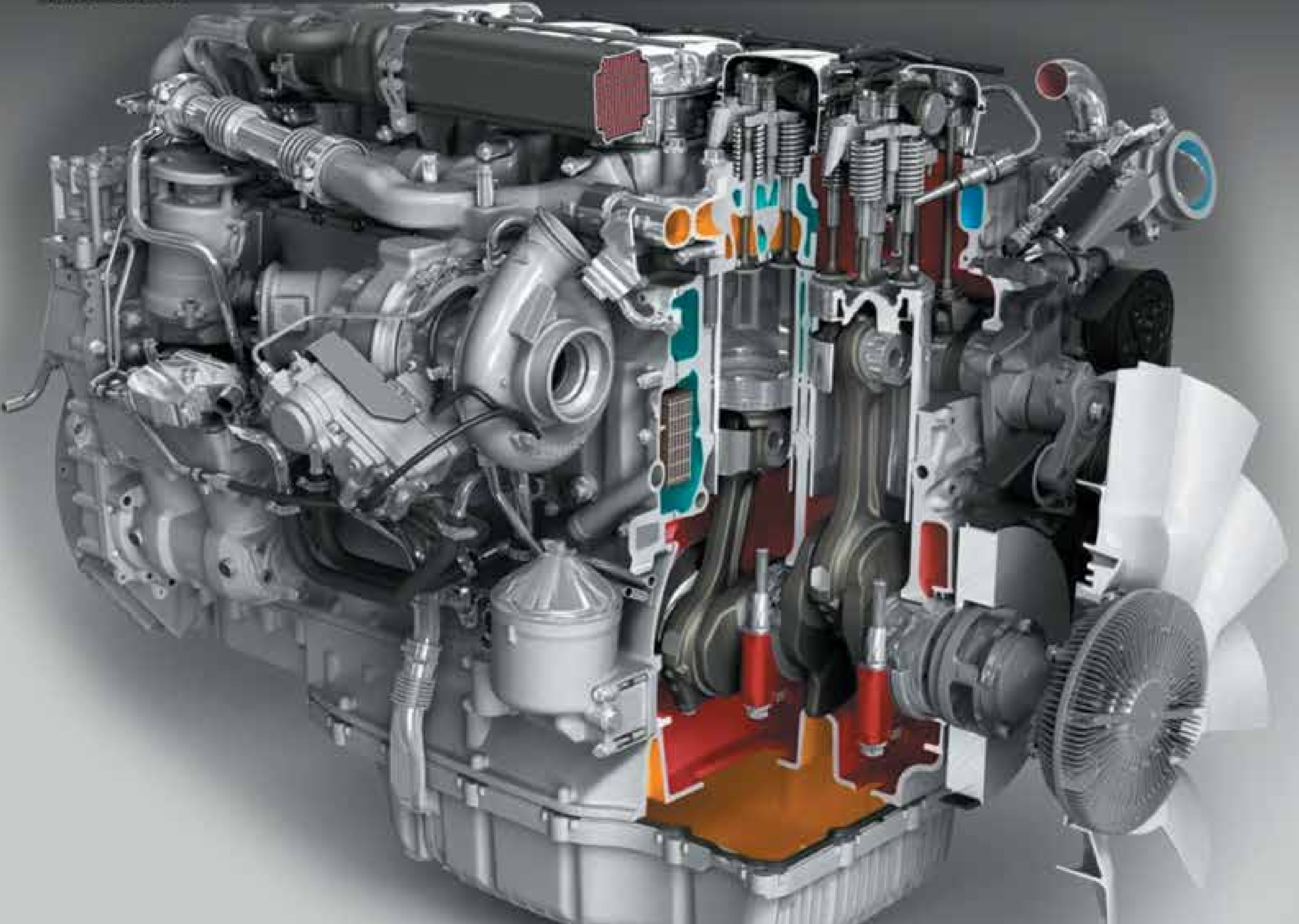
MARCH - APRIL 2022

Machinery Lubrication

INDIA

machinerylubricationindia.com



Also Inside

- Lubricant Environmental Compliance
- Oil analysis - Deficiencies of membrane patch colorimetry (MPC) test

NORIA

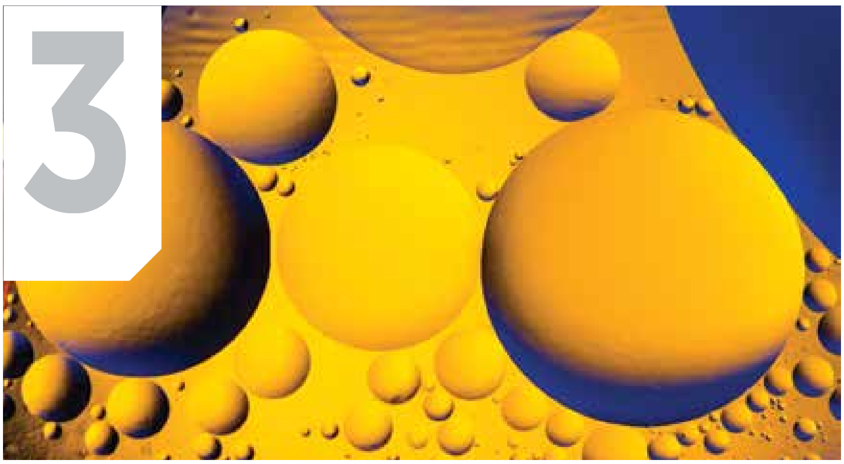
VAS TRIBO

Solutions Unlimited

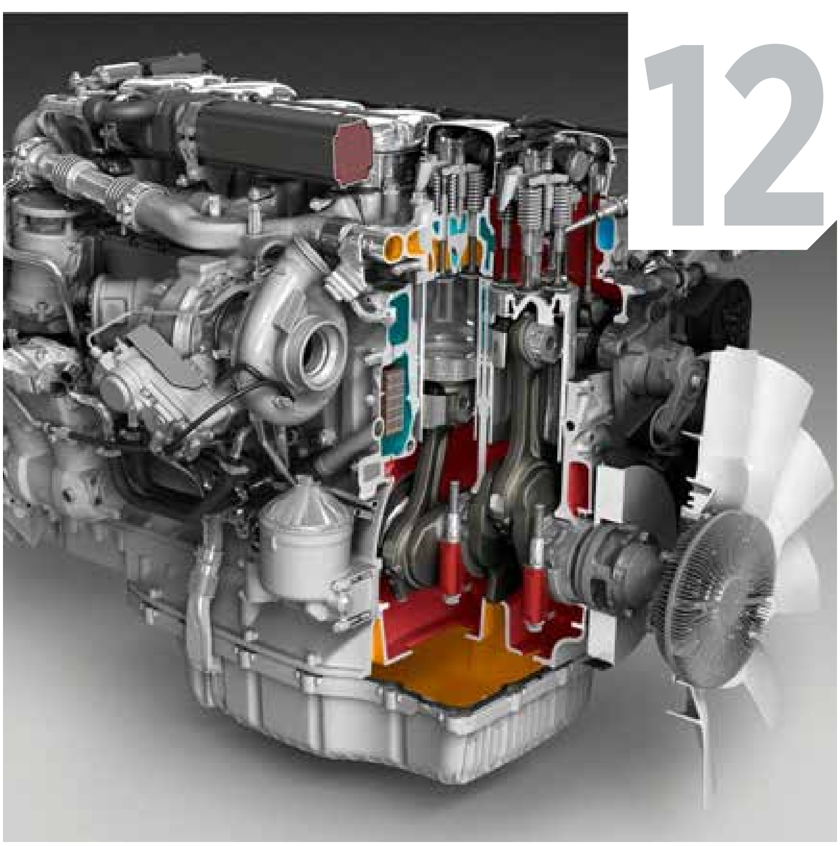

When World's Largest Two Wheeler manufacturing
company was looking for a partner for world class
"Lubrication Services"

Machinery Lubrication INDIA

AS I SEE IT



COVER STORY



EDITORIAL FEATURES

Publisher's Note

The Indian commercial vehicle (CV) landscape continues to grow in parallel to achieving the latest emission standards. As the inclusion of diesel particulate filters in newer vehicles is now occurring, reduced SAPS oils such as API CK-4 and ACEA E6 are starting to see an increase in demand within the market. Concern over air quality in cities has seen India tightening its emissions standards with unprecedented speed. Bharat Stage VI (BS VI) was implemented nationwide from April 2020.

Whereas Europe progressed from Euro IV emissions standards to Euro VI over a period of nine years, the Government of India has moved from its (equivalent) BS IV to BS VI standards in just three years, skipping BS V entirely.

BS VI governs ALL new On Road vehicles in India: both heavy and light duty diesel vehicles as well as 2-, 3- and 4-wheel light duty petrol vehicles. Off Road vehicles are subject to separate TREM and CEV legislation, which are not discussed here.

All commercial vehicles (CVs) manufactured after April 2020 must meet these BS VI emissions standards, bringing India in line with global emissions standards and placing the country on a par with Europe, the US and China.

Indian CV OEMs have had to apply additional exhaust aftertreatment technologies on all their new truck models in order to comply. Engine oils must therefore now be compatible with all the sensitive aftertreatment systems in use.

In addition to stricter emission requirements, India has simultaneously tightened its fuel economy standards, which also helps to reduce emissions. Phase I was introduced in 2018 and Phase II in 2021, both of which apply to importers of new vehicles as well as Indian OEMs. This adds further complexity for the heavy-duty engine oil:

Keeping in mind the ever-evolving space of Diesel Engine Oil Specifications, we decided to cover this as a cover story in this issue. We do hope this would be of interest for our readers. This is in line with our promise to cover automotive lubricants frequently.

Environment being the focus area in the current times, we have included two articles – "Do's & Don'ts of used oils" and "Lubricant Environmental Compliance" . These articles shall give our readers a new perspective on how to handle and dispose used or waste oils in their organisations.

As usual we welcome feedback from our readers which helps us in improving the quality and presentation of the magazine.

Wishing our readers, a very happy festival of colors-Holi.

Stay safe and healthy,

Warm regards,
Udey Dhir

The Four States **of Water in Oil**

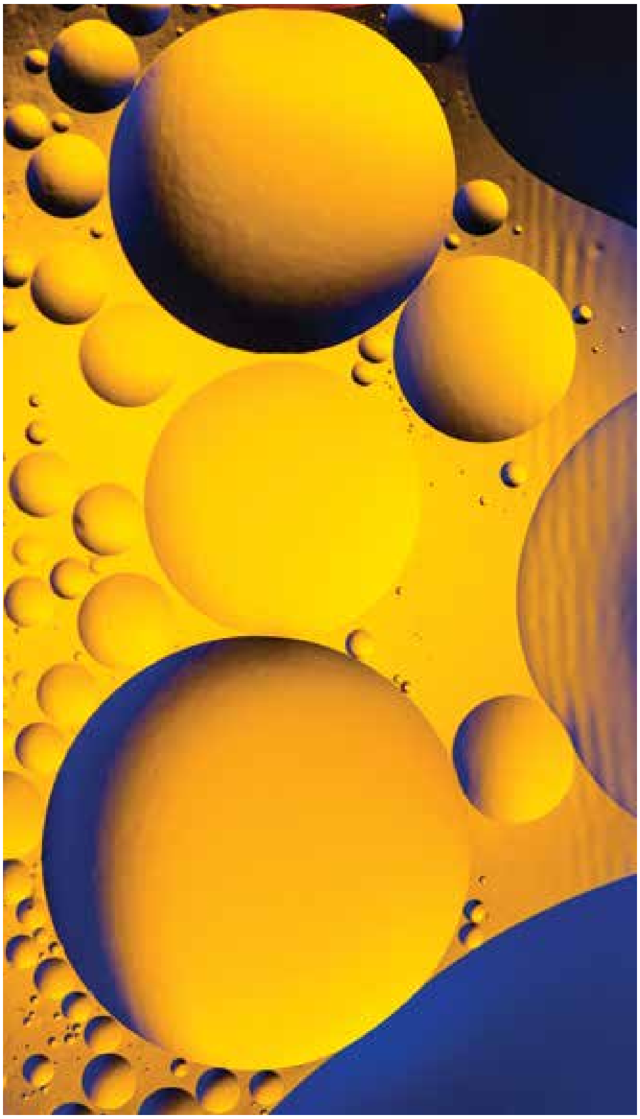
"By far, the most important, effective and practical condition monitoring sensor is the eyeometer"

Why is this important? Water is a highly destructive contaminant. It's important to know how it behaves and coexists when it invades our oil, machine or system.

The understanding of its coexistence has evolved over the years from the initial perception of two states, then three and now four. Three of these states are clearly visible and not only tell us about the presence of water, but also about the condition of the oil. By far, the most important, effective and practical condition monitoring sensor is the eyeometer (I love that word!). It is imperative that we train our eyes and be keen inspectors which is integral to Inspection 2.0. If you want world-class reliability, you must have world-class lubrication. If you want world-class lubrication, you must have world-class inspection. Back to water…

How Many States?

Historically, water contaminated oil has been said to exist in two states, the first dissolved water (bound molecularly in the matrix of the oil) and the second free water (not molecularly bound). In the last 30 years or so most of the literature, including Noria's publications, refer to water as having three states. Free water has been redefined as being



water that, by force of gravity, will phase out of the oil. This means it will separate below (most common) or above the oil phase depending on oil density.

The new third state is emulsified water. Water that is held tightly in micro-globules in the oil is no longer referred to as free water. Instead it has been more accurately referred to as emulsified water or a microemulsion. Emulsified water does not separate quickly, or at all in many cases. This is due to polarity, relating to cohesive forces between the water and the oil, especially its additives. Also influencing this is the high oil-water interfacial area which relates to the contact area between the water and the oil. The smaller the water globule, the greater the relative interfacial area of water contacting the oil, which holds the water tighter and longer in the body of the oil. Stoke's Law plays a role too (Google it).

> "In the last 30 years or so most of the literature, including Noria's publications, refer to water as having three states."

These micro-globules are basically locked in the body of the oil and as such become a homogeneous part of the oil, physically and chemically. They are what cause the oil to become hazy or cloudy depending on oil concentration. This noteworthy parameter is referred to as turbidity, which actually increases the oil's viscosity. Figure 1 shows three samples of hydraulic fluid. The first sample is dry oil while the middle sample and the right sample have increasing amounts of emulsified water, hence the cloudy, turbid appearance.

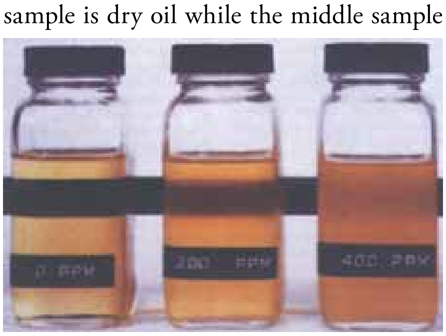


Figure 1 Shown here is dry hydraulic fluid on the left and increasing amounts of emulsified water (water-in-oil) to the right.

There are two common ways emulsified water can form in oil. The first is from colloidal condensation due to a supersaturated state of water in oil. This occurs when the oil's temperature drops below its dew point. The dissolved water concentration in oil is 100% when it is at its dew point. The colder the oil gets, the cloudier the oil becomes from condensation. The dew point temperature is influenced by the polar chemistry of both the oil's basestock and additives.

The second way an emulsion can occur is from shear or mechanical agitation. In this case, free water is crushed by high mechanical mixing into the oil, similar to how mayonnaise is made in a blender. Crushing can occur by pumping, by fine filtration, from turbulent flow and at frictional zones (gears, bearings, etc.). Crushing can increase the interfacial (touching) surface area between the oil and the water by over one million times. This, combined with polar chemistry, locks the water in the oil, preventing it from stratifying downward easily. Typically, the size of micro-globules of water in oil is about 5-10 microns.

Invert-Emulsion, the 4th State

Above, I referred to water as being emulsified in the form of micro-globules. In such case the oil is the continuous phase and the water globules are discontinuous (separated by oil). The 4th state relates to the inversion of water and oil as an emulsion. When an inversion happens, the water is in the continuous phase and the oil is the discontinuous phase. The oil is

Machinery Lubrication India

Publisher
Udey Dhir
udeydhir@tribologysolutions.com

Creative Director
Sumita Maniktala
smassociates@gmail.com

Advertisement Sales (US/Canada)
Brett O'Kelley - bokelley@noria.com

Advertisement Sales
(India/all other countries)
Kaustav Das
kaustuvdas@machinerylubricationindia.com

CORRESPONDENCE
You may address articles, case studies, special requests and other correspondence to our

Operation office :

Editor
213, Ashiana Centre, Adityapur,
Jamshedpur-831013, India
email : editor@machinerylubricationindia.com
Tel: +91-657-2383238
Tel:(USA): +1-918-960-9738

Marketing Office
Rider House, 136,
Sector 44, Gurgaon-122003, Haryana
National Capital Region, India

Machinery Lubrication India Volume 58 - Issue 2, March-April 2022 is published bi-monthly by VAS Tribology Solutions Pvt. Ltd. Operation Office:213, Ashiana Centre, Adityapur, Jamshedpur-831013, India.

SUBSCRIBER SERVICES: The publisher reserves the right to accept or reject any subscription. Send subscription orders, change of address and all related correspondence to: VAS Tribology Solutions Pvt. Ltd. Operation Office:213, Ashiana Centre, Adityapur, Jamshedpur-831013, India.

the globule or micro-globule, not the water.

The invert-emulsion typically occurs either at the interface between oil and free water or in the rare case when there is more water than there is oil in a turbulent vessel or circulating system. Many metal-working fluids and coolants are high-water based fluids, i.e., oil-in-water emulsions. The same is true for certain fire-resistant hydraulic fluids.

Emulsified oil-in-water can easily be composed of 90% water or more. The high density of the water holds it down in sumps and reservoirs, meaning it is generally not as mobilized like its unruly sibling (water-in-oil). Figure 3 shows two oil samples that are clearly exhibiting evidence of all four states of water in oil.

Figure 2 shows an annotated illustration of the common appearance and locations of all four states of water and oil. At the top you see dissolved water (but not really). Just as water in humid air is invisible to the eye, the same is the case with dissolved water in oil. It is worth noting that all lubricants have dissolved water to some degree.

Oil is hygroscopic and as such will draw water directly from humid air above. For instance, if the air has a relative humidity of 80% then a hygroscopic oil in contact with the air will absorb water from it until it is also at 80% relative humidity. At which point the air and the oil are in equilibrium.

The Most Destructive State

Emulsified water-in-oil is the greatest offender in terms of damage to the oil

Figure 3. Two different samples exhibiting all four states of water and oil. Note the milky white appearance of the free water phase in both samples. Many oil impurities transfer to free water including some dead additives. Seeing what's in the water phase can provide supplemental information about other contaminants and the condition of the oil. Pay attention! The band in the middle of both samples is the oil-in-water emulsion. How thick is this band? Does it diffuse or does it have good definition?

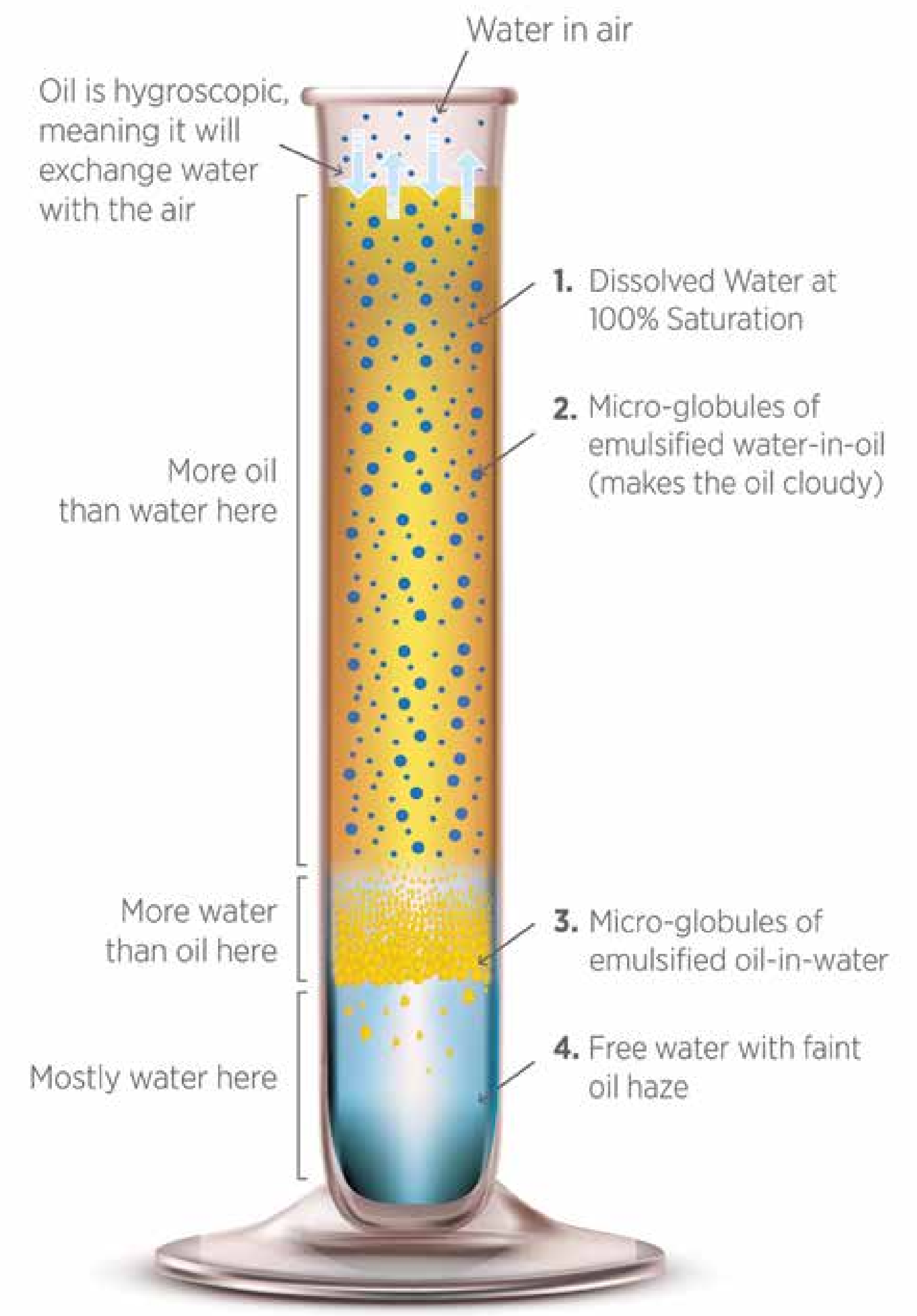


Figure 2. Illustrated example of the presence of the four states of water in oil. There are so many determining factors that influence where the water is and how much water there is in each zone.

and the machine. Its enormous oil-water interfacial puts it at high risk to incite considerable harm, both physically and chemically. Most serious is the fact that it is mobilized, meaning that it travels unrestricted to the far reaches of the machine including those critically sensitive frictional surfaces. Wherever the oil goes, so goes this aggressive contaminant.

As we've said many times in this publication and throughout Noria training courses… get water under control! Recognize it quickly, remove it quickly. Inspection is your first line of defense. Any visual form of water should be of serious concern. Oil analysis is even more revealing. Figure out where it's coming from and stop its ingression into the oil.

Different Oils; Different States

Know your oils from the standpoint of how water behaves and co-exists with them. Engine oils for instance are loaded with polar additives such as detergents, dispersants, antiwear additives, etc. The free water state is unlikely with engine oil, even if there is 90 percent water. Conversely, emulsions quickly and tightly form between water and engine oil.

Healthy, clean turbine oil is at the other extreme. It rapidly sheds water as there are no polar handles for the water to latch onto to form emulsions. Therefore, only free water and dissolved water may exist. As turbine oil ages, you will see water hang in the oil in a direct microemulsion state and/or as an invert-emulsion at the interface. Because of this we are using water as an inspection aid to help us learn more about the health of the oil.

When oil-water mixtures are at rest, stratification occurs based on oil density, polarity and Stoke's Law. This is seen hypothetically in the illustration of Figure 2 and the photo images of the oil samples in Figure 3. Violently agitating an

35 things that are not happening when oil is clear, bright and the correct color when observed at both the oil level sight glass and the BS&W sight glass (some exceptions apply):

1. Oil is NOT oxidized
2. Oil additive system is NOT instable
3. Oil is NOT contaminated with free water
4. Oil and water are NOT emulsified
5. Oil is NOT laden with heavy varnish potential
6. Oil is NOT hydrolyzed
7. Oil does NOT contain sludgy suspensions
8. Oil is NOT cross-contaminated with another lubricant
9. Oil additives have NOT turned to floc from chemical degradation
10. A wrong oil is NOT being used
11. The fishbowl effect is NOT happening (Google: noria fishbowl effect)
12. Filter has NOT burst or not gone into bypass
13. Oil is NOT loaded with sediment or stratified solids
14. Oil is NOT thermally degradation
15. Oil is NOT loaded with soft organic insolubles from various sources
16. Oil does NOT have impaired air release properties
17. Oil is NOT exhibiting foam tendency/stability problems
18. Oil does NOT have microbial contamination
19. Oil does NOT have severe corrosive potential
20. Oil does NOT need to be immediately changed for various reasons
21. Antifreeze contamination has NOT occurred
22. Abnormal levels of particle or water ingression conditions is NOT occurring
23. Advanced wear debris generation is NOT likely occurring
24. Machine is NOT starved of oil due to low oil level
25. Machine is NOT dangerously flooded with oil
26. Machine sump/reservoir is NOT over-agitated for various reasons
27. Circulating machine does not have a suction line air-induction leak
28. Process chemicals/liquids have NOT invaded the lubricant
29. The desiccant breather and general headspace management are NOT malfunctioning
30. Machine is NOT likely to have hotspots
31. Severe misalignment is NOT likely to be occurring
32. Precipitous gear or bearing failure is NOT likely to be occurring
33. Process gases have NOT invaded the lubricant system
34. Failure of internal or external seals does NOT appear to have occurred
35. Negligent PMs and inspection practices does NOT appear to be occurring

oil contaminated with water in a sample bottle and then letting it rest helps us understand more about both the oil and the water (also air release and foaming tendency). Very similar to the blender test for field inspection of oil condition (use our search engine for more information on this metho).

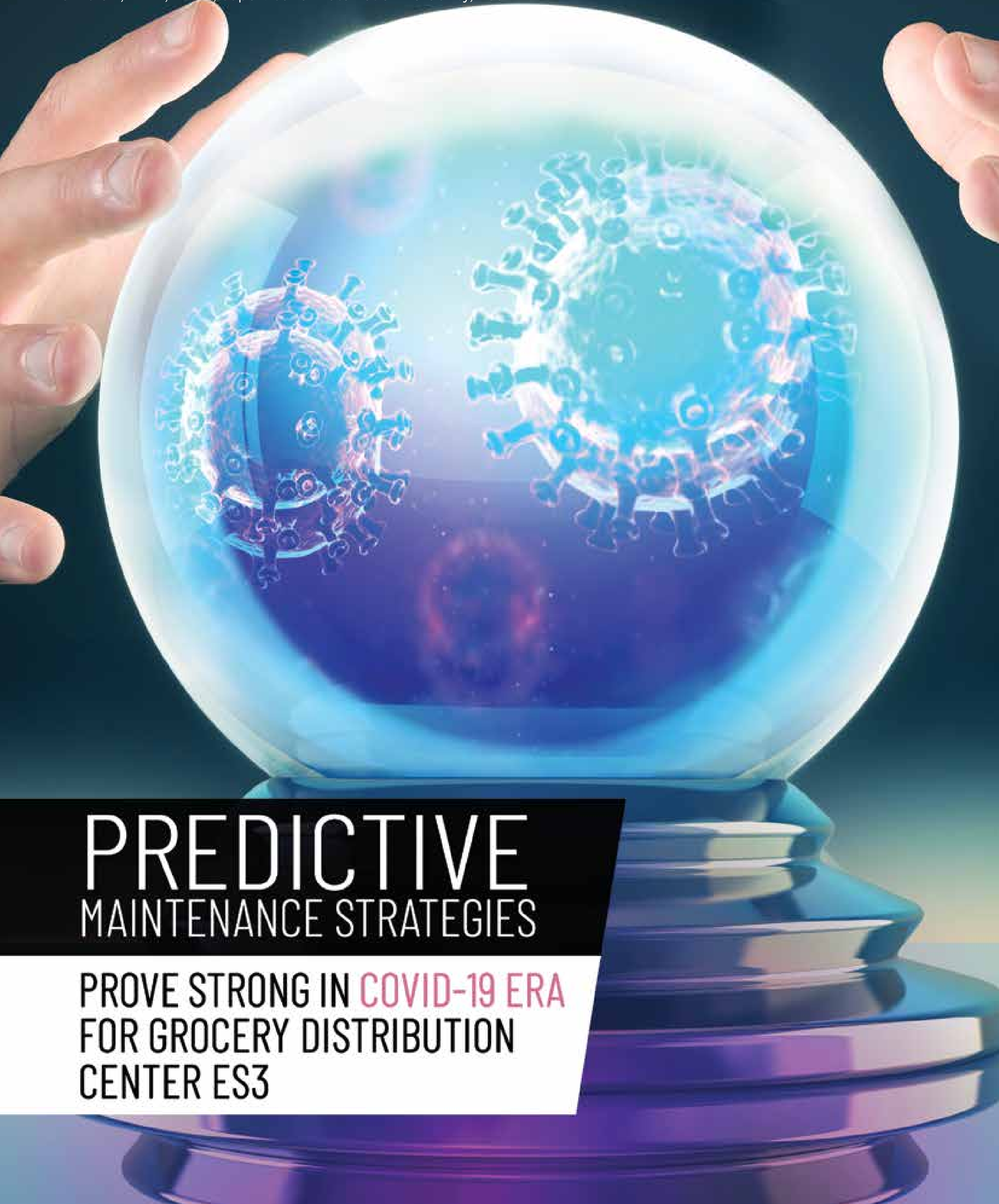
35 Things that Aren't Going Wrong

Have a good sight glass center-line with your machine's target oil level. Have another one at the sump bottom (BS&W bowl). Let's say that you visually inspect your machine with good light at both locations. All you see is clear and bright oil of the right color. What can you conclude? Well, there are about 35 things that could be going wrong with your oil and machine but you know are not going wrong (see sidebar) due to this simple visual inspection, including the harmful presence of water. Do it! *ML*

About the Author

Jim Fitch has a wealth of "in the trenches" experience in lubrication, oil analysis, tribology and machinery failure investigations. Over the past two decades, he has presented hundreds of courses on these subjects. Jim has also published more than 200 technical articles, papers and books. He serves as a U.S. delegate to the ISO tribology and oil analysis working group. Since 2000, he has been the director and a board member of the International Council for Machinery Lubrication. He is the CEO and a co-founder of Noria Corporation. Contact Jim at jfitch@noria.com.

By Lisa Williams, CLS, LLA II, Technical Solutions Specialist, AMETEK Spectro Scientific
Travis Sanderson, CLS, ACP Automation Specialist, ES3
Chris Orr, MLT I, LLA II, Supervisor of Automation Reliability, ES3



PREDICTIVE MAINTENANCE STRATEGIES

PROVE STRONG IN COVID-19 ERA FOR GROCERY DISTRIBUTION CENTER ES3

The 2020 calendar year has certainly brought with it many challenges for a variety of industries. The medical field, pulp and paper industry and food supply chain have all been significantly impacted by the unprecedented COVID-19 pandemic. At the grocery store, people experienced (or are still experiencing) empty shelves, limited food supply and less variety when doing weekly shopping. In March 2020, grocery and supply sales increased 29% from the previous year (3).

With this significant change to everyone's daily lives, people immediately assumed the nation's food supply must be low, which led to panic buying and hoarding, thus, escalating the problem. The root cause of the problem, however, had very little to do with limited food supply and more to do with global supply chains being shut down around the world due to COVID-19. This lockdown lead to massive shifts in production and packaging methods, and major delays getting the final products on the shelves.

With grocery stores already operating at "just-in-time" inventory levels even pre-pandemic, the strains on the global grocery supply chain due to COVID-19 became all too apparent. Product demand became so high that many production facilities did not have the luxury of taking equipment offline for maintenance. In fact, most machines were operating at full capacity. With machines experiencing minimal to zero downtime, predictive maintenance strategies not only became a competitive advantage to corporations, but imperative to company operations. While timely delivery of product is always important, the COVID-19 pandemic made it absolutely critical for Spectro Scientific MiniLab customer and grocery distribution center, ES3.

Headquartered in Keene, New Hampshire, ES3 provides storage and shipping services for grocery items throughout the United States and has facilities located in Iowa, Ohio and Pennsylvania. The flagship facility in York, Pennsylvania, ships to more than 300 grocery stores in the Northeast and provides storage services to more than 50 manufacturing partners. This is one of the largest automated grocery distribution warehouses in the world, with 380,000 pallet storage locations and the capability to ship 5 million cases per week. The York site also holds their in-house lubrication laboratory and MiniLab 53, supporting nearly 100 critical assets with expansion always on the horizon. They routinely assess samples of gear oil from the two different automated systems at this site, including enclosed gearboxes and robotic arms.

Time to Bring In-house: Creating the Reliability Culture

In December 2013, Travis Sanderson, the ACP automation manager at ES3, decided to pursue the idea of building a lubrication laboratory onsite. At that time, Sanderson was working closely with many of the robotics and automation components within the facility.

"We weren't checking our oils and we weren't changing them like we should, and it was starting to cost us a lot of money," he said. "Failures of our machines and our inability to control them were hurting us pretty drastically to the point that it was getting a lot of attention and we needed to find a new strategy of going after it."

The new strategy included onsite lubricant analysis that focused on quickly understanding the oil condition.

US consumer food spending, Mar 2019 vs Mar 2020, $ billion

Source: Administrative records; Mckinsey Annual Retail Trade Survey; McKinsey Monthly Retail Trade Survey; McKinsey Service Annual Survey

McKinsey & Company

"We had to make sure our leaders bought into what we were doing and understood the value behind it."

– Travis Sanderson, ACP Automation Manager, ES3

"We proposed the idea of the lubrication laboratory using the MiniLab and we nailed down working on oil integrity and contamination and trying to get it so that within the hour, we can have a sample of where we stand," said Sanderson. "ES3 is one of the largest automated facilities in the world for distribution of groceries. Every single thing we have in our facility is on a massive scale. With our machines, we have so many duplicates of everything that if we can't see the heartbeat of it, the health of it or how well it's doing, there's no way we could get ahead of it."

By working with reliability consultants and obtaining certifications through the International Council for Machinery Lubrication (ICML) and the Society of Tribologists and Lubrication Engineers (STLE), ES3 was set up for success when approaching management with this pioneer idea of onsite oil analysis.

Sanderson said that it wasn't always easy getting that support, but his certifications and learning how to convey his ideas in a way that related to management goals really helped.

"We had to make sure our leaders bought into what we were doing and understood the value behind it," he said. "Having my certifications helped me be a player in that discussion."

Soon after, Sanderson began building their lab space, sourcing lab equipment and developing a program for managing their critical assets. At that point, Chris Orr, supervisor of automation reliability, came onboard and started managing the lab process.

Knowledge is Power: Establishing an Oil Analysis Program

Orr's background in engineering led him into the position, but he admitted that his knowledge about lubrication was lacking prior to his ICML Level I Machinery Lubrication Technician (MLT I) certification.

"Most of my education about the lab and lubrication was completely outside anything related to college. It's all stuff that you can learn by going and taking a class for a week and passing a test," said Orr, who now holds MLT I and Level II Laboratory Lubricant Analyst (LLA II) certifications through the ICML.

As the lubrication program started to gain more traction at ES3, Orr was tasked with selecting the right lab tests to run on the machines, setting the alarm limits and deciding when there was a problem with the equipment that needed to be addressed. A tall order, but possible when equipped with the right tools and knowledge.

ES3 was one of the early adopters of the TruVu 360 Fluid Intelligence Software used in conjunction with the MiniLab 53 system. The TruVu 360 software is designed with 31 different component types already programmed into the software with recommended parameters, alarm limits and diagnostic statements. Pairing his oil analysis knowledge with TruVu 360, Orr was able to create rules and alarm sets specifically for their gearboxes by monitoring particle count, wear particles, oxidation levels and total acid number (TAN).

Managing oil changes was one of the biggest challenges, but with the right strategy (and data), ES3 was able to manage it fairly smoothly. ES3 has 38 gearboxes across their cranes, each containing 30-35 gallons of oil. Using the proper oil analysis data, Orr has been able to optimize exactly when they need to change the oil in those gearboxes.

"On our larger gearboxes, the particle count from the LNF is particularly helpful because it helps us determine whether we can just filter the oil and get more life out of it, rather than changing the oil entirely," said Orr. "We also look at the wear particle analysis. That's been really helpful for us because we aren't able to do some of the other wear analysis techniques, but that gives us a quick, easy way of seeing whether there is a potential problem inside that gearbox. Since we send out our gearboxes for rebuild, this is especially helpful to understand if we need to schedule downtime to get the gearbox rebuilt."

Sharing the Good News

As the Supervisor of Automation Reliability, Orr also has the responsibility of sharing the data from the lab with his PM technicians, who are extremely interested in learning about the data being gathered and how to apply it to their daily duties. Orr often brings technicians into the lab to show the results of a sample.

"Each technician, to some degree, has an idea of what we are trying to accomplish here, and they are very interested," said Orr.

The lubricant analysis process seamlessly fits into the computerized maintenance management system (CMMS) workflow where Orr can process data and issue work orders for his team. "The whole process is very easy, honestly," he said.

Both Sanderson and Orr truly believe in the power of certifications to help build a strong foundation in lubricant analysis. From there, the foundation allowed for them to convey a compelling story to their management team in support of an onsite lubrication lab at ES3. After the culture was created, it was a matter of putting the knowledge to use and selecting the right tools and people to get the job done.

When the crisis hit, Sanderson and Orr successfully implemented their combined education and resources and this, in turn, enabled them to keep ahead of equipment failures, efficiently meet demand and deliver products when they were needed most. Although COVID-19 is still ongoing and impacting the global grocery supply chain, ES3 is well-positioned to ride out the storm. *ML*

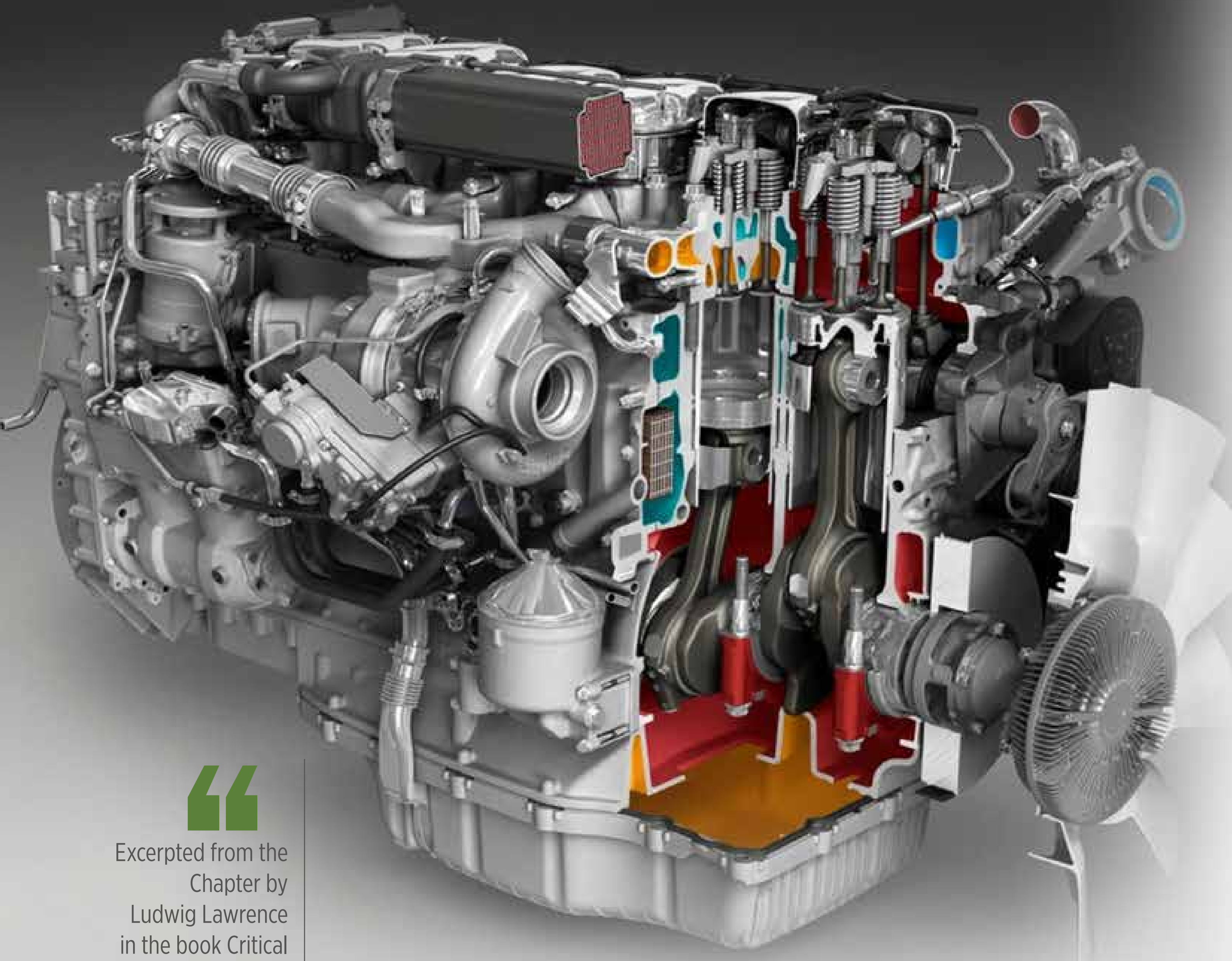
References

www.businessinsider.com/how-long-grocery-store-shortages-supply-chain-disruptions-could-last-2020-4

www.marketwatch.com/story/coronavirus-pandemic-shows-the-us-food-supply-chain-is-due-for-an-upgrade-experts-say-2020-04-17

www.mckinsey.com/industries/consumer-packaged-goods/our-insights/us-food-supply-chain-disruptions-and-implications-from-covid-19#

Ludwig Lawrence | P. A. Lakshminarayanan | Nagaraj S. Nayak



Excerpted from the Chapter by Ludwig Lawrence in the book Critical Component Wear of Heavy-Duty Diesel Engines (2011) edited by P. A. Lakshminarayanan and Nagaraj S. Nayak

Requirements of Heavy-Duty Diesel Engine Oils

1. What Drives the Changes in Diesel Engine Oil Specifications?

The main drivers for recent changes in engine oil formulation and specifications have come from three sources: the government, original equipment manufacturers (OEMs), and the consumer.

2. Engine Oil Requirements

2.1 What Engine Oil Must Do?

Engine oil reduces friction and prevents wear between the moving parts of the engine. The development of more powerful engines is constantly changing the technology of engine oils formulated for use in today's mod-ern engines. The efficient operation of any engine depends on the engine oil performing many functions.

2.2 Permit Easy Starting, and Pumping

The ability of an engine to reach a critical firing speed promptly, and keep running depends not only on the condition of the battery, starter, and ignition system, proper fuel volatility, and air/fuel ratio but also on the flow properties of the engine oil. The viscosity of the engine oil in engine journal bearings during cold temper-ature start-up is the key to determining the lowest temperature at which an engine will start. The Cold Cranking Simulator Viscosity (ASTM D-5293) is determined under conditions similar to those experienced in engine bearings during start-up from -10°C to -35°C, and under high shear rate conditions. All oils thicken when the temperature drops, but there is also a danger that wax and additive components of the engine oil may come out of solution at low temperatures, and convert the engine oil to a gel-like thick milkshake or even a solid (ASTM D-4684).

2.3 Lubricate, and Prevent Wear

Once an engine is started, and pumping of the engine oil begins, it quickly circulates to all moving parts of the engine to prevent metal-to-metal contact that would result in wear, scoring, or seizure of engine parts. Oil films in bearings and on cylinder walls are sensitive to movement, pressure, and oil supply. The viscosity of engine oil must be low enough at starting temperatures to permit rapid cranking and starting, and high enough at peak operating temperatures to ensure adequate engine protection. Unless counteracted by the oil's anti-wear additive system, the result is either immediate seizure or the tearing apart, and roughening of the surfaces when the film is not developed. Such conditions are found around the top piston ring where oil supply is limited, temperatures are high, and a reversal of piston motion occurs, Fig. 1 . Full film lubrication occurs when a film of oil continuously separates the moving surfaces.

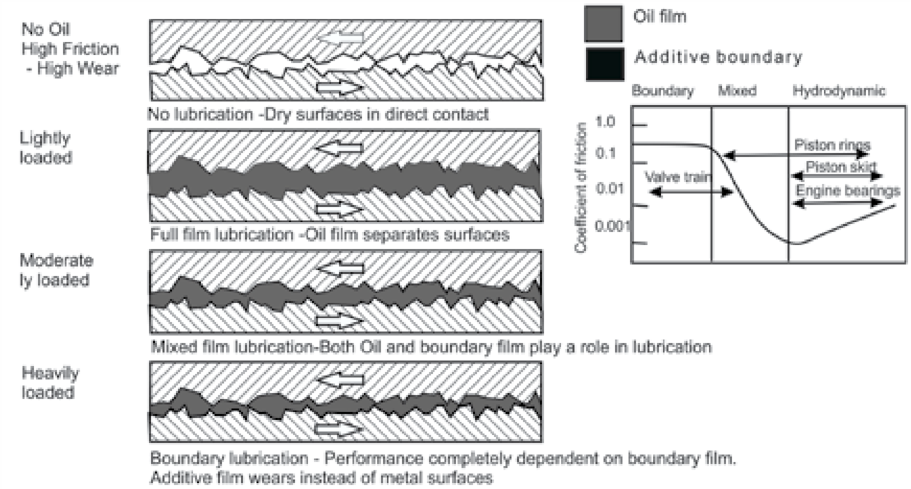


Fig. 1 Engine Lubrication Regimes

2.4 Reduce Friction

The viscosity of the engine oil should be high enough to maintain an unbroken film, but should not be higher than necessary, since this increases the amount of force required to overcome this fluid friction, reducing engine fuel economy. The viscosity increases as the oil become contaminated with soot, dirt, and sludge, and decreases if it is contaminated with fuel.

2.5 Protect against Rust, and Corrosion

For a variety of reasons, an engine does not burn all of the fuel completely. The other by-products from in-complete combustion of the fuel like nitrogen oxides, and sulfur oxides dissolve into the engine oil apart from the acids formed by the normal oxidation of oil, and hence the potential for rust and corrosion is significant.

2.6 Keep Engine Parts Clean

Combinations of water from condensation, dirt, the products of oil deterioration, and the by-products of in-complete combustion of the fuel become sludge deposits at low engine operating temperatures. Therefore, a basic objective formulation of engine oils is to keep the engine clean and prevent the build-up of sludge, and varnish deposits from interfering with proper engine operation. In performing its lubrication function, some oil must reach the area of the top piston ring to lubricate the rings and cylinder walls. To further control combus-tion chamber deposits the engine oil is formulated from base oils that exhibit low volatility characteristics as it comes in contact with the turbocharger, cylinder walls, valves, and the under-crown, and ring belt area of the pistons.

2.7 Cool Engine Parts

After the warm-up, engine oil temperatures reach 93° to 135°C, and the oil is supplied to the bearings at this temperature. What is critical is the continuous circulation of large volumes of oil throughout the engine, and over hot engine parts. This is made possible through the use of an oil of the right viscosity for that engine, high-volume oil pumps, and unclogged oil passages adequate to handle the required volume of oil.

2.8 Seal Combustion Pressures

The surfaces of the piston rings, ring grooves, and cylinder walls show minute asperities. Engine oil fills these and helps to seal the combustion chamber. Oil consumption may also be high in a new or rebuilt engine until the hills, and valleys on these surfaces have smoothed out enough to allow the oil to form a tight seal.

2.9 Non-foaming

Because of the many rapidly moving parts in an engine, the air in the crankcase is constantly being beaten into the engine oil. To help ensure proper engine protection, all engine oils contain anti-foam additives.

2.10 Aid Fuel Economy

Engine oils are formulated to provide fuel economy benefits. There are two ways engine oils may help to improve fuel economy. For both monograde and multigrade engine oils, friction reduction is achieved by the use of additives (surface-active materials) that lower the friction during boundary lubrication, which do not in-terfere with anti-wear/extreme pressure agents. This can also be accomplished by changing to lower viscosity oil, causing less friction. Also, multigrade oils that contain polymeric additives as viscosity index improvers, provide a variable viscosity when lubricating high shear zones. This results in reduced resistance to flow, lower operating temperatures, and better fuel economy.

3. Components of Engine Oil Performance

3.1 Viscosity

The viscosity of the oil is the resistance to flow and is a basic criterion for predicting engine oil performance. To ensure that the proper viscosity grade is used the Society of Automotive Engineers (SAE) has developed a viscosity grade classification for engine oils. The worldwide standard for defining engine oil viscosity is the SAE viscosity classification system assigning a grade to a specific viscosity range; the high-temperature, high shear (HTHS) viscosity relates to the viscosity at 150°C under shear stress conditions similar to the very thin film area found at the piston ring-to-cylinder wall interface. These oils (SAE 5W-40, 10W-30, SAE 15W-40, or other combinations) can be used over a wider temperature range than single-grade oils. A higher viscosity in-dex shows less change in viscosity over a wide temperature range. For example, an SAE 10W-30 engine oil meets the Cold Cranking Viscosity, and Mini-Rotary Viscosity low-temperature viscosity requirements of SAE 10W, and the high-temperature viscosity requirements of SAE 30.

3.2 Protection against Wear, Deposits, and Oil Deterioration

Deposits like sludge, and varnish cause valve and ring sticking, clogged oil passages, piston, and cylinder wear. Oil deterioration – the result of high-temperature oxidation, and reaction with combustion by-products-can increase the viscosity of oil, and impede oil flow to critical engine parts.

4. How Engine Oil Performance Standards are developed

Several guidelines have been developed to define the overall capability for gasoline, and diesel engine oils to prevent wear, deposit formation, and oil deterioration by the following institutions: (1) The American Petro-leum Institute (API) in conjunction with the SAE, the American Standard for Testing Materials (ASTM), ILSAC (International Lubricant Standardization and Approval Committee), and the Diesel Engine Oil Advisory Panel (DEOAP), (2) ILSAC is composed of North American and many Japanese automobile manufacturers, (3) Indi-vidual OEMs. The development of any new diesel API Service Classification is done in three phases that con-sist of three following steps for a category: Request, and Evaluation, Development and Implementation

4.1 API Licensing Process

If the candidate oil qualifies, the oil marketer must enter into a formal licensingg agreement to display the API Certification Mark (Starburst), and/or API Service (Donut) on their oil containers.

4.2 API Current Service Classifications, 2021

Category	Service
CK-4	API Service Category CK-4 describes oils for use in high-speed four-stroke cycle diesel engines designed to meet the US 2017 model year on-highway and Tier 4 non-road exhaust emission standards as well as for previous model year diesel engines. API CK-4 oils are designed to provide enhanced protection against oil oxidation, viscosity loss due to shear, and oil aeration as well as protection against catalyst poisoning, particulate filter blocking, engine wear, piston deposits, degradation of low- and high-temperature properties, and soot-related viscosity increase.
CJ-4	For high-speed four-stroke cycle diesel engines designed to meet the US 2010 model year on-highway and Tier 4 non-road exhaust emission standards as well as for previous model year diesel engines. API CJ-4 oils exceed the performance criteria of API CI-4 with CI-4 PLUS, CI-4, CH-4, CG-4, and CF-4 and can effectively lubricate engines calling for those API Service Categories
CI-4	CI-4 oils are formulated to sustain engine durability where exhaust gas recirculation (EGR) is used and are intended for use with diesel fuels ranging in sulfur content up to 0.5% by weight.
CH-4	CH-4 oils are specifically compounded for use with diesel fuels ranging in sulfur content up to 0.5% weight.
FA-4	API Service Category FA-4 describes certain XW-30 oils specifically formulated for use in select high-speed four-stroke cycle diesel engines designed to meet 2017 model year on-highway greenhouse gas (GHG) emission standards. API FA-4 oils are designed to provide enhanced protection against oil oxidation, viscosity loss due to shear, and oil aeration as well as protection against catalyst poisoning, particulate filter blocking, engine wear, piston deposits, degradation of low- and high-temperature properties, and soot-related viscosity increase.

4.3 ACEA Specifications

Oil can be approved against many different specifications that are issued by industry bodies such as ACEA (Association des Constructeurs Européens de L'Automobile), the API, or individual vehicle manufacturers. For heavy-duty diesel engine oils, the ACEA specifications are referred to as "E" Sequences: Sulfated ash content, % Sulfur, % Phosphorus, % Noack Volatility, High-Temperature High Shear Viscosity, TBN

4.4 OEM Specifications

Some OEMs like Caterpillar, Cummins, Detroit Diesel, Mack, and Volvo create and recommend their engine oil performance standards when a need or a desired performance level is not met by a current API Service Clas-sification.

4.5 Why Some API Service Classifications Become Obsolete?

For the diesel engine oil service categories, new categories cannot always include the performance proper-ties of all of the prior categories.

5. Engine Oil Composition

Heavy-duty diesel engine oils are comprised of approximately 75 to 85% base oil with the remainder made up of additive systems.

5.1 Base Oils

The base oils used in the formulation make up a substantial portion of the finished lubricant and contribute significantly to the performance characteristics of the finished oil in areas such as thermal stability, viscosity, volatility, the ability to dissolve additives, and contaminants (oil degradation materials, combustion by-products, etc.), low-temperature properties, air release/foam resistance, and oxidation stability. Base oil is de-fined as a refined petroleum fraction or a synthetic material that is produced to a given set of specifications by a single manufacturer. Mineral-based oils are derived from petroleum base oils. Petroleum-based oils are derived from crude oil, which is also used to produce gasoline, diesel fuel, kerosene, asphalt, gases, and petrochemical feed-stocks. Of these types of crudes, the most favored type of crude used for producing petroleum base oils are the paraffinic type crudes, which are analogous to long straight kinds of pasta such as spaghetti, because of their high viscosity index. Unconventional base stock refining utilizes severe hydrocracking refining tech-niques such as two-stage hydrotreating process, hydroisomerization, or iso-dewaxing/hydrocracking processes. During the refining process the different types of hydrocarbons are separated into different types through the process of distillation (kind of like removing the very big, and little pieces of pasta), cracking (like breaking the very long pieces of pasta like linguini, and spaghetti into shorter pieces), hydrogenation (converting some pieces into others), and dewaxing (removing certain large pieces like lasagna), and so forth. These processes produce approximately two-thirds of the world's paraffinic base stocks.

The two basic processes used for obtaining petroleum lubricant base stocks consist of separation and con-version processes are as follows. [1] Separation type procedures: (a) distillation: atmospheric, vacuum, (b) pro-pane deasphalting, (c) solvent extraction (d) solvent dewaxing. [2] Chemical conversion procedures: (a) hy-drotreating, (b) hydrofinishing, (c) hydrocracking methods like two-stage hydrocracking, raffinate hydrocon-version, isodewaxing/ hydroisomerization, (d) catalytic dewaxing. To further improve the performance of the lubricant base stock performance several hydro-processing techniques can be used. These hydro-processing methods use hydrogen in the presence of a catalyst to further remove impurities and improve performance: hy-drofinishing (hydrotreating), hydrocracking, hydroisomerization.

5.2 Synthetic Base Oils

Synthetic base oils are base stocks in which a chemical conversion of one complex mixture of molecules in-to another complex mixture has taken place. They have higher viscosity indexes, flashpoints, lower coefficients of traction, (lubricant's molecular resistance to motion of one layer of fluid sliding over or along with another layer of fluid), and lower pour points than mineral base stocks.

5.3 API Base Oil Categories

Base oils used in the formulation of engine oils with different physical and performance properties depend-ing upon their crude source, refining methods, and the chemical conversion methods used to produce them are divided into five API categories, Table-1.

Table 1. API Base Oil Categories

Group	Sulfur, % weight		Satu-rates	V.I.
I	>0.03	and/or	≤ 90	80-120
II	≤ 0.03	and	≥ 90	80-120
III	≤ 0.03	and	≥ 90	≥ 120
IV	All PAO			
V	All base oils not included in Groups I-IV (naphthenic, esters, and polygly-cols)			

Note: In recent years, these categories have been informally subdivided into Group I+, Group II+, and Group III+

Groups I, II, III are classified by the amounts of saturates, and sulfur content, and by the viscosity index of each. Group V is reserved for other base stocks such as diesters, polyol esters, polyalkylene glycols, naphthenic, and aromatic stocks.

5.4 Detergent-Dispersant Additives

Oils deteriorate due to oxidation or by contamination and form insoluble sludge and varnishes and resins on the surfaces of the engine and can block oil passages. They lift any deposits from the engine surfaces to form a barrier film, which keeps the deposits from coming out of suspension and coagulating, Fig. 2 . These molecules attract each other like magnets and form clusters called "micelles". The oil-insoluble precursors of deposits have a greater affinity for the detergent molecule than the oil molecules. When the number of particles exceeds the capacity of the type of detergent, then deposits can form. Also, detergents neutralize any acids formed by the combustion by reacting to form harmless neutralized chemicals.

Polar dispersants (Fig. 3) envelop soot particles and scatter sludge and soot particles preventing agglomera-tion and settling. The polar heads attach themselves to deposits or deposit precursors or acids that may be formed by the combustion of the fuel to form micelles. Dispersants can hinder the agglomeration of soot, sludge, and dirt particles via two different mechanisms, Fig. 4 . (1) Steric stabilization: once the polar head group has adsorbed onto the surface of the dirt particle, the tail provides a physical barrier to attraction, Fig. 5 9. (2) Electrostatic stabilization: Dispersants can also induce a charge on the soot, sludge, and dirt particles. Agglomeration is then inhibited by electrostatic repulsion of the negatively charged dirt particles, Fig. 6 10.

5.5 TBN

As previously stated earlier in this discussion on detergents and dispersants, one of their functions is to help neutralize any acids that are formed by the combustion of the fuel, by proving the engine oil with a Total Base Number (TBN). The oil must have the ability to retain its alkalinity reserve contributed by both the detergents and dispersants during its entire drain interval, the former offering the best alkalinity reserve, over the entire drain period.

5.6 Anti-Wear Additives

During periods of high shock loading, high pressures, high speeds, heavy loading, or at cold start-up, the lubricant film between the two metal surfaces is either squeezed out or ruptured, causing the two metal surfaces to come into contact with each other and as a result, the entire load is carried by the contacting metal surfaces, Fig. 7. The predominant type of anti-wear additive for the past 50 years is zinc diorgano dithiophosphate (ZDDP), Fig. They dissolve all of the inorganic compounds in the molecule (such as zinc) in oil so that they can be carried by the oil to where it is needed. ZDDP breaks up at high temperatures to form protective films of zinc sulfides and zinc phosphates.

5.7 Friction Modifier

They reduce the coefficient of friction and prevent wear where boundary lubrication conditions occur like the piston rings and the cylinder walls at dead center reversal points or the valve train. They work by plating and absorbing on the metal surfaces of the engine to form a long-lasting solid lubricant film, Fig. 8 .

5.8 Rust and Corrosion Inhibitors

Corrosion particularly of ferrous metal surfaces occurs when oxygen and moisture act together on the metal surfaces, further aggravated by the presence of acids formed by the oxidation of the oil or the combustion of the fuel, Fig. 9 .

5.9 Oxidation Inhibitors

At high engine operating temperatures, and in the presence of catalytic metals like copper and its alloys, the oxygen in the air reacts with the oil to form unstable compounds known as free radicals and peroxides. If al-lowed to go unchecked, it can lead to corrosive bearing wear, abrasive wear of various parts of the engine, plugged filters, and oil passages, lack of lubrication, and eventual engine failure. Therefore, oxidation inhibi-tors are added to extend the life of an engine oil 10 to 100 times.

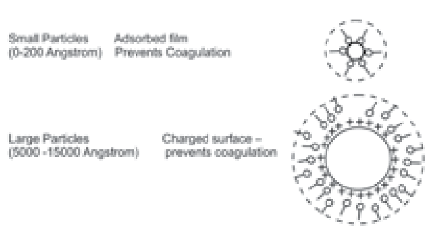


Fig. 2 The action of organo-metallic detergents

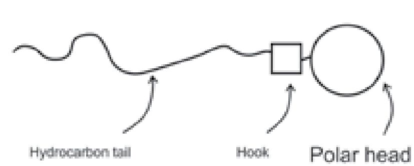


Fig. 3 Dispersant molecule

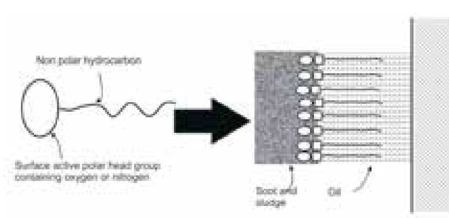


Fig. 4 Polar head adsorbed on to the dirt particle providing a physical barrier to attraction

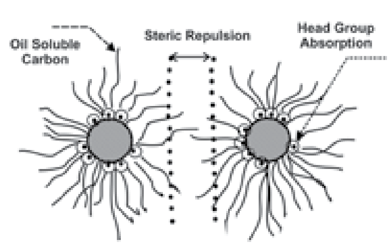


Fig. 5 Separation of small particles and prevention from coming into contact with others and increasing in size

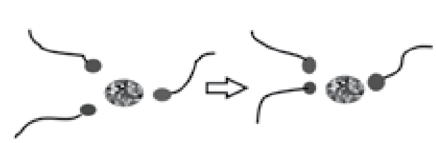


Fig. 6 Electrostatic repulsion of charged particles

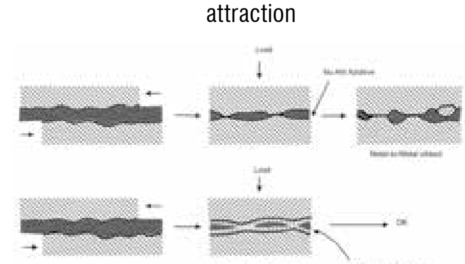


Fig. 7 Anti-Wear Additives: Mode of Action

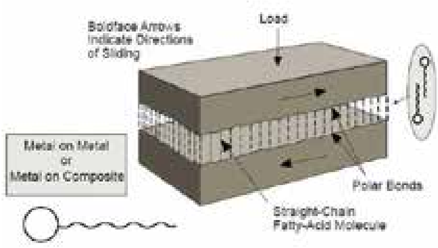


Fig. 8 Friction modifiers plate and are adsorbed to the metal surfaces to form a long-lasting solid lubricant film

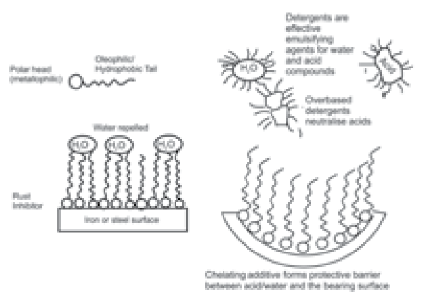


Fig. 9 The action of rust inhibitor

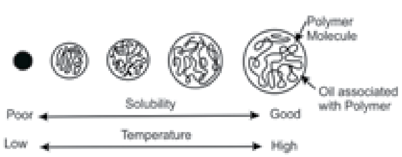


Fig. 10 Viscosity Improver Mode of Action

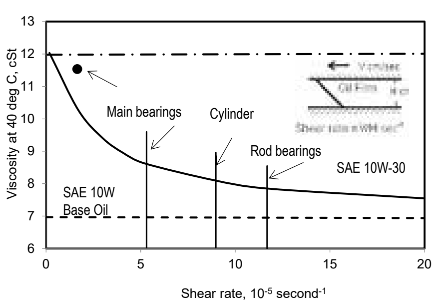


Fig. 11 Loss in viscosity due to shear rate

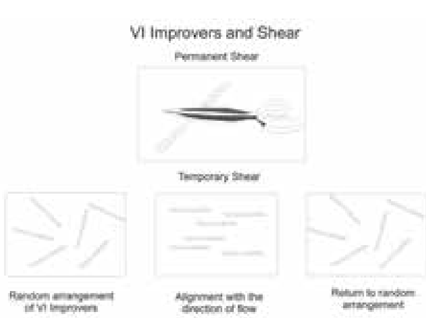


Fig. 12 VI Improvers; Permanent, and temporary shear

5.10 Viscosity Index Improvers

The ideal engine oil would have a constant viscosity adequate to prevent contact of the contacting metal surfaces of the engines at high temperatures while reducing viscous drag at low temperatures. In other words, at low temperatures, the thickening in viscosity is less than that at higher temperatures, because at low tempera-tures the viscosity index improver is less solvated, occupies a smaller volume, and tends to contract and be at-tracted to itself than to the molecules of the base oil by folding upon itself to form small coils or clumps of the polymer that interfere less with the flow of oil and offer less resistance to oil flow and pumpability, Fig. 10 However, the use of VI improvers can lead to problems if they do not exhibit shear stability (resistance to me-chanical shear or tearing apart of the polymer structure), and chemical, and thermal stability. Unlike monograde oils, multigrade oils exhibit non-Newtonian viscoelastic rheological characteristics, i.e., their viscosity depends upon the degree of mechanical shear stresses, Fig. 11 . When the engine oil leaves the high shear zone, the pol-ymers revert to their former arrangement, and the engine oil recovers its higher viscosity.

High shear rates can also cause a permanent loss in viscosity due to the breakdown of the polymer to lower molecular weight fragments, Fig. 12 In addition, polymers can also lose viscosity by undergoing thermal deg-radation can occur when they break down by chain scission or oxidative degradation when weak carbon to hy-drogen bonds react with oxygen to form hydroperoxides and peroxide radicals. Loss in viscous grip can result in increased: oil consumption, oil leakage, engine noise, deposits on critical engine parts, fuel consumption, wear, and emissions. Therefore the right type of chemistry must be chosen to provide not only shear stability but also improved viscosity-temperature characteristics, particularly low-temperature viscosity, and protection against the formation of high-temperature deposits.

5.11 Pour Point Depressants

Pour point is the lowest temperature at which the lubricating oil will pour when cooled under defined test conditions. At low temperatures, these kinds of paraffin tend to separate as crystals and form a lattice honey-comb-like structure that can trap a substantial amount of oil via association, thus inhibiting proper oil flow and circulation to critical engine parts at start-up leading to catastrophic wear. Base oil refiners remove most of the wax through the use of either solvent dewaxing or catalytic dewaxing processes. To control problems with the crystallization pour point depressants are used, e.g., high molecular weight organic polymers that are either al-kylated naphthalenes, oligomerized alkylphenols, polyalkylmerthacrylates, ethylene-vinyl acetate copolymers, or phthalic acid esters, Fig. 13 .

5.12 Foam Inhibitors

Air can be whipped into the oil by the rapidly moving of the engine, or be trapped in the oil during high-pressure release or when the oil pump sucks in air with the engine oil resulting in a mass of oily foam. This compressible foam impairs its ability to prevent wear and can result in the collapse of hydraulic valve-lifters. Surface-active foam-inhibitor chemicals in a few ppm (polymeric materials: polysiloxanes, polydimethylsilox-ane i.e., silicones or poly alkyl acrylates) attach themselves to the air bubbles formed by the whipping of the oil. They form unstable bridges between the bubbles, alter the surface tension of the oil, and facilitate the sepa-ration of air bubbles from the oil phase, Fig. 14 .

6. Maintaining and Changing Engine oils

Only fully formulated and fortified engine oils can provide the protection required by modern, high preci-sion heavy-duty diesel engines. The most important thing

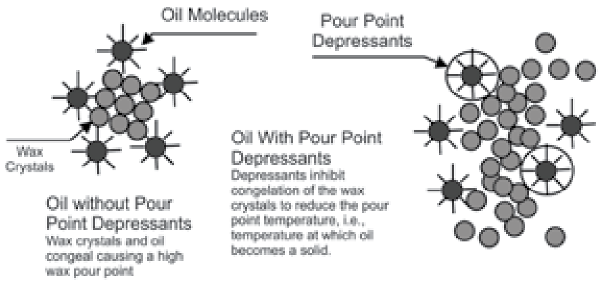


Fig. 13 Mode of Action: Pour point depressants

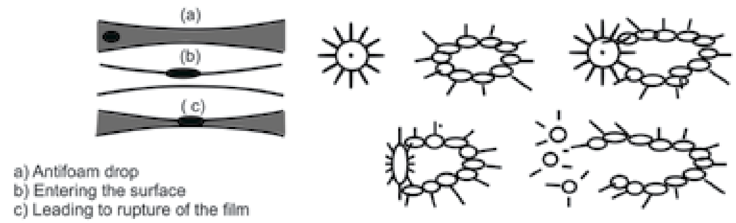


Fig. 14 Mode of Action: Antifoam additive

about additives is that no matter what their chemical make-up is the amounts they are used in the formulation, and the types of base oils, they are only effective for a certain period.

6.1 Oil Change Intervals

Engine oil drain intervals are governed by the "severity" of use, and by the amount, and types of contami-nants to which the engine is exposed. The detergent/ dispersant, anti-wear, oxidation inhibitors, rust, and corro-sion inhibitors eventually become depleted, and the oil eventually loses its ability to prevent the formation of deposits on or the wear of critical engine parts. For this reason, it is essential to drain the oil before contaminant levels, and other stresses on the oil exceed the engine oil's ability to handle them. The best guide to proper oil drain intervals in a heavy-duty diesel engine is the recommendations published by the engine manufacturer.

6.2 Used Engine Oil Analysis

A scientific and regular analysis of used engine oil ensures that the engine oil is performing. A historic data-base and trend analysis of the following are maintained: (a)The condition of the engine oil, and if it is still ser-viceable or ready for change, (b) The presence of contaminants such as dirt, water, soot, or process contamina-tion, (c) The presence of wear to identify the possibility of failure or to assist in making critical maintenance decisions

Used oil samples can tell if water, coolant, or fuel is mixing with the engine oil, indicating a head gasket leak or a leaking fuel injector can forewarn impending problems. The good oil analysis report will provide in-formation regarding: (a) If the unit can go to the next maintenance or sampling interval without any issues, (b) If there is a problem what is it? (c) If any excessive wear or contamination takes place. (d) Is the lubricant suitable for continued use? (e) If engine oil-drain intervals are extended? (f) Any wear trends that may be occurring? (g) What corrective actions may or need to be taken?

P. A.Lakshminarayanan
P. A. Lakshminarayanan studied at the Indian Institute of Technology, Madras for his B. Tech, M.S., and Ph.D. degrees. He worked at the Loughborough University of Technology and Kirloskar Oil Engines Ltd. for about 25 years before moving to Ashok Leyland to head the Engine R&D. he Currently he teaches at IIT Kanpur and Industrial Academies.

With his teams, he has developed more than eight diesel and CNG engine platforms.

Larry Ludwig, CLS, OMA, CMFS, is the Chief Chemist and Technical Director at Schaeffer Manufacturing, USA with more than fifty years 'rich experience in oil research and development. He received his Ph. D. from Saint Louis University, St Louis, Missouri, United States.

Nagaraj Shivappa Nayak is a research and development professional with overall 27+ years of experience, with a focus on teaching, research, mechanical design, product development, project management, and quality assurance. He was Associate Professor, Postdoctoral Fellow in different universities in India and abroad. He is currently associated with KBAT Technologies Private Ltd., India and leads their technology excellence team.

Ghasem Shilati | Naham Pala Engineering

Deficiencies of membrane patch colorimetry (MPC) test

The Varnish Potential Test

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

API Group II oils have been commonly used in gas turbines during the past two decades. As a result, varnish contamination has been one of the most concerning problems for those who maintain them. These contaminants are sludge-like and sticky compounds that are the result of interactions of phenol and amine antioxidants in the oil environment. The high solubility of varnish at different lubricant temperatures makes varnish contamination a complicated problem to tackle. Because of this, gas turbines may experience numerous technical difficulties.

Currently, the most common laboratory test for detecting varnish potential in the oil is the membrane patch colorimetry (MPC) test (ASTM D7843). Despite its overall value, it still suffers from some shortcomings. Understanding these shortcomings helps analysts prevent otherwise probable errors and mistakes.

The Current Testing Method

ASTM D7843 is intended to estimate the amount of risk that varnish contamination poses to gas turbine performance. According to this standard, the oil sample should first be kept at about 65° C for 24 hours prior to the test and then left for about 72 hours at 20° C. Then a certain volume of the oil sample is diluted by a non-polar solvent such as petroleum benzene and passed through standard membranes with a 0.45-micron pore size.

Depending on the amount of varnish contamination in the oil, the standard white membrane will discolor to varying degrees. The intensity of the color created on the membrane is measured by a spectrophotometer and a number ranging from 0 to 100 (in rare cases even above 100) will be assigned as an indicator of varnish potential.

Despite the valuable results of this standard, there are some shortcomings in current practice. This article will address two of these weaknesses, as noted by two

Surface View by reflecting light | Back View by transmitting light

Figure 1. Comparison of reflecting light and transmitting light

international experts.

Observations on the current testing method

In 2014 Professor Akira Sasaki authored an article pointing to a major flaw in the ASTM D7843 standard.

Since the spectrophotometers recommended in this standard are not designed to address the specific needs of the test, a significant portion of the varnish sub-micron particles trapped inside the membrane volume are not visible and are often missed during measurement.

As you see in Figure 1, the intensity of the color when the membrane is lit from the back leads to different results when compared to the way it looks when lit from the front.

In 2015, Professor Sasaki developed a new colorimetric patch analyzer (CPA) which can measure the color of contaminants on the patch surface using reflected light and the color inside the patch by using transmitted light.

One of the most common concerns when using a solvent to dilute in a lab test is that the solvent may dissolve part of what is to be measured and distort the test results.

In 2014, Andy Sitton presented a new index in order to address this concern in Machinery Lubrication magazine.

In Sitton's method, the volume of oil sample is passed through membranes in accordance with ASTM D7843, but no solvent is used. Although the proposed method can take considerable time because of the need to pass thick oil through the membrane, it will eliminate the possible effects of the solvent. The varnish potential is obtained by using a solvent in the ASTM D7843. Sitton's new index is also measured by a spectrophotometer and is called iMPC. The final index will be the number obtained from the division of iMPC into MPC.

The closer the index is to the unit, the more likely it is to deposit varnish on the interior surfaces of the turbine and the greater risk it poses to its safe operation.

Soluble and insoluble varnish contaminant:

The results from the ASTM D7843 standard do provide a useful index, but do not provide distinct estimates of the probable volumes of soluble and insoluble varnishes. Because of the 72 hour oil retention time required by the ASTM D7843 and the agglomeration phenomenon, soluble varnish particles are instead added to the volume of insoluble varnish in the sample and their total volume is then measured.

However, doing so disregards the fact that the hazardous effects of oil-soluble varnish contamination are far greater than those of oil-insoluble varnish. The soluble varnish will be able to circulate further, reaching the smallest openings and clearances of control valves due to its solubility in oil. Then, as the oil temperature drops for any reason, the varnish particles join together and are dissolved into the oil. The resulting viscous sludge mass can easily interfere with the normal operation of the turbine and even cause sudden stops. In addition, the accumulation of these contaminants in the turbine can cause serious damage to mechanical parts such as bearings (4).

If a comparison can be made between the volume of soluble and insoluble varnish present in the lubricant, an estimate of the actual hazards in the gas turbine can be more accurately determined. In the following method, an index will be introduced that can measure oil-soluble varnish and insoluble varnish separately and its benefits will be examined more closely.

The procedure for measuring soluble and insoluble varnish

1. In accordance with the instructions given in ASTM D7843, the oil sample is kept at 65 ° C for 24 hours.
2. The first patch test will then be performed. Since only the insoluble varnish present in the oil can be identified at this stage, the results indicate the insoluble varnish present in the oil.
3. Then the oil sample is kept at about 20 ° C for 72 hours.
4. The second patch test is then performed, and both membranes are evaluated via spectrophotometer.
5. The result obtained from the first membrane is the index of the insoluble varnish present in the oil sample (X_MPC)
6. The result obtained from the second membrane is the sum of the soluble and insoluble varnish present in the oil sample (MPC).

Evaluating results:

With the aid of the oil insoluble varnish index (X_MPC) and the soluble and insoluble varnish sum index (MPC) the R index value can be determined according to the formula below:

R = MPC + (5 - X_MPC)

It should be mentioned that 5 units have been added to the formula to help eliminate the effects of new oil color on a standard membrane.

Now that R has been determined, it is possible to eliminate insoluble particles from the test results providing a more

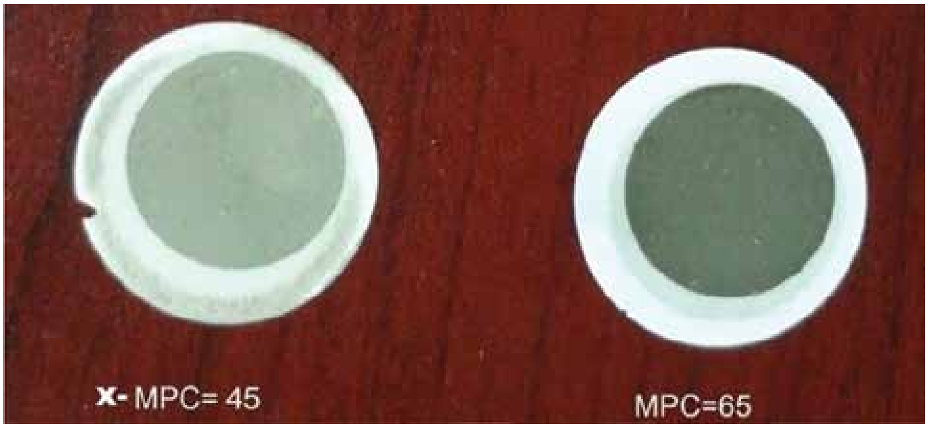


FIG 2. Sample of oil patch for a gas turbine in petrochemical plant.

FIG 3. Sample of oil patch for a gas turbine in a power plant.

relevant measurement of real world risk. If R is less than 15, the turbine conditions are acceptable. From 15 to 30, turbines should be monitored continuously, and if more than 30, turbines are in an abnormal or critical condition and require immediate action. Solutions for cleaning up the varnish in affected gas turbines is a topic for another article.

Fields practical observations:

What prompted me to introduce a new index was my experience dealing with the different effects of the contaminants discussed in this article despite relatively similar MPC results.

As shown in Figure 2, the varnish potential of the turbine oil employed in a petrochemical plant is MPC = 65. Another example shown in Figure 3 is a turbine working in a thermal power plant, showing a varnish potential of MPC = 63.
Although both oil samples appear to be at high risk of varnish contamination, the calculation of the R index indicates that the oil used in the thermal power plant turbine has a higher risk. Here is what this method of testing looks like in practice:

Calculation of Varnish Index R1 for Petrochemical Plant gas turbine.

R1 = MPC + (5 - X_MPC) = 65 + (5 - 45)

>>> R1 = 25

Calculation of R2 Varnish Index of Thermal Power Plant gas turbine.

R2 = MPC + (5 - X_MPC) = 63 + (5 - 17)

>>> R2 = 51

The MPC value for both samples are nearly identical and both appear to indicate serious risk. In fact, because of the higher amount of oil-soluble varnish in the second sample, the probability of sediment contamination is higher at the critical points within the second gas turbine at the thermal power plant.

Importance of particle counting report:

Most oil labs currently use laser particle counters calibrated in accordance with ISO4406:99 to count suspended particles within the oil. In this standard, only suspended particles larger than 4 microns are examined and counted. Field observations have shown that high contamination of turbine oil with particulate matter can contribute to profound errors in MPC varnish potential test results.

Therefore, it is important to consider particle counts when evaluating MPC values. Clearly, calculating the R index and thus removing insoluble particles from the varnish potential test results can be of great value to analysts.

Conclusion:

Though this article is a critique of deficiencies in the ASTM D7843 standard, it is still available and viable as a powerful and reliable tool. Analysts' attention to the test results and the issues mentioned in this article can help to mitigate misunderstandings and errors in the final analysis. Focusing only on the numerical value of MPC tests can be misleading and could lead to costly, inaccurate and ineffective decisions.

The smart choice is to supplement your particle counting results with the R index presented here in order to ensure useful analysis of MPC value. ***ML***

REFERENCES

- Dr. A. Sasaki, CPA newsletter (October 2015)
- US Patent NO. 8,390,796B2 (Mar. 5, 2015)
- Andy Sitton, Focuslab.
- Machinery Lubrication Magazine. (6/2014)
- The varnish issue: strategies for successful monitoring and acceptable level.
- Dr. H. Tubisu. Dr. A. Sasaki.
- Review of varnish problems of modern gas turbines.
- Society of tribologists and lubrication engineers annual meeting. (2010)

Matt Adams | Noria Corporation

PERSPECTIVE

Adhesive Wear Explained

"Adhesive wear is the result of the transference of material from one surface to another typically taking place in poorly lubricated, sliding applications."

What is Adhesive Wear

One of the primary concerns with machinery lubrication is wear generation. Understanding this process, why it occurs, its presence and development, how to detect and analyze it, and what prevention measures need to take place to avert it can greatly improve site equipment reliability and work to minimize associated downtime resulting in a more profitable and enjoyable workplace. Let's take a closer look at adhesive wear and discuss the noted parameters mentioned above.

While there are many types of wear generation within lubrication, we will be specifically reviewing adhesive wear. Adhesive wear is the result of the transference of material from one surface to another, typically taking place in poorly lubricated sliding applications.

As we look further into adhesive wear, it will become apparent that there are several alternative names often associated with this type of wear. As such during discussion or analysis one may encounter terminology such as scuffing, seizing, cracking, smearing, and galling and must bear in mind that all of these can and must all fall within the realm of adhesion.

Adhesive Wear Sources

During inadequate sliding lubrication, asperities, or surface peaks, are subject to interaction with one another. As this transpires, strong adhesive interface can result in "cold welding" and the potential for

coarser surfaces and wear generation are intensified by means of fragment material transfer. It is important to know that there are two fundamental elements that endorse adhesive wear: 1) the proclivity of dissimilar types of materials to form solids or compounds once contact occurs and 2) the overall cleanliness of the surfaces that interact with one another. With this being said, there are several other influencing factors that should be considered. The additive package and film thickness of the lubricant, the size of components that make up the asset, and certain specific operating parameters such as load and speed should also be considered.

As adhesive wear begins to occur it often forms into two types of wear. At very high loads, the debris is often oxides, but at lower loads it is metallic. The oxidation process occurs as the wear and protection

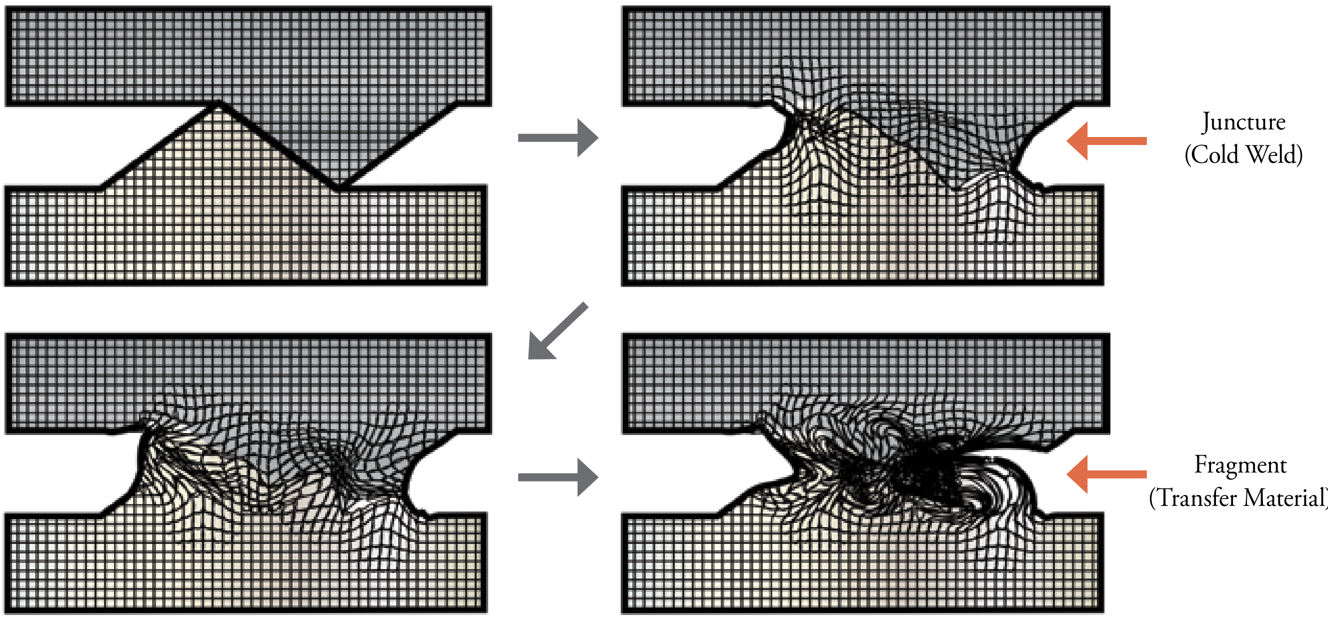


Figure 1: Adhesive wear interaction between surfaces

films begin to wear away and the metallic process commences directly afterward. It is during the transition from oxidative to metallic wear that there is often an immediate increase in the rate of wear. The severity of adhesive wear generated during this process is directly proportional to the load applied and the distance covered during contact over this time.

Now that we have a better understanding of how adhesive wear occurs, we can begin to look at what causes this undesirable interaction between surfaces. There are a multitude of noted causes that drive this unwelcome contact and they boil down to roughly four main driving forces: 1) extreme or inadequate loading, 2) elevated temperatures and pressures, 3) acceleration or deceleration in the load zone, and 4) excessive moisture present in the load zone. As mentioned above, having a sufficient lubricating film thickness and additive package in place to combat against the concerns of loading as well as a sound understanding of the maximum operating temperature when selecting lubricants will aid in reducing these concerns, but as temperatures exceed the identified target range, moisture becomes notably present, and excessive loading begins to take place; one or more of these scenarios will likely rear their head and begin the adhesive wear generation process. The most common components that will be directly affected by adhesive wear are rolling element bearings, cylinders, gearboxes, pistons, and swash plates.

Presence and Development

Acknowledging the presence of adhesive wear in lubricating systems is key and knowing what this wear looks like as well as how it progresses can aid in minimizing concern. The overall appearance of adhesive wear will almost always vary depending on its level of severity. This severity range is commonly broken down into three specific areas: 1) normal or mild wear, 2) moderate wear, and 3) excessive or severe wear.

Normal or mild adhesive wear occurs during initial, small scale wear and tear of the asperities and may be seen as polishing. This wear may appear during a break-in period of machine operation or more commonly during the initial stage of adhesive wear. This early stage wear is often not visible with the naked eye alone but is commonly noted with further inspection of the small weld tears that frequently form in a line. It is important to note an early indication of this wear pattern but continued use of the equipment is typical.

Moderate adhesive wear becomes much more noticeable and often forms darkened color lines or marks on the component. Some bluing of the machine surface may also start to become apparent due to the thermal nature of the scuffing present at this stage. Additional weld tears become noticeable and often lead to metal "pull off" and some mild scuffing of the component. It is important to track and trend the development of wear at this stage and work to execute a plan in the near future to address this concern during equipment downtime.

Excessive or severe adhesive wear is the most damaging stage of adhesive wear. In this stage of wear metal "pull-off" begins to become excessive and accumulate as it moves along the surface, taking on the appearance of being "smeared." This leads to more noticeable scuffing, torn surfaces, cracking and macropitting. In more severe cases, the surface layer can dislocate from the subsurface due to high tangential friction, resulting in a material pile up or avalanching effect which further promotes the advancement of this "smeared" outcome. If excessive or severe adhesive wear is noted, there is much greater concern for equipment failure and a plan should be established to remove this equipment from service and perform a replacement as soon as feasibly possible.

It is worth mentioning, like any other wear progression it is imperative to identify which wear pattern is present and work to isolate and separate certain patterns from one another. Doing so will aid in driving correct root cause analysis results.

Detection and Analysis

Identifying the detection of each stage of adhesive wear generation is imperative and there are specific ways in which to validate this concern through analysis.

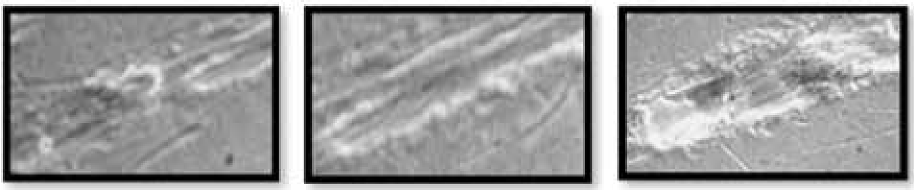
Basic visual inspections are the most simplistic method of identifying adhesive wear-related concerns. Machine surface inspections must take place with the asset out of service while visual inspections, where applicable, of debris generation accumulated at inspection ports such as BS&W (Bottom Sediment & Water) bowls and CMPs (Condition Monitoring Pods) can be observed while the asset is in service. Generally, these visual inspections only work to identify adhesive wear during the later stages of wear to due incipient wear often being smaller than the human eye can observe. During visual inspections it is imperative for the observer to specifically look for noticeable wear on the machine surfaces in question and report any noted visible anomalies so that detailed planning and action can be promptly initiated if necessary. It is always good practice to incorporate machine surface inspections during outages and turn arounds as a failsafe if other indicators or analysis has been overlooked or omitted.

Borescope inspection are another visual analysis tool that should be utilized to look for adhesive wear generation. This advanced visual inspection will provide much greater detail on any related concerns and will provide insight to adhesive wear much earlier in the generation process. The use of this analysis and inspection tool is often triggered in response to a noted concern during predictive maintenance such as vibration or oil analysis but can be utilized as a stand-alone tool during scheduled downtime.

Vibration analysis is another option commonly utilized for detection of wear development and generation. While traditional vibration analysis will provide awareness of wear and failure related concerns further along in the process, high-frequency analysis focused on impacting may aid in obtaining valuable information during the earlier stages of surface wear development.

Oil analysis can also aid in the identification of adhesive wear. While early detection of adhesive wear is not commonly distinguished in particle population growth due to limited release of surface material in the initial stage of wear generation, there are additional measures within oil analysis that may provide indications of the increase potential for adhesive wear to occur. One specific parameter worth observing is the trending of wear and friction control additives. While this task can sometimes be difficult due to certain elements showing up as both additive packages as well as contaminants in the system the case for doing so cant still be made. If there is a sound understanding of the asset at hand and oil analysis in general, identifying the loss of the wear and friction control additives in the system that may forecast the initial advancement of adhesive wear debris can still be done. As advanced adhesive wear generation begins to increase in the asset, prized information obtained through spectrometric analysis, particle counting, moisture analysis, patch testing, ferrous density, and analytical ferrography will provide specific detail with regards to the volume, size, shape, and potential source of the issue.

It is essential to note that all detection analysis methods have their place and utilizing multiple analysis tools will aid in identifying and validating concerns throughout this process.



Normal Mild/Wear | Moderate Wear | Excessive/Extreme Wear

Figure 2: Examples of surface wear progression

Prevention

As reliability professionals, we need to have a sound understanding of wear generation, why it arises, and how to address or minimize its occurrence. As we have already noted in the sources section of this article, adhesive wear is generally caused by over or under-loading and improper lubricant selection. Properly identifying loading concerns during the installation phase and utilizing the correct lubricant makeup that takes into account the application, film thickness, temperature, surface stressors, and environment will make a strong case for minimizing the concerns of adhesive wear generation. Furthermore, identifying moisture ingression, addressing alignment concerns, and properly monitoring the asset through the detection and analysis methods noted will provide additional support to minimize the chance of this problem occurring during operation. *ML*

References

- Noria Corporation Oil Analysis III Training Manual. Tulsa, OK: Noria Corporation
- W.F. Gale and T.C. Totemeier. Smithells Metals Reference Book (8th Edition), Butterworth-Heinemann, 2004
- https://onyxinsight.com/wind-turbine-failures-encyclopedia/bearing-failures/adhesive-wear/
- https://www.tribonet.org/analyzing-the-evolution-of-adhesive-wear/
- https://www.wmv.nl/adhesive,_abrasive_and_tribo_oxidative_wear_prevention.htm
- Trevor M. Hunt. Handbook of Wear Debris Analysis and Particle Detection in Liquids, Elsevier Science Publishers LTC, 1993
- Noria Corporation Wear Particle Atlas, Noria Corporation, 2012

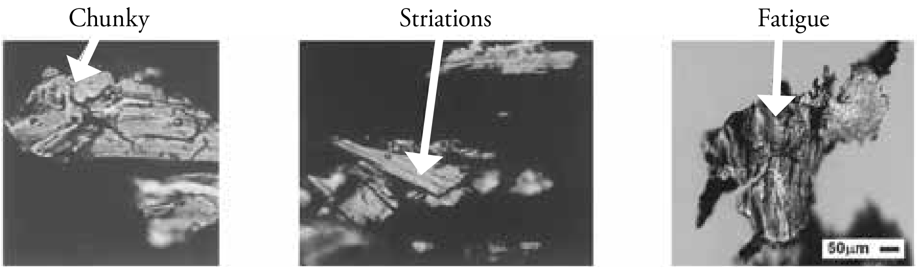


Figure 3: Examples of adhesive wear particles

About the Author

Matthew Adams is a technical consultant for Noria Corporation, concentrating in the field of predictive maintenance. He has experience in multiple condition-based maintenance technologies and focuses the majority of his attention on lubrication program development, training and general consulting. Matthew holds a Machine Lubricant Analyst (MLA) Level III certification and a Machinery Lubrication Technician (MLT) Level I certification through the International Council for Machinery Lubrication (ICML). Contact Matthew at madams@noria.com to find out how Noria can help you maintain the compressors at your facility.

TEST YOUR KNOWLEDGE

This month, *Machinery Lubrication* continues its "Test Your Knowledge" section in which we focus on a group of questions from Noria's Practice Exam for Level I Machine Lubrication Technician and Machine Lubricant Analyst. The answers are located at the bottom of this page. The complete 126-question practice test with expanded answers is available at store.noria.com.

1. Which maintenance strategy employs condition monitoring to detect early-stage failures with the repair or replacement of the asset scheduled based on this condition?

a) Reactive
b) Preventive
c) Predictive
d) Proactive

2. Slow speeds, high loads, shock loads and machine stops/starts can all cause what form of lubrication?

a) Boundary Lubrication
b) Hydrodynamic Lubrication
c) No Lubrication happens during these conditions
d) Particle Lubrication

3. What is the term used to define the measure of a fluid's internal resistance to flow?

a) Shear
b) Viscosity
c) Back Flow
d) Friction

4. The primary reason that machinery is replaced is due to:

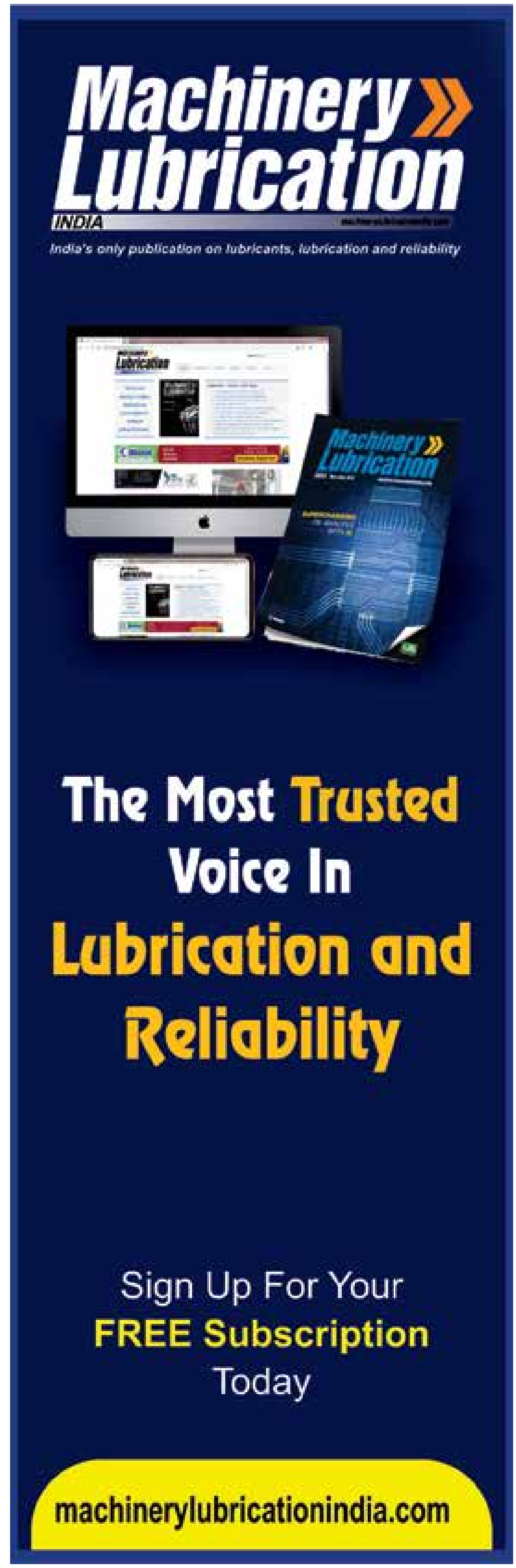
a) Erosion
b) Accidents
c) Obsolescence
d) Surface Degradation of the Metal
e) Corrosion

5. For a typical hydraulic fluid, how full should a sample bottle be filled with hydraulic fluid?

a) 50%
b) 75%
c) 90%
d) 100%
e) Doesn't Matter

ANSWERS

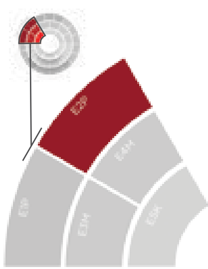
1.C 2.A 3.B 4.D 5.D



Paul Farless | Noria Corporation

THE DOs AND DON'Ts OF USED OIL

More about this
ASCEND™ Factor



Factor:
E2P – Storage & Disposal of Used Oil & Materials

Level:
Platform (P)

Stage:
Energy Conservation, Health & Environment

About:
Used oil, lubricants and other contaminated materials should be stored in accordance with laws and regulations while incorporating Reuse, Reduce and Recycle methodology to minimize environmental impact.

Learn More:
noria.com/ascend/

First and foremost, I want to make something clear: USED oil and WASTE oil are not the same. According to the Environmental Protection Agency (EPA), used oil is defined as any oil, either synthetic or refined from crude oil, that has been used and, as a result of such use, is contaminated by physical or chemical impurities. Waste oil, on the other hand, is any oil that has been mixed with a known hazardous substance such as glycol (antifreeze) or kerosene. Animal and vegetable oils are excluded from the EPA's definition of used oil, but they are considered waste oil when they are utilized as a lubricant. This article will focus on used oil, with the objective being to educate lubrication and reliability personnel about what to do (and what not to do) with it. Establishing proper procedures in this department is crucial to upholding environmental integrity and a safe work environment.

RECYCLE AND CONSERVE

When it comes to a precious resource like oil, we need to make every effort to recycle whenever possible. There are several efficient ways to turn used oil into usable oil again; for example, some oils can be cleaned and re-used through filtering or reconditioning. Utilizing a dedicated filter cart is a great way to recondition a used oil to prolong its life and save costs along the way. There is also the practice of re-refining used oil to use as a base stock for new lubricating oils.

In some instances, used oil can be repurposed. A common example is recycling oil to be used for gasoline and coke production through a petroleum refinery. Recycled oil is also used for energy recovery: water and particulates are removed, and the remaining oil is burned as a fuel source for energy production. Although this is an efficient way to repurpose used oil, it is not always preferred because you're only getting one re-use out of the oil. Once it is burned, it's gone.

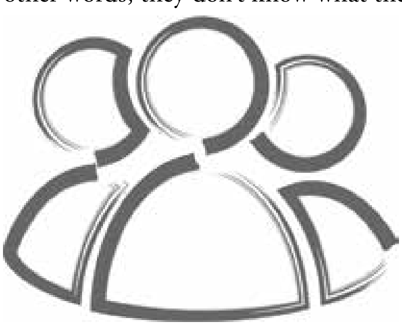
STORAGE AND HANDLING OF USED OIL

I prefaced this article by differentiating between waste oil and used oil because we often see used oil being wasted when it isn't necessary. I'm not saying we've seen people dumping out oil, but not knowing the difference between waste and used oil can result in unnecessary disposal — this is where used oil storage and handling comes in.

Collecting the used oil is the first step, but proper storage and handling should be the key focus. Start with labeling — ensure that the oil containers are properly labeled and conspicuously marked as "USED OIL" or "WASTE OIL." Next, ensure that the new oil containers are separated from each other and far away from any new lubricants to avoid potential cross-contamination. Anytime personnel are working with or near waste oil and used oil, good handling practices are crucial for a safe and contaminant-free lubrication environment. Improperly handling waste oil can potentially be a hazard, depending on what contaminant or exposure caused the oil to become waste oil. Used oil is less of a safety hazard but is still dangerous due to weight, transport and spill potential.

TRAINING

When it comes to lubrication, some people are unconsciously incompetent. In other words, they don't know what they don't know. So, a good fundamental knowledge of lubrication is priceless. Noria's Machinery Lubrication Fundamentals or Introduction to Lubrication Fundamentals online training courses (available at store.noria.com/online-training) are great ways to get started on the path to safe and efficient used oil practices. **ML**



KEY TAKEAWAY

DO'S AND DON'TS

1. DO RECYCLE USED OIL IF POSSIBLE. CONSERVE WHAT OIL YOU CAN; IT IS A PRECIOUS RESOURCE.
2. DO STAY VIGILANT OF YOUR SURROUNDINGS WHEN HANDLING USED AND WASTE OIL.
3. DO RECONDITION USED OILS WITH A DEDICATED FILTER CART OR OTHER SIMILAR DEVICES.
4. DO SEEK OUT TRAINING AND EDUCATION TO ASSIST PROGRESS IN THE LUBRICATION PROGRAM AS FAR AS USED OIL PRACTICES ARE CONCERNED.
5. DON'T WASTE USED OIL. DO LABEL USED OIL CONTAINERS SO THAT NO ACCIDENTAL WASTE HAPPENS.
6. DON'T STORE USED AND WASTE OIL NEAR NEW LUBRICANTS TO PREVENT POTENTIAL CROSS-CONTAMINATION.
7. DON'T HANDLE ANY LUBRICANTS WITHOUT THE REQUIRED PPE. DO FOLLOW ALL FACILITY SAFETY REGULATIONS WHILE DOING SO.

Travis Richardson | Noria Corporation

Lubricant Environmental Compliance

"Put plainly, they are distinct, and each term has a specific definition."

When comparing multiple assorted products these days you might read about the different ways in which they might affect the environment. Many companies are even highlighting through their advertisements that their products are "green" or eco-friendly. Terms such as biodegradability, Environmentally Acceptable Lubricants (EAL), or Environmentally Friendly Lubricants (EFL) might be used to describe a lubricant's effect on the environment. When reading about terms like these you might wonder; are they all referring to the same thing or do they each have their own meaning? Put plainly, they are distinct, and each term has a specific definition. To get a better perspective on the meaning of the above-mentioned terms, we will examine the standards that must be met for lubricants used over water. Since extreme care must be taken when using lubricants over water, this is a good place to start.

Vessel General Permit

The Vessel General Permit (VGP) is a Clean Water Act National Pollutant Discharge Elimination System permit that authorizes, on a nationwide basis, discharges incidental to the normal operation of non-military and non-recreational vessels greater than or equal to 79 feet in length. This permit covers 26 distinct types of discharges that could potentially pose a threat to the aquatic ecosystem. The VGP includes a set criterion that lubricants must meet to help reduce this threat. I don't want to get too far into the weeds on this permit, but it does go into detail about describing the above-mentioned terms and how they relate to lubricants.

Environmentally Acceptable lubricants

In the VGP, EALs are described as lubricants that have been shown to meet standards for biodegradability, toxicity, and bioaccumulation potential that minimize the adverse consequences they are likely to have on the aquatic environment compared to normal lubricants. While EFLs are often defined as lubricants that may be expected to have desirable environmental qualities, they have not been proven to meet these standards. In short, EALs are lubricants that have passed the test to establish that they meet certain defined requirements while EFLs are lubricants that might have some good environmental qualities but may or may not meet the standard. Now that we know the difference between EALs and EFLs, let's examine some of the standards that must be met to qualify a lubricant as an EAL.

To lower the threat in an aquatic environment, the chemical compound the lubricant started out as must be able to be broken down. Biodegradability is the measure of this breakdown by microorganisms, and it plays a big part in EALs. There are two types of biodegradation: Primary and Ultimate. Primary biodegradation is breaking off a piece of the chemical compound's make-up. When this happens, the chemical compound can no longer perform the function it was created to do. Ultimate biodegradation is the complete breakdown of a chemical compound into carbon dioxide, water, and mineral salts. Primary and Ultimate biodegradation together can be classified as the physical breakdown of the lubricant. The method in which the breakdown occurs is classified as Inherent biodegradation and is determined by the compound's ability to break down in any number of biodegradability tests. In addition, a lubricant is said to be Readily biodegradable where a part of the compound is biodegradable within a specific time using a specific test method. To be classified as an EAL, a lubricant must contain a certain percentage of readily biodegradable material.

Due to the potential for harm to plants and wildlife in the water, an EAL must have low toxicity. There are a few distinct types of aquatic toxicity tests that can be performed, some are done to determine the lubricant's toxicity to fish while others are used for plants. These tests range in length from 48 -96 hours Rather than a passing or failing grade, the results of the test are typically displayed as either high or low toxicity. If we were going to look at toxicity levels of different lubricating base oils from high to low it would be as follows; mineral oils, Polyalkylene Glycols (PAG), synthetic esters, and vegetable oils.

Bioaccumulation

Bioaccumulation is the gradual accumulation of substances like a lubricant's constituent chemicals in an organism. In EALs it is desirable to have an extremely low bioaccumulation potential, as this will enable the lubricant's compounds to break down at a faster rate. Compounds like mineral oils that have a higher potential for bioaccumulation can cause more harm. Because they don't readily break down, the compounds in these lubricants stack up over time and create a cumulative threat to the environment. Also, worth noting is that water solubility and bioaccumulation are inversely related; if the water solubility of a lubricant is high the rate of bioaccumulation will be low.

While the use of lubricants on vessels is unavoidable, the VGP helps reduce the negative effects that can be posed to the aquatic environment. By examining the chemical makeup of the allowable lubricants and identifying a set of standards that these lubricants must meet, their potential for harm has been lowered. The VGP was created to help govern vessels over water, but it also serves as a good reference point to learn more about EALs in general. *ML*

About the Author

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

Preeti Prasad | Tehchnical Consultant

WHERE IS THE GAP? KNOWLEDGE OR MINDSET

There is a famous quote by Jim Rohn "Successful people do what unsuccessful people are not willing to do. Don't wish it were easier; wish you were better.". And this quote is not only for people, but more applicable for the entire management team of any industry or company's thought process.

Some companies talk about industrial 4.0, Reliability centered maintenance, Real-time information, and many advanced technologies to improve equipment reliability through lubrication maintenance. Whereas there are also companies which treat lubrication as the least important segment, and they still follow substandard/historical lubrication practices just to "fill and forget" the machines.

In this article, I would like to share my personal experience on a later one.

I was in my hometown a couple of months ago, where I got an opportunity to visit a nearby open cast mining site. Though I grew up in a mining town but had never seen a mine though the eyes of a lubrication specialist.

Let me just give a brief of this visit

(Lubrication Audit). The main objective of the lubrication audit was to find the gaps between current vs standard practices which gives a holistic picture of the lubrication management, organization's awareness on contamination, and proactive approach to control it. The audit includes some of the undermentioned points:

- What quality checks are undertaken at the time of reception of oil?
- Storage of oil – outdoor or indoor and with right practices.
- Methods or tools for lubrication handling i.e. top-up containers, grease guns, etc.
- How are lubricants identified?
- Condition of Lube room to prevent contamination.
- Machine modification for easy visual inspection.
- Sampling methods & data recording process.
- Lube room management
- Oil renewal (contamination removal) of lube oil .
- Contamination exclusion strategies.
- Environmental disposal of used oil.
- Oil condition monitoring.
- Lubricant validation & consolidation
- And many more…

With this audit & recommendation, one can identify the areas for improvement or continue the right practices with a more strategic approach.

Now coming to my audit, I started with the area which is treated as "Kitchen of Lubrication Management". What do you see in image 1- a lube room or lube disposal room?

It's only a closed room which is named as Oil Storage and serves both the purpose. Different grades of in-service oil like Hydraulic, Gear oil, Coolant, Transmission oil, Engine oil, Grease, etc. were present there. Also, a few old and damaged barrels were kept in a corner of the room for disposal, spilling dirty oil on the floor.

The condition of the oil storeroom was extremely bad and hazardous. A small spark could lead to a major fire accident. Lack of awareness was clearly visible like oil-soaked floor, poor ventilation, dust & dirt on barrels, a leaking roof allowing rainwater seepage, single barrel pump for all lubricants, galvanized and substandard top-up containers, Uncovered Grease barrels, No fire safety equipment, and many more. Let us have look at images 2 & 3:

I spoke to a senior official of that mining company and shared my concern about the situation at their site and how the poor lubrication management can impact their machinery health, the equipment uptime, the environment and several other aspects. Based on my observation, I briefly suggested a few basic points as listed below:

- Firstly, to make a dedicated lube room where only fresh oil & accessories should be stored.
- Discard empty, used, and damaged barrels from the room.
- Introduction of LIS (Lubrication Identification System)
- Repair & painting of walls & roof.
- Dedicated barrel pump for different oil types.
- Dedicated & standard oil top-up containers
- The practice of color-coding the accessories
- Arrangement of fire extinguishers & alarms, etc.
- Usage of filter carts
- Provision of ventilation system & adequate lights, etc.
- Proper housekeeping

In no uncertain words, I told them "You don't need to make a World Class Lube room but at least give a class to your Lubes".

After an hour of discussion, the response I got from the official was disappointing. He said "Why would I do so much when I know that I will be transferred out by next year? And my senior will retirement in the next couple of years. Nobody is going to take care of this after we leave. Then why do so much work and additional investment. We have also not faced any major problem with contamination. The dust particle usually gets settled at the bottom of the drum and we discard the barrel by that time oil reaches the bottom, so basically, we use only clean oil from the top. We keep the oil storage room locked mostly so chances are also low for dust & dirt. We do a time-based change of oil in machines. We do conduct some basic oil analysis but that is mostly for keeping audit objections away. The dust in open cast mines is so high that no amount of filtration can help." And many other excuses because he felt that focus on lubrication was a waste of time and money.

Though in his heart he was convinced that my suggestions would result in a huge benefit for the mining company, still the inertia of bringing about the change was compelling him to deny the benefits of the change.

This is when the heading of the article comes to my mind - "Where is the Gap? Knowledge or mindset…I was trying to share as much knowledge I could, but the other person was reluctant to believe anything because of the mindset that the mine has been running for the last many years and nothing major has happened due to lubrication. Contamination is no big deal for them. This is not the thought of any individual, but the entire organisation. Perhaps the sad fact of many industries which are not assertive to adopt any change in their historical wrong practices. And again, a question arises "Why so?" It is likely due to lack of rewards system or appreciation for the new initiative, Unsupportiveness for any investment from the company, a fear of "what if something went wrong"………

I am ending this article with a question for you all the readers :

"How can we bridge the GAP?" and encourage a revolution of Achieving Reliability through Lubrication.

About the Author

Preeti Prasad (MLA/MLT-1) is a Technical Consultant in the field of Lubrication Reliability. A chemical engineer with work experience in O &G and providing lubrication consultancy services to various companies/sectors.

Preeti may be contacted on preetiprasad25@gmail.com

Kumbhar Keeps Lubrication on Track at JSW Steel

Name: Sachin Kumbhar
Age: 34
Job Title: Mechanical Maintenance Engineer
Company: JSW Steel Ltd
Location: Dolvi India Mumbai
Length of Service: 14 years

With 14 years under his belt at JSW Steel Ltd., Sachin Kumbhar has a vested interest in the company's lubrication program. Realizing that lubrication is the life-blood of the facility's machines, Kumbhar has actively furthered his own technical knowledge while keeping JSW Steel's lubrication program on track.

Q: How long have you worked for your company and which positions have you held?

A: I have been working with JSW Steel since 2006. I am presently working as the Assistant Manager, Mechanical Maintenance.

Q: What other companies have you worked for and which positions did you hold?

A: Ispat Industries Limited

Q: When did you get your start in machinery lubrication and how did it happen?

A: I came across machinery lubrication when I was reading articles on lubrication on the internet.

Q: What types of training have you taken to get you to your current position?

A: I have taken lubrication training, and training on bearings and its lubrication at the SKF Training Center.

Q: What professional certifications have you attained?

A: SKF Bearing & Lubrication

Q: Are you planning to obtain additional training or achieve higher certifications? If so, why and which ones?

A: Yes, I think staying updated and upgraded keeps me active and helps my performance at my organization.

Q: What's a normal workday like for you?

A: Each day is learning on the shop floor.

Q. What is the amount and range of equipment that you help service through lubrication/oil analysis tasks?

A: At JSW Steel Dolvi Work's Steel Melt Shop, we have customized bearings for our critical equipment's gantry and top lance.

Q. What lubrication-related projects are you currently working on?

A: We are working on fixing the auto lubrication system for one of our top lance equipment which is one of the most critical pieces of equipment.

Q. What have been some of the biggest project successes for which you've played a part?

A: Erection and commissioning of an auto lubrication system and consistent equipment reliability, and all auto lubrication systems at the Steel Melt Shop.

Q: How does your company view machinery lubrication in terms of importance and overall business strategy?

A: With the largest product portfolio in steel, JSW Steel Dolvi Works is India's largest steel exporter, shipping to more than 100 countries across 5 continents. Over the last 35 years, we have been at the forefront of science and cutting-edge technology … and we are just warming up. Machinery lubrication plays a crucial role in terms of achieving production. JSW Steel Dolvi is a well-cultured organization in lubrication systems and has set a trend in lubrication systems.

Q: What do you see as some of the more important trends taking place in the lubrication and oil analysis field?

A: Predictive Maintenance related equipment is definitely helping.

Q: What has made your company decide to put more emphasis on machinery lubrication?

A: A lubrication system is considered the life blood of a plant's equipment. At JSW Steel Dolvi Works, lubrication is given a top priority which is evident by the machinery lubrication system in one of our most critical departments, the Steel Melt Shop. The upkeep of the equipment's lubrication system has raised equipment reliability and helped improve production. ***ML***

Be Featured in the Next 'Get to Know' Section

Would you like to be featured in the next "Get to Know" section or know someone who should be profiled in an upcoming issue of *Machinery Lubrication* magazine? Nominate yourself or fellow lubrication professionals by emailing a photo and contact information to **editor@noria.com.**

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

Failure Triage Classifications (3 Tees)

- Trivial – incipient (about to occur)
- Treatable – impending (is occurring)
- Terminal – catastrophic (has occurred)

We know that when critical failures occur, every effort should be made to prevent repeat performances. Yet, without an intervention to remove the underlying root cause, a recurrence is almost guaranteed. Maintenance organizations should consider failure investigations as seriously as they do immediate repair. Yet all too often, once production is restored, the urgency and memory of the failure begins to fade.

Ferrous Density Meters and Canaries

Ferrous density meters can foretell disastrous events just like canaries in a coal mine. These instruments can often save a machine from sudden operational failure. Their role is to monitor the density of a single type of wear metal commonly found in oil or grease: cast iron or low-alloy steel. Such common metallurgy is deployed in a wide range of frictional machine surfaces including bearing rolling elements/raceways, gears, pistons/cylinders, cams/followers and many others.

Hope to Inspect a Gearbox

Although a comprehensive on-site gearbox inspection is desirable in many situations, there may be constraints that limit the extent of the inspection such as cost, time, accessibility and qualified personnel. Quick but effective gear inspections:

- Visual: pitting, scratch marks, polishing, etc.
- Touch: shelf formation
- Measure: backlash with feeler gauge
- Debris: magnetic probe or BS&W

The Destructive Potential of Engine Oil

It only takes one liter of engine oil to destroy the demulsibility of 6000 liters of turbine oil. Lubricants that require good demulsibility (water separation) should never be mixed with lubricants that contain dispersants or high concentrations of detergents. Small amounts of oil with good emulsion characteristics will destroy the water shedding properties. Rarely can the demulsibility be restored. ***ML***

Did You Know?

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

Have Some Tips?

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

MAK Lubricants – 'Lubricating the Future of Mobility'

Bharat Petroleum Corporation Limited (BPCL), a 'Maharatna' and a Fortune Global 500 Company has introduced four new MAK lubricant products. Each product is designed to enhance performance, reliability, and durability for customer use. The New range of MAK lubricants were launched in presence of Shri V.R.K. Gupta, Director Finance, Smt. Meenaxi Rawat IES, CVO, Shri Sanjay Khanna, Executive Director Refineries, Shri G. Krishnakumar, ED Lubes and other officials of BPCL.

Commenting on the new products launched, Mr. G. Krishnakumar, ED Lubes BPCL said "We are extremely delighted to launch these five new MAK products that reflect our company's focus on innovation, sustainability, and dynamic product offerings. At BPCL, we have always provided our customers with high quality products and services consistently. Continuing to create new values for customers and our belief that the future of mobility is EV, with the correct use of products, we aim to continue to create meaningful experiences for our customers."

After recently launching southern India's first EV Fast-Charging corridors on Chennai-Trichy-Madurai Highway, BPCL's MAK lubricants launches MAK e-Drive, a premium quality synthetic driveline fluid specifically developed to meet the special requirements of Electric Vehicles (EV's). MAK e-Drive is formulated with synthetic base oil and an advanced additive technology that ensures gear protection and compatibility with various materials used in EV powertrain.

The second lubricant named MAK e-Kool, is a long-life Anti-freeze coolant concentrate, used in indirect cooling of battery packs of BEV (battery operated electric vehicle

Eco-friendly products are no more a choice, but a future necessity. Owning the responsibility MAK Eco-Mini has also been introduced. The eco-friendly engine oil is suitable for mini-truck & light commercial vehicles working on Diesel or CNG as fuel.

MAK has also launched MAK Chain Spray Oil and MAK Multipurpose Spray. The chain spray adds to the better performance of motorcycles and is especially recommended for chains in high-performance motorcycles. The multipurpose spray marks the entry of MAK into the household of consumers catering to their requirements eliminating squeaks, and easing household machines.

Noria Skill Training

Lubrication Institute
www.lubrication-institute.com

Noria Skill Certification
Live Online Training

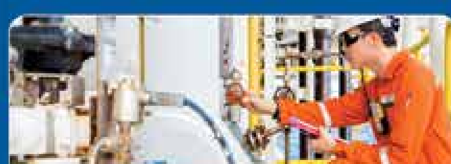
Expand your skills from the convenience of your home or office with Noria's Live Online Training. Featuring the same benefits of live Instructor interaction and the convenience of learning in a comfortable setting, Live Online Training is conducted by industry experts with years of experience.

Machinery Lubrication Level - I (MLA I / MLT I)

MAY 17-19th | OCTOBER 18-20th

Oil Analysis Level - II (MLA II) Ferrography and Interpretation

JUNE 14-16th | DECEMBER 13-15th



Machinery Lubrication Engineer (MLE)

AUGUST 22-26th

Machinery Lubrication Level - II (MLT II)

JULY 26-29th

Oil Analysis Level -III (MLA III)

SEPTEMBER 20-23th

+91-9431117604 | E-mail : info@lubrication-institute.com | Website : www.lubrication-institute.com