will run onpaper. With this mentality, some ask, "What should be found in a standards manual?"

It's a good question, and in order to build a thorough manual, you will want to think of the lubrication program holistically. Below are several key areas to document.

- **Lubricant Selection** - Selecting the proper lubricant is key to machinehealth. Doing this properly requires balancing the needs of the equipment, the number of lubricants onsite, the price of the lubricant and the supplier's ability to provide the lubricant in a timely manner. A mechanism for selecting, consolidating and reviewing your supplier should be included.
- **Lubricant Reception and Storag**e - Incoming lubricants may be contaminated or compromised, which makes them unfit for use. As they are stored, they can deteriorate and become even more contaminated. Documenting aspects such as testing incoming lubricants, lube room requirements and inventory management are key for this stage.
- **Lubricant Handling and Application** - Getting the lubricants to the machines and applying them in the correct manner is where many programs fall short. This area represents the biggest area of improvement for most companies. Key things to document here are tools and devices used to apply and transfer lubricants, how tasks are performed, how they are managed and recorded, and how the machines are set up to receivelubricants in the best way possible.
- **Contamination Control and Lubricant Reconditioning -** Most machine fail due to some contamination-related mechanism. The same is true for lubricants. We must ensure that we are outfitting the machines and people with the best tools and accessories to combat this. This section will be all about filtration, contaminant exclusion and setting tangible contamination level goals/alarms.
- **Condition Monitoring, Lubricant Analysis and Troubleshooting -** There are many different predictive methods available, and they all must be harmonized to get the maximum benefit. In this section, you should document sampling activities, lab selection, methodology for integrating all predictive tools and inspections, RCA strategies, and alarms and limits for each test.
- **Energy Conservation, Health and the Environment -** An important area that continues to get more scrutiny, especially as it pertains to lubricants. We have to be able to do our work in a safe manner that doesn't impact the environment, all while lowering the carbon footprint of

the facility. All of the seaspects should be documented, such as lubricant disposal, lubricants to be used for energy conservation, safety guidelines for all tasks, and active management of leaks.

- **Staffing and Task Accomplishment** - In many facilities, lubrication is a shared task between many departments. This can lead to a lack of accountability and tasks not getting accomplished. It should be written out who is responsible for each type of lubrication task, how the task is to be performed, and the system that is involved in the management of the program.
- **Stakeholder Training** - Lubrication is often regarded as a menial task, andformalized training in that area doesn't happen to the level it should. Too often, it is simply an apprentice-style training where bad habits are passed down. Training should be targeted to the job being performed, and expected trainings and certifications per job title should be developed and documented.
- **Program Metrics** - Failing to track anything within the program leads to ambiguity about what is happening and makes it hard to know where to improve. For each of the key areas of the lubrication program, a set of key performance indicators (metrics) should be decided on, and the mechanisms to track them established.
- **Optimum Reference State** - Throughout the entire document, we don't have to treat each piece of equipment or each task the same way. Activities, tasks and tools should be selected based on impact and cost. A common way to do this is based on machine criticality and manpower requirements.

By taking the time to develop the standards, you can establish a baseline of expectations for all members of the lubrication team. Without having a plan or anything on paper, the status quo prevails, and a continual cycle of reverting back to bad habits wins out. It's not enough to just write the document, put it into action and get your team's involvement in its development. This is one way tostart a grassroots improvement initiative in your plant.

About the Author

Wes Cash is the director of technical services for Noria Corporation. He serves as a senior technical consultant for Lubrication Program Development projects and as a senior instructor for Noria's Oil Analysis I and Machinery Lubrication I and II training courses. He holds a Machine Lubrication Technician (MLT) Level II certification and a Machine Lubricant Analyst (MLA) Level III certification through the International Council for Machinery Lubrication (ICML). Contact Wes at wcash@noria.com.

TEST YOUR KNOWLEDGE

This month, *Machinery Lubrication* continues its "Test Your Knowledge" section, in which we focus on a group of questions from Noria's Practice Exam for Level I Machine Lubrication Technician and Machine Lubricant Analyst. The answers are located at the bottom of this page. Practice Questions supplied by Noria Academy. Visit **noria.com/Academy** to learn more.

1. Which inspection should be performed when draining oil from a sump or reservoir?

A. Particle count
B. Visual inspection of bottom sediment and water
C. Viscosity test
D. Oxidation

2. Large circulating systems are more suitable for which type of oil change?

A. Reactive based
B. Operator Based
C. Condition based
D. Interval based

3. Which type of grease thickener is more resistant to high temperature?

A. Saponified soap
B. Simple soap
C. 12-hydroxy
D. Complex soap

4. Where do maintenance costs impact the company's financial performance?

A. Credit rating
B. Pay raises
C. Stockholders' investment
D. Company profits

5. On average, how much dirtier is an oil with a particle count of ISO 18/16/13 compared to an oil with a particle count of ISO 17/15/12?

A. 0.25
B. 4
C. 0.5
D. 2

ANSWERS

1.B 2.C 3.D 4.D 5.D

GULF OIL LUBRICANTS SCOUTING FOR MORE ACQUISITIONS

Gulf Oil Lubricants is on a look out for more acquisitions in India and globally within the charging EV ecosystem as it seeks to strengthen its presence in the electric mobilitys where it's a new entrant. The Hinduja Group company announced acquiring a controls take in Tirex Transmission for Rs 103 crore on Monday

New Delhi: Gulf Oil Lubricants is on a lookout for more acquisitions in India and globally within the charging EV ecosystem as it seeks to strengthen its presence in the electric mobility segment where it's a new entrant. This is even as the company plans to continue to focus on its core lube business. The Hinduja Group company announced acquiring a controlling stake in Tirex Transmission for INR 103 crore on Monday. This is part of Gulf's global ambition towards being a leader in the EVcharging ecosystem, a market which is already valued at USD 20 bncurrently and expected to cross USD 200 bn by 2030, it said. India had 26,700 EV chargers at the end of 2022 and wants to scale the number upto 365,000.

"This is a starting point of the journey. We would like to make more such acquisitions in areas we can win," Ravi Chawla, MD & CEO of Gulf Oil Lubricants India, told ET. For instance, in India the company is looking at more acquisitions in the EV charging infra space in the two-wheeler segment. This could be in battery swapping, he pointed out. The acquisition of Tirex – a third in the mobility space, is in line with the company's broader plan to expand its footprint in the EV landscape and make a significant play in the EV value chain.

Gulf Oil Lubricants has invested in Indra Renewables- a UK based AC charging (slow charging) company with a ~8% share of the UK home charging market. It has also invested in ElectreeFi, a leading EV SaaS player which provides charging management software (CMS) solutions for major automakers in India. The investment in Tirex, which is a manufacturer of DC Fast Chargers, will enable Gulf towards a synergisticend to end play in the global EV charging ecosystem, said Chawla.

Tirex Transmission manufactures DC fast Chargers for EVs in India. It has deployed over 400 high-capacity EV fast chargers across the country with the range spanning from 30 KW to 240 KW. It counts public sector undertakings, charge point operators and automakers as its key customers. Projections from the India Energy Storage Alliance (IESA) suggest a demand surge for around 1 million chargers by 2030, translating to a potential market value ranging from USD 1 billion to USD 1.4 billion in India alone. Further, there is a multi-billion-dollar opportunity in the global market where DC Charging is a fast-growing segment.

SCHAEFFLER INDIA ACQUIRES B2B AUTO SPARES PLATFORM

This acquisition presents an ideal synergy for Schaeffler's future aftersales activities in India. It will be a key enabler for the after-market ecosystem, including distribution partners and help to play an important role in the fast growing and evolving after market digital landscape, the company said.

Schaeffler India Board of Directors has approved the acquisition of 100% shares of KRSV Innovative Auto Solutions Private Limited (Koovers), a Bengaluru-based private limited company offering spare parts solutions to Indian after market workshops via a B2B e-commerce platform.

This acquisition presents an ideal synergy for Schaeffler's future aftersales activities in India. It will be a key enabler for the after-market ecosystem, including distribution partners and help to play an important role in the fast growing and evolving after market digital landscape, the company said.

Schaeffler's Automotive Aftermarket division supplies components and holistic repair solutions for the automobile spare parts business worldwide and sees itself as an enabler of garages. With an overarching understanding of systems and comprehensive services, Schaeffler supports garages in complex repairs and at the same time contributes to extending the operating life of vehicles, the company

said in a media release.

Founded in 2015, Koovers has established a B2B e-commerce platform offering spare parts solutions to after market workshops in India. With revenues of INR 77.7 crore in the financial year 2022-23, the company has a compelling growth story and is one of the fast-growing players in the Indian B2B e-commerce market. Koovers supplies to over 7000 plus workshops and has a portfolio of around 1.8 million parts from various manufacturers. The platform will continue to operate under Koovers brand name.

"We are happy to announce the acquisition of Koovers, a milestone moment for Schaeffler in India. This will be a strategic step to maximize value creation through our repair solutions for all customers. Schaeffler Automotive After market's ambition has always been to simplify workshop operations with plug and play products and solutions, while building consumer connect. Koovers strongly supports this ambition with its innovative digital offering", Harsha Kadam, Managing Director and Chief Executive Officer, Schaeffler India said.

Under the share purchase agreement, Schaeffler India Limited will acquire 100% shares of KRSV Innovative Auto Solutions Private Limited for a consideration of approximately INR 142.4 crore. The transaction would be completed in the third quarter of CY 2023, subject to customary closing conditions. This acquisition will be fully funded by own cash generation.

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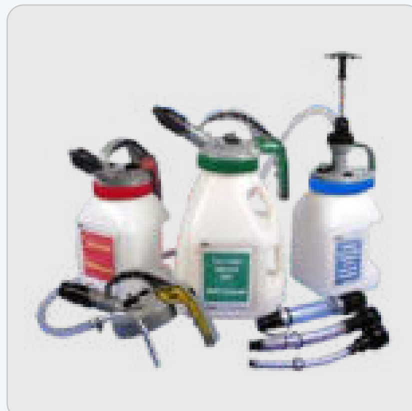

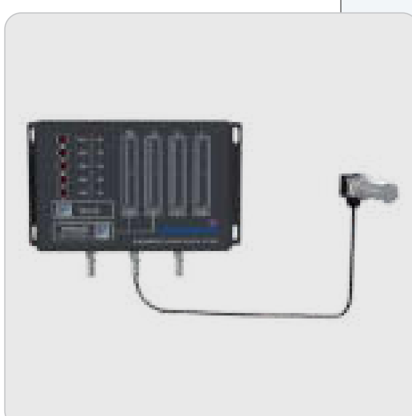

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